

March 15, 1960

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2,928,469

WELL PACKER WITH EJECTABLE PLUG

Filed May 12, 1958

2 Sheets-Sheet 1

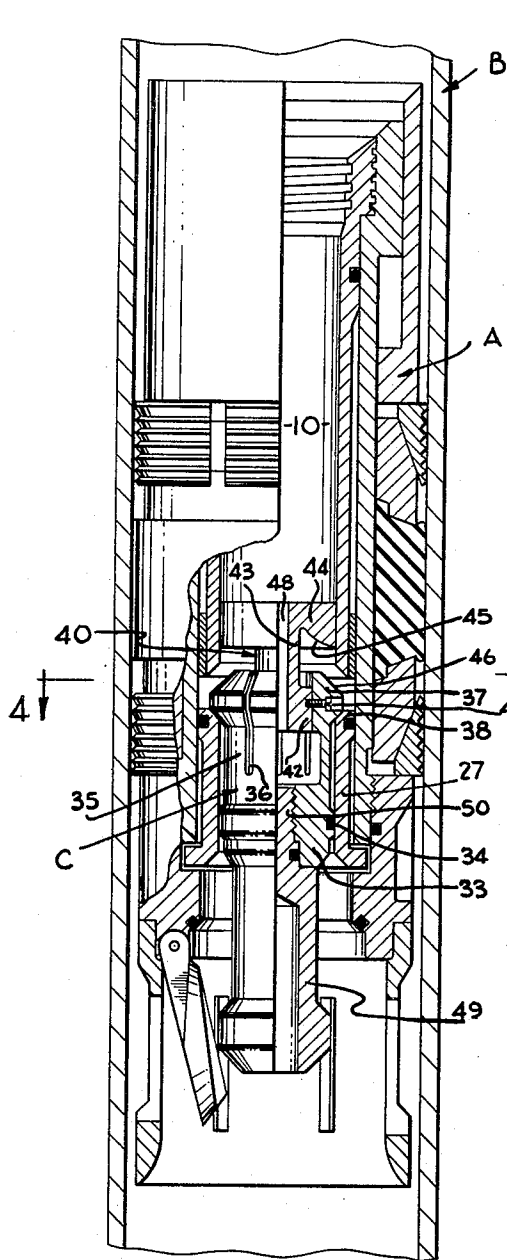


FIG. 1.

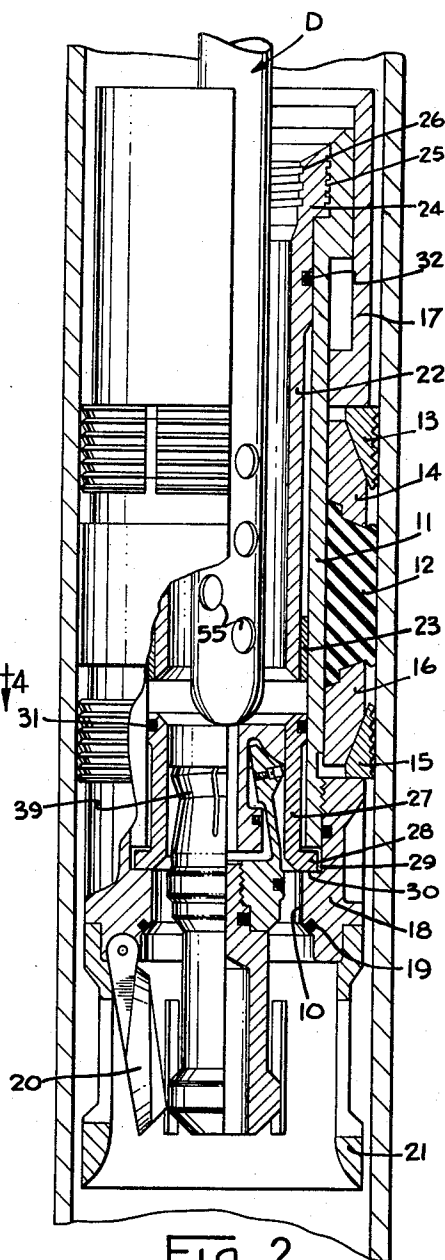


FIG. 2.

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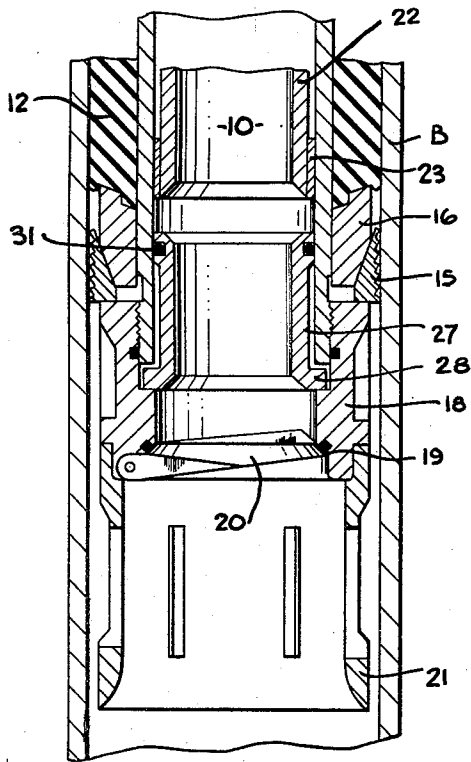


Fig. 3.

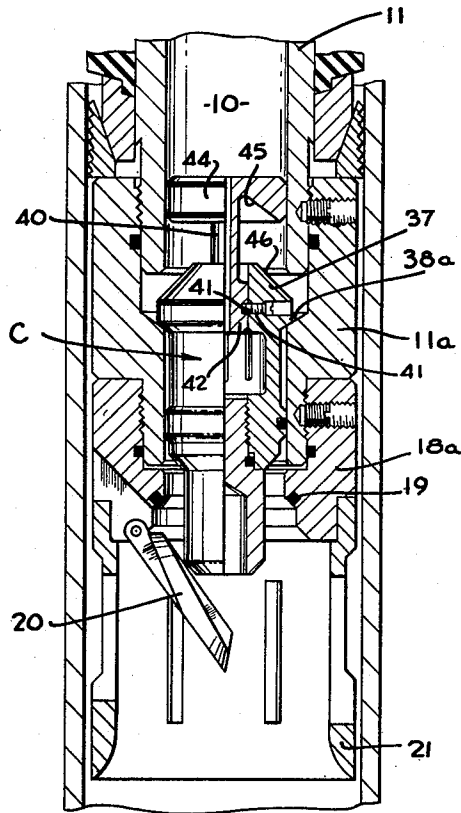


Fig. 5.

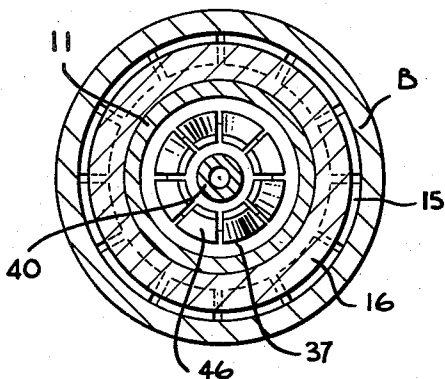


Fig. 4.

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WELL PACKER WITH EJECTABLE PLUG

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7 Claims. (Cl. 166—126)

The present invention relates to subsurface well equipment, and more particularly to well packers adapted to be set in well bores.

An object of the present invention is to provide a well packer adapted to be set in a well bore and capable of functioning as a bridge plug therein, and of later being converted into a packer having a passage therethrough, the conversion taking place while the packer remains in the well bore.

Another object of the invention is to provide a well packer initially embodying a plug device therein for enabling the packer to function as a bridge plug in the well bore, the plug device being readily and positively ejectable from the well packer when it is desired to open a passage through the latter.

A further object of the invention is to provide a well packer initially embodying an ejectable plug device therein so that the packer functions as a bridge plug, the plug device being capable of withstanding relatively high fluid pressures and of being easily ejected from the packer when its passage is to be opened.

An additional object of the invention is to provide a well packer initially operable as a bridge plug to withstand pressure differentials in the well bore above the packer, the packer being converted to a well production device having a passage therethrough as an incident of running production tubing through the packer.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several forms in which it may be embodied. Such forms are shown in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a combined longitudinal sectional and side elevational view of a well packer embodying an ejectable plug device therein;

Fig. 2 is a view similar to Fig. 1, illustrating the plug device being ejected from the packer;

Fig. 3 is a longitudinal section through the lower portion of the apparatus disclosed in Figs. 1 and 2 after the plug device has been ejected from the well packer;

Fig. 4 is a cross-section taken along the line 4—4 on Fig. 1;

Fig. 5 is a longitudinal section through the lower portion of a modified form of well packer, with an ejectable plug device therein.

A well packer A is illustrated in the drawings as being anchored in packed-off condition in a well casing B, or similar well conduit, this packer having a central passage 10 therethrough initially closed by an ejectable or expressible plug device C so that the well packer can function initially as a bridge plug. The well packer may be

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of any suitable form, the one specifically illustrated in somewhat diagrammatic fashion being more particularly shown and described in the patent to R. C. Baker, 2,703,623, patented March 8, 1955, for "Packer Apparatus."

As disclosed in such patent, the well packer may be lowered in the well casing by means of a string of tubing (not shown) and is adapted to be hydraulically anchored in packed-off condition therewithin.

The well packer A includes a main body 11 having a packing sleeve 12 of rubber or rubber-like material thereon which has been expanded outwardly into sealing engagement with the wall of the well casing. Upward movement of the body 11 of the well packer is prevented by a set of upper segmental slips 13 held in anchored engagement against the well casing by an upper expander 14 which engages the upper end of the packing structure 12. A set of lower segmental slips 15 is wedged into anchoring engagement with the well casing B by a lower expander 16 which engages the lower end of the packing structure 12. As described in the aforementioned patent, the packer can be anchored in packed-off condition in the well casing as a result of shifting a setting sleeve 17 downwardly along the body 11 of the tool, as by elevating the body of the tool after the upper slips 13 have been anchored against the well casing, to foreshorten the packing sleeve 12 and expand it against the wall of the well casing, and also to shift the lower slips 15 upwardly along the lower expander 16 into anchoring engagement with the well casing.

The packer body 11 may include a lower body abutment 18 against which the lower slips 15 bear, which has a valve seat 19 surrounding the passage 10 through the packer body adapted to be engaged by a flapper valve head 20 pivotally mounted on the body abutment 18 and swingable upwardly into engagement with the valve seat. This flapper valve head 20 may be received within a slotted junk catcher and pusher 21 suitably secured on the lower body abutment, all as disclosed in the aforementioned patent.

As shown in the form of invention illustrated in Figs. 1 to 4, inclusive, the internal diameter of the packer or body 11 has been reduced by inserting a body liner 22 therewithin having a lower centering ring 23 suitably attached to the lower portion of the liner, as by means of brazing or a screw (not shown). This centering ring 23 engages the wall of the main body 11 of the packer. The upper head 24 of the body liner is threaded into an internally threaded box 25 of the body 11 and, in turn, has an upper threaded box 26 for the reception of a tubular string (not shown), the threaded boxes normally being left-hand threaded members.

The central passage 10 through the liner and body can be closed initially by the ejectable or expendable plug C which is supported upon the upper end of a holding and guide sleeve 27 located within the main body 10 of the packer below the liner 22, and preferably having substantially the same inside diameter as the liner 22. This holding sleeve is held in position by a lower external flange 28 thereof being received within an internal groove 29 defined between the lower end of the main body 11 of the packer and an inwardly directed portion 30 of the lower body abutment 18. Leakage of fluid around the outside of the holding and guide sleeve 27 is prevented by a suitable seal ring 31, such as a rubber or rubber-like O ring, mounted on the sleeve and sealingly engaging the wall of the body. Similarly, leakage of fluid around the exterior of the body liner 22 is prevented by a suitable side seal 32, such as a rubber or rubber-like O ring, mounted on the upper portion of the liner and sealingly engaging the wall of the body 11.

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The ejectable plug device C includes a body portion 33 initially disposed within the holding and guide sleeve 27, the body carrying a side seal 34, such as a rubber or rubber-like O ring, for sealingly engaging against the wall of the holding and guide sleeve 27. The body also includes a plurality of upwardly extending circumferentially spaced arms or latch elements 35 formed by longitudinal slots 36 extending downwardly from the upper end of the body 33, the arms being integral with upper latch elements or fingers 37 extending outwardly into engagement with the upper end 38 of the holding and guide sleeve 27. The fingers have lower outer tapered surfaces 39 inclined in a downward and inward direction engaging a companion tapered surface 38 at the upper inner portion of the holding sleeve 27. The fingers 37 and arms 35 are adapted to spring inwardly to an extent sufficient for the fingers to pass down through the sleeve 27. However, such inward motion is prevented initially by a retainer and retractor member 40 disposed within the finger portions 37 and suitably secured to one of said finger portions, as by means of a shear screw 41. The lower portion 42 of the retainer and retractor member has a diameter to fit behind the fingers 37 and hold them outwardly in engagement with the tapered end 38 of the holding and guide sleeve 27. The member 40 also possesses a reduced diameter intermediate portion 43 merging into an upper retracting head portion 44 having a diameter conforming to the inside diameter of the body liner 22 and the holding and guide sleeve 27, the intermediate portion 43 having a length greater than the length of the fingers 37, so that the latter can move inwardly between the lower retaining portion 42 and the upper head retracting portion 44.

The retracting head 44 has a lower tapered surface 45 inclined in an upward and inward direction which is adapted to engage correspondingly tapered surfaces 46 at the upper portions of the fingers 37 such that engagement of the head surface with such finger surfaces forces the fingers inwardly, to remove them from engagement with the upper end 38 of the holding and guide sleeve 27. The retainer and retractor member 40 has a passage 48 therethrough to prevent fluid pressure to act thereon and shift it from its retaining position. The passage allows fluid pressure in the body and liner passage 10 to act both above and below the retainer and retractor member and be equalized since it can act over equal and opposite areas. Thus, the fluid pressure will not only pass through the passage 48, but also through the slots 36 into the holding and guide sleeve 27, as well as into the body 11 of the well packer between the seal rings 31, 32, the centering ring 23 allowing fluid to pass thereby. However, such fluid pressure cannot pass downwardly of the plug body 33 because of the seal ring 34 on the latter, and further in view of the fact that a plug extension 49 which is threadedly secured into the plug body 33 closes the central passage 50 through the latter. This plug extension 49 is engageable with the flapper valve head 20 when the fingers 37 engage the upper end 38 of the holding and guide sleeve 27 to retain the flapper valve head 20 to one side and insure that the plug C can be subsequently ejected from the well packer when its presence is no longer desired.

The well packer A is run in the well casing B and is anchored in packed-off condition therewithin with the ejectable plug device C mounted in the body 11 of the packer, such as disclosed in Fig. 1. The well packer then actually constitutes a bridge plug, permitting certain pressuring operations to be performed in the well casing B and well bore thereabove. For example, if the well is to be acidized or a formation fracturing operation is to take place above the packer A, the latter will prevent the fluid under pressure from passing down through the packer. Substantial fluid pressure can then be imposed in a downward direction on the well packer, the expandible plug C remaining in place. The retainer and retractor member

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40 is not shiftable downwardly by the presence of fluid pressure thereabove since there is no pressure differential acting on this member. The fingers 37 are held out against the tapered end 38 of the holding and guide sleeve 27, the downward pressure imposed on the plug being incapable of urging the fingers inwardly without destroying the retainer and retractor member 40. Accordingly, the retainer and retractor member 40 positively locks the fingers 37 in their outer position to hold the plug C in place. By way of example, it has been found that the entire plug device will hold about 4,000 p.s.i. pressure differential safely.

After the operation above the packer requiring its use as a bridge plug has been completed, the expendable plug C can be ejected and removed completely from the well packer, to open the passage 10 therethrough. Such opening will occur as an incident to lowering production tubing D through the packer, so as to conduct well production from a region therebelow into the tubing perforations 55 and upwardly through the tubing D to the top of the well bore. After the lower end of the tubing enters the packer A and comes to rest upon the retainer and retractor member 40, a downward weight can be imposed on this tubing, and when it exceeds the strength of the shear screw 41, which, by way of example, might require about 2500 pounds for its disruption, the shear screw is sheared by the retainer and retractor member 40, allowing the latter to move downwardly within the arms 35 of the plug body 33, the lower retaining portion 42 of the retainer and retractor member shifting below the fingers 37 and the upper tapered head portion 44 coming into engagement with the tapered ends 46 of the fingers 37, forcing the fingers inwardly and completely from engagement with the upper holding shoulder 38 of the holding and guide sleeve 27 (see Fig. 2). The downward movement of the production tubing string D can continue, which will then force the complete plug C downwardly and out of the packer, the retractor and retainer 40 sliding from the lower end of the body liner 22 into the sleeve 27 and moving down through the sleeve and past the valve head 20, from which position it will drop down into the well bore to a lower location where it cannot interfere with the securing of production from the zone in the well bore below the set position of the well packer. If the production tubing D is now removed, the flapper valve head 20 can swing upwardly into engagement with its companion valve seat 19 to prevent upward flow of fluid through the well packer A, as shown in Fig. 3. However, the production tubing D will normally remain extending through the well packer and a portion thereof (not shown) will be sealed off against the wall of the body liner 22 to prevent leakage of fluid around the exterior of the production tubing (in a known manner).

In the form of invention shown in Fig. 5, the expendable plug device C is essentially the same in the other form of the invention. However, it is releasably secured in a well packer that does not possess a liner nor a holding and guide sleeve separately installed within the body 11 of the tool. Instead, the packer body includes a body extension 11a which is threaded onto the lower part of the main body 11 of the tool, this body extension, in turn, threadedly receiving the lower body abutment 18a having the flapper valve seat 19 and pivotally carrying the flapper valve head 20. This lower body abutment 18a also carries the feeler and junk pusher 21, as in the other form of the invention.

The expendable plug device C is mounted within the main body 11 of the tool and within the body extension 11a, sealing off against the wall of the latter and with the fingers 37 initially resting upon the inwardly and downwardly tapering lock surface 38a on the body extension. The upper retracting head 44 of the retainer and retractor device 40 slidably engages the wall of the main body 11 of the well packer, this wall having sub-

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stantially the same inside diameter as the inside diameter through the body extension 11a.

The specific arrangement disclosed in Fig. 5 functions in the same manner as the other form of the invention. When the production tubing string D, or other device, is inserted in the body passage 10, it will engage the retainer and retractor member 40, shearing the screw 41 and forcing the retainer portion 42 downwardly below the fingers 37, allowing the cam or tapered surface 45 on the head 44 to engage the companion tapered surfaces 46 at the upper portions of the fingers 37 to deflect the latter inwardly from engagement with the lock surface 38a, whereupon the entire expendable plug can be ejected fully from the well packer.

The inventor claims:

1. In combination: a well packer adapted to be set in a well bore and including a body having a passage and means thereon for securing said body in the well bore, a plug in said passage to prevent flow of fluid therethrough, latch means on said plug engaging said body to hold said plug against downward movement in said passage, retaining means engaging said latch means to prevent release of said latch means from said body; and means for shifting said retaining means from said latch means to permit release of said latch means from said body and ejection of said plug from said passage.

2. In a well packer adapted to be set in a well bore: a body having a passage and means thereon for securing said body in the well bore; a plug in said passage to prevent flow of fluid therethrough; latch means on said plug engaging said body to hold said plug against downward movement in said passage; and means engageable with said latch means to withdraw said latch means from holding relation to said body to allow said plug to be ejected from said passage.

3. In combination: a well packer adapted to be set in a well bore and including a body having a passage and means thereon for securing said body in the well bore, a plug in said passage to prevent flow of fluid therethrough, latch means on said plug engaging said body to hold said plug against downward movement in said passage, retaining means engaging said latch means to prevent release of said latch means from said body; means for shifting said retaining means from said latch means and for engaging said retaining means with said latch means to withdraw said latch means from holding relation to said body to allow said plug to be ejected from said passage.

4. In combination: a well packer adapted to be set in a well bore and including a body having a passage and means thereon for securing said body in the well bore, a plug in said passage to prevent flow of fluid therethrough, said plug having a plurality of latch elements; said body having a shoulder engaged by said latch elements, a retainer member disposed behind said elements to hold them in engagement with said shoulder to prevent downward movement of said plug from said passage; and means for shifting said retainer member downwardly from

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holding engagement with said elements to allow said plug to be ejected from said passage.

5. In a well packer adapted to be set in a well bore: a body having a passage and means for securing said body in the well bore; a plug in said passage to prevent flow of fluid therethrough; said plug having a plurality of latch elements; said body having a shoulder engaged by said latch elements; a retainer and retractor member including a lower retainer portion disposed behind said elements to hold them in engagement with said shoulder to prevent downward movement of said plug from said passage, said member including an upper retractor portion engageable with said elements to shift them inwardly from engagement with said shoulder to allow said plug to be withdrawn from said passage.

6. In a well packer adapted to be set in a well bore: a body having a passage and means for securing said body in the well bore; a plug in said passage to prevent flow of fluid therethrough; said plug having a plurality of latch elements; said body having a shoulder engaged by said latch elements; a retainer and retractor member including a lower retainer portion disposed behind said elements to hold them in engagement with said shoulder to prevent downward movement of said plug from said passage, said member including an upper retractor portion engageable with said elements to shift them inwardly from engagement with said shoulder to allow said plug to be withdrawn from said passage; and means releasably securing said member to said plug with said retainer portion disposed behind said elements.

7. In combination: a well packer adapted to be set in a well bore and including a body having a passage and means thereon for securing said body in the well bore, said body having a valve seat surrounding said passage, a valve member movable upwardly into engagement with seat, a plug in said passage having a plurality of latch elements, said body having a shoulder engaged by said latch elements, a retainer device disposed behind said elements to hold them in engagement with said shoulder to prevent downward movement of said plug from said passage and to hold said plug in engagement with said valve member to prevent said valve member from engaging said seat; and means for shifting said retainer member downwardly from holding engagement with said elements to allow said plug to be ejected from said passage and from engagement with said valve member.

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