March 1, 1955 O. C. CLIFFORD, JR 2,703,144

REMOVABLE PACKER FOR WELLS

Filed June 9, 1951

2 Sheets-Sheet 1

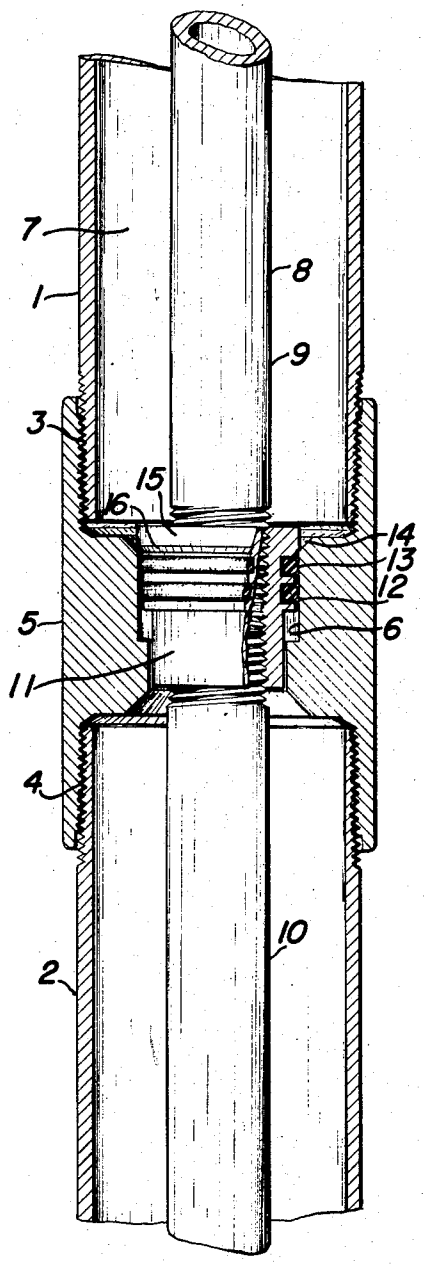


Fig. 1.

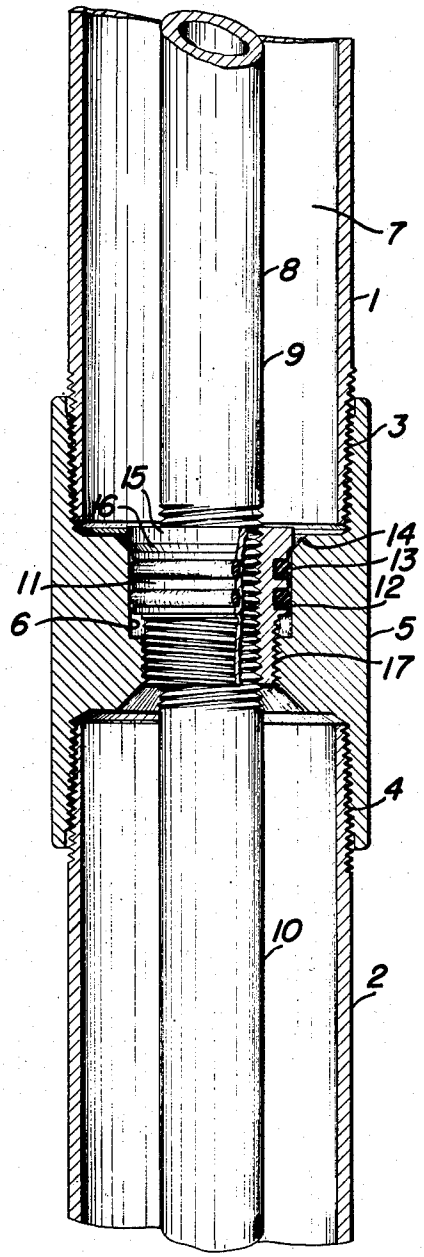


Fig. 2.

ATTEST

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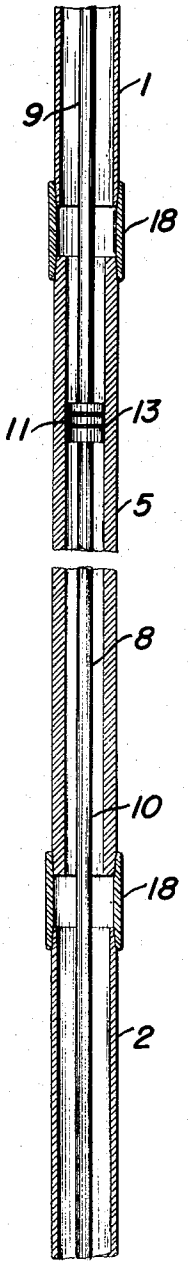


Fig.3

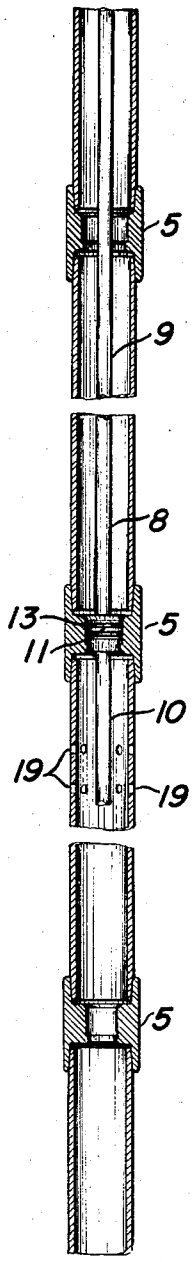


Fig.4

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REMOVABLE PACKER FOR WELLS

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6 Claims. (Cl. 166—115)

This invention relates to improvements in well packers, and more particularly to a removable type packer which is not susceptible to leakage under high pressures for providing a seal at a desired position in an oil or gas well.

In oil field practice, it is conventional procedure to produce oil or gas from a reservoir through a production tubing disposed within a well casing lining the bore hole wall. A packer usually is provided adjacent the lower end of the production tubing for sealing the annular space between the casing and the production tubing, thereby to direct well fluid into the latter.

Heretofore many different types of packers have been designed and employed for this purpose. Substantially all of such packers include a resilient packing element usually formed of rubber and having an external diameter considerably less than the internal diameter of the casing, whereby the packer may be lowered into the well on the tubing string without damage to the packing element. When the packer is located at the desired position the resilient packing element is expanded into sealing engagement with the casing by any one of numerous well known methods. In all of these packers, heretofore known, the packing element is required to be expanded a considerable amount in order to effect the desired seal with the casing wall because of the necessity of allowing an appreciable clearance between the casing and packing element prior to expansion of the packing element so as to avoid damage to the latter during the running of the packer into the well. Because of this, the relatively high pressures normally acting on the packer cause the resilient packing element to extrude between the casing and the packing element retainer, thereby permitting leakage of fluid past the packer.

To avoid these difficulties, attempts have been made to reinforce the packing element with wire, metal supporting shoulders, or other similar means. Although this has resulted in somewhat improved performance, many of these heretofore known packers are still susceptible to leakage.

Accordingly, it is one object of this invention to provide an improved packer of the removable type for oil and gas wells which will overcome the above mentioned difficulties.

Another object is to provide a removable well packer constructed and arranged so that extrusion of the resilient packing element under high pressures substantially will be prevented, thereby eliminating, or reducing to a minimum, leakage of fluids past the packer.

A further object is to provide such a well packer for providing a seal at a desired position in a well including an outer conduit and an inner conduit disposed in the outer conduit, and wherein a coupling member having a longitudinal bore of a diameter less than that of the outer conduit is connected in the latter at said position, thereby providing a sealing surface for a resilient packing element; and wherein a retainer member carrying a resilient packing element is connected in the inner conduit and is adapted to pass into said coupling member with only a close clearance therebetween and with the packing element in sealing engagement with the sealing surface.

An additional object of the invention is to provide apparatus for selectively providing a seal at any one of several positions in a well including an outer conduit and an inner conduit disposed in the outer conduit, the inner conduit being adapted to conduct fluid from the well, and wherein a coupling member having a longitudinal bore of a diameter less than that of the outer conduit is provided in the outer conduit at each of said positions, thereby providing a plurality of sealing surfaces for a resilient packing element; and wherein a retainer member carrying a resilient packing element is connected in the inner conduit and is adapted to be passed selectively into the coupling members with only a close clearance therebetween and with the packing element in sealing engagement with the sealing surface.

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

Figure 1 is a fragmentary, elevational view, partially in section, showing a well packer constructed in accordance with this invention in sealing position within a well.

Figure 2 is a fragmentary, elevational view, partially in section, showing a packer similar to that of Figure 1 with threads for maintaining the packer in sealing position.

Figure 3 is an elevational view, partially in section, showing another embodiment of the invention wherein the packer is shown in combination with a coupling member having a longitudinal bore of a diameter less than that of the outer conduit for providing a sealing surface for the packing element of the packer.

Figure 4 is an elevational view, partially in section, showing apparatus, constructed in accordance with this invention, for selectively providing a seal at any one of several positions in a well.

Broadly, this packer for providing a seal at a desired position in a well including an outer conduit and an inner conduit disposed in the outer conduit in a manner so as to provide an annular space therebetween, the inner conduit being adapted to conduct fluid from the well, comprises a coupling member having a longitudinal bore of a diameter less than that of the outer conduit and connected in the latter conduit at the desired position, thereby providing a sealing surface for a packing element. A retainer member carrying a resilient packing element is connected in the inner conduit and is adapted to pass into said coupling member with only a close clearance therebetween and with the packing element in contact with the sealing surface.

The invention further contemplates apparatus for selectively providing a seal at any one of a plurality of positions in such a well. This apparatus includes a coupling member having a longitudinal bore of a diameter less than that of the outer conduit and connected in the outer conduit at each of said positions thereby providing a series of sealing surfaces for a resilient packing element. In the inner conduit is connected a retainer member carrying the resilient packing element and adapted to be passed selectively into the coupling members with only a close clearance therebetween and with the packing element in sealing engagement with the sealing surface.

Referring to the drawings, and at this time particularly to Figures 1 and 2, numerals **1** and **2** denote generally successive sections of an outer conduit or casing of a well threadably connected as at **3** and **4**, respectively, to a coupling member **5** having a longitudinal bore of a diameter less than that of the outer conduit. Coupling member **5** is connected in the outer conduit at the position in the well where it is desired to provide a seal. While it is preferred to make the inner diameter of coupling member **5** from ¼ to ½ inch less than the inner diameter of the outer conduit, this difference is not critical and may be made one inch or more depending upon the size of outer conduit employed. Further, although the coupling member **5** is shown in Figures 1 and 2 in the form of a coupling or collar the invention is not to be so limited but rather coupling member **5** may comprise a regular length of well casing having a reduced opening therethrough, as will be described in detail in connection with Figure 3 of the drawings. The inner wall **6** of coupling member **5** forms a sealing surface for the resilient packing element, as described hereinafter.

Disposed in the outer conduit in a manner so as to provide an annular space **7** therebetween, is an inner conduit generally denoted by numeral **8** for conducting

fluid from the well. Threadably connected, as shown, to successive sections 9 and 10 of inner conduit 8 is packing element retainer 11. Inner conduit section 10 serves as a tail pipe, but may be omitted if desired, and the well fluid passed directly through the axial opening of the retainer into section 9 of inner conduit 8. Preferably, retainer 11 is of a tubular configuration with one or more circumferential recesses 12 formed on the exterior thereof to receive the resilient packing element. As shown, the packing element in the preferred embodiment of the invention consists of one or more O rings 13, each of which is retained in one of the recesses 12. While only two O rings are shown in the drawings, the invention is not to be so restricted and three or more may be employed if desired. The retainer 11 is formed so that it may be passed into coupling member 5 with only a close clearance such, for example, as 1/16 inch therebetween and with O rings in contact with the sealing surface or inner wall of the latter whereby the desired seal in annular space 7 is provided upon distortion of the O rings by fluid pressure to cut off communication between the portions of the outer conduit above and below the packer. The pressure of fluid in annular space 7 acting on O rings deforms the same, thereby providing a tight seal with the sealing surface of coupling member 5.

It is to be noted that a bevel 14 is provided at one end of coupling member 5 for directing retainer 11 into sealing position in the axial opening of coupling member 5. In the embodiment of the invention shown in Figures 1 and 2 shoulder 15, formed at the upper end of retainer 11 and having a complementary bevel 16 at its lower end for engagement with bevel 14, limits the downward movement of retainer 11.

In many cases in practice, the weight of inner conduit 8 is sufficient to maintain retainer 11 in sealing position in coupling member 5 against high pressures acting on retainer 11 from below the packer. However, where such pressures are usually high it may be necessary to provide additional means for maintaining the packer in sealing position. This may be accomplished by means of cooperating threads 17 on coupling member 5 and retainer 11, as in the packer shown in Figure 2. It is to be understood, however, that any conventional devices or means for accomplishing this may be employed without departing from the spirit and scope of this invention. For example, on the inner conduit 8 conventional slips, not shown, may be provided for releasably engaging the wall of the outer conduit to prevent any relative movement between the inner and outer conduits after the slips have been set.

In operation, after the outer conduit or casing has been set in the well with coupling member 5 at the position where it is desired to establish a seal, inner conduit 8 carrying retainer 11 is lowered into the outer conduit until the retainer passes into coupling member 5 with O rings 13 in engagement with the sealing surface of section 5, whereby the desired seal is formed upon distortion of the O rings by fluid pressure. It is apparent that well fluids passing into the outer conduit through suitable perforations, not shown, below the packer will be directed into inner conduit 8 through which such fluids will be conducted to the well head. When gas lift valves, not shown, are employed in outer conduit 1, 2 above the packer for lifting well fluid to the well head, the lifting fluid may be injected into annular space 7 above the packer.

In Figure 3 there is shown another embodiment of the invention wherein the coupling member 5 takes the form of a regular length of well casing with a reduced inner diameter. Coupling member 5 is connected between successive casing sections 1 and 2 by conventional collars or couplings 18. It is apparent that the location of the seal may be varied by means of this construction over a range of about 30 feet, the nominal length of a casing section. In this embodiment, shoulder 15 of retainer 11 is eliminated and downward movement of the packer is limited by contact of tail section 10 of inner conduit 8 with the bottom of the well, or by slips, not shown, provided on the inner conduit 8 for engagement with the outer conduit.

It is one purpose of this invention to provide apparatus for selectively applying a seal at any one of a plurality of positions in a well. Referring to Figure 4, to this end a coupling member 5 having a longitudinal bore of a diameter less than that of the outer conduit is connected in the latter at each of such positions. The retainer 11 is then selectively passed into one of the coupling members 5 dependent upon the position at which it is desired to form the seal. It is apparent that location of the seal thereafter may be changed to another of such positions, as desired. In Figure 4, the inner diameters of the coupling members 5 are made progressively smaller beginning at the uppermost section and continuing successively to the lowermost one. It will be evident that the seal may be provided at any one of the positions of the plurality of coupling members 5 merely by selecting a retainer 11 having the proper outer diameter. As an alternative, the diameters of the longitudinal bore in the several coupling members 5 may be made equal and shoulder 15 of retainer 11 eliminated whereby the latter may be moved freely, if desired, from one coupling member 5 to another.

In operation of the apparatus shown in Figure 4, after the outer conduit or casing has been set in the well with the several coupling members 5 located at preselected positions, the inner conduit carrying retainer 11 adapted to pass into a selected one of the coupling members 5 with only a close clearance therebetween is lowered into the outer conduit until the retainer is in position in the selected coupling member with the O rings in sealing engagement with the inner wall thereof. With the apparatus in the position shown in Figure 4, fluid entering the outer conduit through perforations 19 is directed into inner conduit 8 through which the fluid is conducted to the well head. When it is desired to change the location of the seal, it is necessary only to pull the inner conduit 8 and replace retainer 11 with a similar retainer adapted to pass into the coupling member 5 at the new location with only a close clearance therebetween. The inner conduit is then run into the well again with the new retainer until the retainer is in position in the coupling member 5 at the new location.

While in the foregoing there has been shown and described the preferred embodiments of this invention, it is to be understood that minor changes in the details of construction, combination, and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as claimed.

I claim:

1. In apparatus for selectively providing a seal at any one of a plurality of positions in a well, in combination, an outer conduit in the well, an inner conduit disposed in the outer conduit so as to provide an annular space therebetween, the inner conduit being adapted to conduct fluid from the well and the outer conduit including a plurality of coupling members each having a longitudinal bore of a diameter less than that of the outer conduit at each of said positions, thereby each of said coupling members providing a sealing surface for a resilient packing element, a packing element retainer connected in the inner conduit and adapted to be passed through selected coupling members with only a close clearance therebetween and into one predetermined coupling member, and a resilient packing element carried by the retainer member for sealing engagement with the sealing surface of said one predetermined coupling member.

2. In apparatus for selectively providing a seal at any one of a plurality of positions in a well, in combination, an outer conduit in the well, an inner conduit disposed in the outer conduit so as to provide an annular space therebetween, the inner conduit being adapted to conduct fluid from the well and the outer conduit including a plurality of coupling members each having a longitudinal bore of a diameter less than that of the outer conduit at each of said positions and a shoulder above said longitudinal bore, thereby each of said coupling members providing a sealing surface for a resilient packing element and a support for the inner conduit, respectively, a packing element retainer connected in the inner conduit and adapted to be passed through selected coupling members with only a close clearance therebetween and into one of said coupling members so that a portion of said retainer abuts against the shoulder of said one coupling member whereby said shoulder supports said retainer and inner conduit, said retainer having an exterior annular surface with annular recesses therein, and resilient packing elements provided in the recesses of the retainer member for sealing engagement with the sealing surface of said one coupling member, the resilient packing element comprising O rings.

3. In apparatus for selectively providing a seal at any one of a plurality of positions in a well, in combination, an outer conduit in the well, an inner conduit disposed in the outer conduit so as to provide an annular space therebetween, the inner conduit being adapted to conduct fluid from the well and the outer conduit including a plurality of coupling members each having a longitudinal bore of a diameter less than that of the outer conduit at each of said positions, thereby each of said coupling members providing a sealing surface for a resilient packing element, a packing element retainer connected in the inner conduit and adapted to be passed through selected coupling members with only a close clearance therebetween, and into one of said coupling members, and a resilient packing element carried by the retainer member for sealing engagement with the sealing surface of said one coupling member, the diameters of the longitudinal bores of said coupling members being made progressively smaller from the uppermost position to the lowermost position to provide for the passing of said packing element through said selected coupling members.

4. An apparatus for providing a seal between a well casing and the tubing within the well casing comprising a plurality of coupling members located at a plurality of positions along the well casing, each of said coupling members having a longitudinal bore with a diameter less than that of said well casing to provide a sealing surface and a shoulder above the sealing surface, a packing element secured to said tubing and provided with a flange on top thereof and sealing means below the flange, said flange having an outside diameter less than the diameters of the longitudinal bores of selected coupling members but greater than the diameter of the longitudinal bore of a predetermined one of said coupling members whereby said flange will pass through the bores of said selected coupling members and engage the shoulder of said one coupling member to support the tubing and also to support the packing element in said one coupling member whereby the sealing means is held in sealing relationship with the longitudinal bore of said one coupling member and the sealing means does not lose its sealing properties by slippage because of the support of the tubing and packing element above said packing element.

5. The apparatus according to claim 4 wherein the diameters of longitudinal bores of the coupling members are progressively smaller going from the top of the well to the bottom whereby the diameter of the packing element and the flange thereof can be selected to correspond with the diameter of said predetermined coupling member and thereby provide a seal at the position of said predetermined coupling member.

6. An apparatus for selectively providing a seal at any one of a plurality of positions in a well comprising a well casing, tubing located concentrically within said well casing thereby providing an annular space between the well casing and the tubing, coupling members located on said well casing at each of said plurality of positions said coupling members each having a longitudinal bore less than that of the well casing at each of said positions thereby providing in each coupling member a sealing surface and a shoulder above said sealing surface, a packing element retainer connected on the tubing and adapted to pass through said well casing and through the longitudinal bores of all the coupling members which lie above a predetermined one coupling member, said packing element retainer having a flange on the top thereof and packing elements below said flange, said packing retainer and tubing being adapted to be supported by the said predetermined one coupling member by means of the flange of said packing element retainer resting on said shoulder of the predetermined one coupling member whereby the packing elements form a seal on the longitudinal bore of said predetermined one coupling member and the packing elements are prevented from losing their sealing properties by slippage because of the support of the packing elements and tubing immediately above the packing element.

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