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WELL PACKER APPARATUS

Filed March 18, 1940

2 Sheets-Sheet 1



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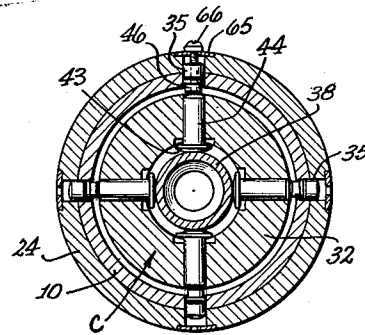
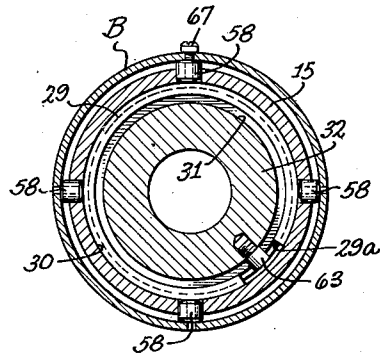
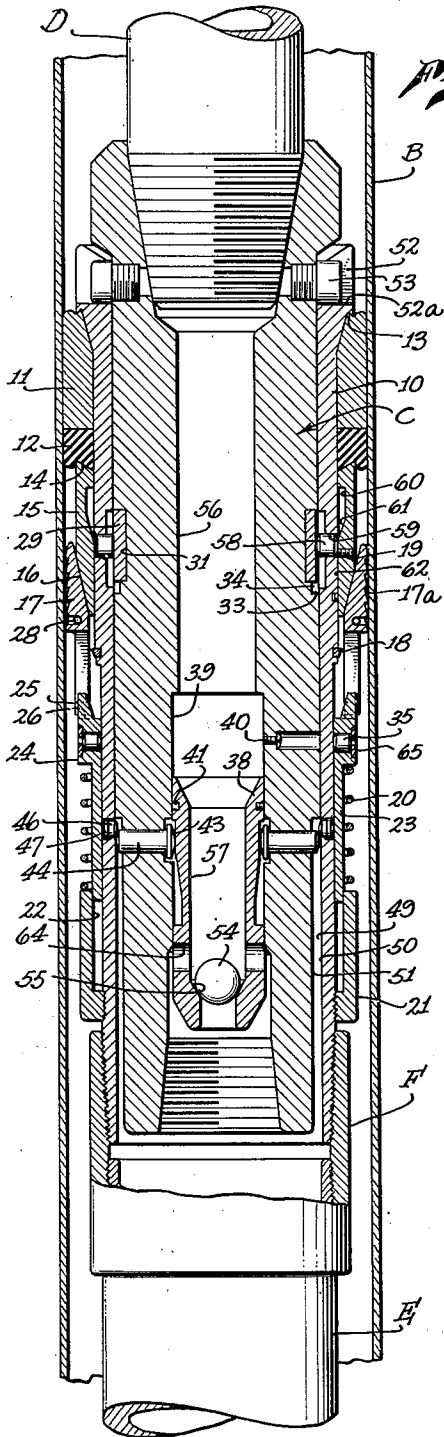
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2 Sheets-Sheet 2



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WELL PACKER APPARATUS

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27 Claims. (Cl. 166—12)

This invention relates to oil well devices, and particularly to a well packer and a setting tool for anchoring it in a well casing.

An object of the invention is to effect automatic release of a setting tool from a packer upon anchoring of the latter in packed-off condition in a well casing, permitting immediate withdrawal of the setting tool from the casing, if desired.

Another object of the invention is to provide an improved device for coupling a well packer to a running-in string by which it is lowered in a well casing.

It is a further object of the invention to provide a well packer, such as a liner hanger, having slips held in retracted position by latches, and to release these latches through the agency of hydraulic instrumentalities.

Another object of the invention is to provide a well packer, such as a liner hanger, embodying a spring device for moving the packer slips to casing engaging position, the spring device being normally held in ineffective position by latches releasable through the medium of hydraulic instrumentalities.

This invention has other objects that will become apparent from a consideration of the embodiment shown in the drawings accompanying and forming part of the present specification. This form will now be described in detail, but it is to be understood that such detailed description is not to be taken in a limited sense, since the scope of the invention is best defined by the claims appended hereto.

Referring to the drawings:

Figure 1 is a longitudinal section of a liner hanger and cooperable setting tool, shown in running-in conditions within a casing;

Figure 2 is a view similar to Figure 1, illustrating the packer with its slips engaging the casing;

Figure 3 is a view similar to Figure 1, with the liner hanger set in packed-off condition in the casing and the setting tool released therefrom for withdrawal to the surface of the well bore;

Figure 4 is a cross-section taken along the plane 4—4 in Figure 1; and

Figure 5 is a cross-section taken along the plane 5—5 in Figure 1.

In the drawings, the well packer A is shown in the form of a liner hanger adapted to be lowered in a casing B to a desired setting point by being coupled to a setting tool C secured to a running-in tubular string D.

The liner hanger consists of a main generally

tubular body 10 encompassed at its upper portion by adjoining initially retracted lead and rubber packing sleeves 11, 12. The lead sleeve is prevented from moving upwardly with respect to the body by fitting within a small lip 13 at its exterior. The lower end of this sleeve 11 abuts the rubber sleeve or ring 12, which in turn engages a downwardly and inwardly tapering end 14 of a conical expander 15 slidably surrounding the body, such tapering end serving to confine the rubber ring against inadvertent displacement. The lower part 16 of this cone expander is tapered downwardly and inwardly for the purpose of producing radial movement of a plurality of segmental slips 17 as the latter are moved longitudinally along the face of the cone. The cone is prevented from moving down along the body 10 by a lock ring 18 secured to the latter member, and it is initially prevented from moving upwardly with respect to the body by one or more shear screws 19 extending through it and threaded into the body.

The slips 17 are urged along the tapered face 16 of the cone by a helical spring 20 engaging a sleeve 21 threadedly attached to the body 10 but spaced therefrom to form an annular guideway 22 for a ring or sleeve 23 having an enlarged upper portion 24 whose underside engages the upper end of the coil spring. T-shaped heads 25, depending from each slip, are slidably received in companion lateral slots 26 in the enlarged portion 24 of the ring. This type of interconnection between the slips 17 and the sleeve 23 couples the members together for longitudinal movement under the influence of the spring 20, but permits the slips to move radially of the packer body and sleeve to casing engaging and anchoring position upon their sliding along the tapered surface 16 of the cone. This radial displacement of the slips occurs against the action of a contractile coil spring 27 encircling the slips and seated within grooves 28 provided in their exterior faces.

As shown in the drawings, the well packer A functions as a liner hanger, supporting a liner E from its lower end through the agency of a threaded sub or coupling F. These parts are lowered in position within the casing by means of the setting tool C attached to the string of drill pipe or tubing D.

The device for coupling the setting tool and packer body together consists of an expansible split snap or spring ring 29 received partly within an internal groove 30 formed in the main body of the packer and partly within an external

groove 31 provided on the main body 32 of the setting tool, which is out of alignment with the other groove when the entire apparatus is being lowered in the well. Under this circumstance, the expansible ring 29 substantially fills the groove 30 in the packer body, and is spaced from the base of the external groove 31 with its lower surface supported on a stepped shoulder 33 formed by a recess 34 in the setting tool body 32 below its external groove.

While being run within the casing, the slips 17 are held in retracted position by their encircling coil spring 27, and the slip setting spring 20 is held in compressed condition by a plurality of latches in the form of buttons 35 extending partly into bores 36 in the enlarged portion of the sleeve and partly into aligned bores 37 extending through the main body of the packer, as shown in Figure 1. With the buttons 35 in this position, the spring and the slips are locked against longitudinal movement along the body 10. However, when the desired setting point within the casing has been reached, these buttons are moved outwardly from the bores 37 in the main packer body to permit expansion of the encompassing spring 20, and its corresponding movement of the slips 17 along the tapered cone face 16 into engagement with the casing B.

Release of these buttons is accomplished through the use of hydraulic instrumentalities, consisting of a sleeve 38 slidable within a central cylindrical bore or passage 39 in the setting tool body. This sleeve is initially held against movement by a shear screw 40 inserted through a hole in the body and extending into an external groove 41 in the sleeve. The exterior of this sleeve between its ends is reduced to form a downwardly tapering conical cam surface 42 adapted to engage the heads 43 of plungers 44 slidable within radial bores 45 extending through the body of the setting tool, and whose outer ends engage inner buttons 46 contacting the outer buttons 35 locking the spring confining ring 23 to the packer body. The inner buttons have heads 47 shouldering against countersunk holes 48 through the packer body to limit innermost positioning of these buttons within the annular space 49 between the inner surface 50 of the packer body and the reduced exterior 51 of the setting tool body.

Alignment between the radial plungers 44 and the sets of buttons carried by the packer body is insured by providing a pair of slots 52 at the top of the packer body in longitudinal alignment with the buttons 35, 46 extending through the radial holes in the packer body. These slots receive plugs or keys 53 threaded or otherwise attached to the setting tool body 32. Since these keys are aligned with the radial plungers 44, the latter members will be positioned opposite the buttons when the setting tool is assembled within the packer body with its keys 53 received within the slots 52.

When the assembled apparatus has been positioned at the desired setting point, a tripping ball 54 is lowered or pumped down the tubular string into engagement with a tripping ball seat 55 formed at the lower end of the tripping sleeve. Upon engaging this seat, passage of fluid through the central bores 56, 57 of the setting tool body and tripping sleeve is prevented, enabling sufficient pressure to be built up within the setting tool to produce shearing of the screw 40 securing the tripping sleeve to the setting tool body and downward movement of the former within the

setting tool passage 39. In pursuing this downward displacement, the conical cam surface 42 of the sleeve forces the plungers 44 in a radial outward direction, and causes corresponding radial movement of the inner buttons 46 against the outer buttons 35, displacing the latter elements entirely into the holes 36 in the sleeve and out of the holes 37 in the packer body. At the same time, the inner buttons 46 are positioned entirely within the holes in the packer body (see Figure 2). As soon as the outer buttons are moved out of engagement with the packer body, the coil spring 20 is released and allowed to elongate for the purpose of shifting the slips 17 upwardly along the divergent surface of the cone expander 15 into contact with the casing.

After the slips have engaged the casing, the packing sleeves 11, 12 are compressed into sealing engagement with both the packer body and wall of the casing. This condition is the result of relieving the strain on the tubular string D to an extent permitting the packer body 10 and attached liner E to descend with respect to the slips and conical expander. These latter members cannot move downwardly, since the wickers 17a of the slips are shaped to dig into the casing upon application thereto of a downward thrust exerted through the cone expander 15, which is held against movement by its wedging action within the slips. As a result, relief of the strain on the tubular string allows the weight of the packer body and liner, or of the tubular string imposed on the body through the keys 53 or the snap ring 29, to rupture the screw 19 securing the cone to the body 10, permitting the body to move downwardly along the cone to compress both the lead and rubber sleeves 11, 12 into sealing engagement with the casing wall. The extent of downward movement of the packer body and liner is limited by the degree of compression of the packing sleeves between the casing and packer body.

It is to be noted that the plugs or keys 53 fixed to the setting tool body are spaced from the bottom 52a of the upper slots in the packer body when the apparatus is being run in the casing and prior to the packing-off of the seals 11, 12 between the packer body and casing. This space must be allowed to permit lowering of the setting tool body 32 within the packer body 10 to an extent producing alignment between the respective external and internal grooves 31, 30 in the two main bodies of the apparatus. After this alignment has occurred, and upon lowering of the packer body to obtain a packed-off condition of the liner hanger, the snap ring 29 is retracted completely within the external groove 31 in the setting tool body by a plurality of buttons 58 slidable within holes 59 extending through the packer body and into an internal annular recess 60 merging into a downwardly convergent cam surface 61 formed within the conical expander or to a member fixed thereto or integral therewith.

As the strain on the tubular string is removed, permitting the keys 53 to engage the bottoms of the slots 52a and the packer body 10 to move downwardly along its conical expander 15, not only are the grooves 31, 30 in the setting tool body and packer body aligned, but the buttons 58 ride along the convergent surface 61 of the internal cone for displacement inwardly, forcing the snap ring 29 against its inherent expansion tendency completely into the groove 31 in the setting tool body. It is preferred that the buttons ride en-

tirely off the tapered internal cam surface and contact the inner lower cylindrical surface 62 of the conical expander in order to prevent accidental repositioning of the buttons 58 within the expander inner cone or recess and corresponding inadvertent repositioning of the snap ring 29 partly or completely within the internal groove 30 of the packer body. As assurance that one of the buttons will not be disposed between the ends of the ring, the latter is prevented from material rotation by a stop 63 secured to the setting tool body 32 and extending into the snap ring gap 29a.

With the snap ring 29 disposed entirely within the confines of the setting tool body (see Figure 3), which condition is automatically produced upon packing-off of the packer within the casing, the setting tool C is completely uncoupled from the packer A and can be removed therefrom without restraint simply by elevating the tubular string D.

In order to permit circulation through the apparatus after the slips 17 have been set or anchored to the casing, it is preferred that the tripping sleeve 38 have one or more ports 64 above its seat 55 establishing communication between the interior 57 of the setting tool sleeve and the exterior of the sleeve, permitting fluid or cement passage through the tubular string and the setting tool to a point within, below or behind the liner. The presence of these lateral ports 64 will also allow fluid to drain from the tubular string as it is being elevated from the well bore.

Outward movement of the outer latch buttons 35 is limited by their engagement with closure members 65 welded or otherwise secured over the exterior of the holes 36 in which the buttons are contained. These closure members act as supports for screws or pins 66 extending therethrough into engagement with the outer buttons, holding these elements in the locking position shown in Figure 1 and the heads 47 of the inner buttons against the countersunk hole portions 48. The snap ring retracting buttons 58 are similarly held out of the inner groove 30 by threaded receiving screws 67 extending through the expander 15. After the setting tool C has been placed in proper assembled relation, all of the screws or pins 66, 67 are removed, allowing displacement of the buttons 35, 46, 58 within their holes under the influence of the plungers 44 and the inner cam surface 61.

I claim:

1. An apparatus of the character described, including a packer body adapted to be moved through a well casing by a tubular string, retracted means carried by said body for engagement with such casing, means coupling said body to said tubular string, means for enabling said body and retracted means to be moved with respect to each other to engage said retracted means with said casing, and means operable during movement of said retracted means to casing engaging position for disconnecting said coupling means.

2. An apparatus of the character described, including a packer body adapted for movement through a well casing, a tubular member within said body, retracted means carried by said body for engagement with said casing, means coupling said body to said tubular member, means for enabling said body and retracted means to be moved with respect to each other to engage said retracted means with said casing, and means operable during movement of said retracted means to casing engaging position for disconnecting said

coupling means, allowing withdrawal of said tubular member from said packer body.

3. An apparatus of the character described, including a packer body adapted to be moved through a well casing, a tubular member within said body, anchoring means carried by said body in retracted position, means for coupling said body to said tubular member, means for engaging said anchoring means with said casing, and means carried by said body for movement therewith longitudinally along said engaging means for disconnecting said coupling means.

4. An apparatus of the character described, including a packer body adapted to be moved through a well casing, a tubular member within said body, slips carried by said body, means comprising an expander for engaging said slips with said casing, means for coupling said body to said tubular member, and means carried by said body for movement therewith longitudinally along said expander for disconnecting said coupling means.

5. An apparatus of the character described, including a packer body, a member within said body forming the lower end of a running-in string by which said body is moved through a well casing, slips carried by said body, means comprising an expander for engaging said slips with said casing, means for coupling said body to said member, cam means fixed to said expander, and means carried by said body for movement therewith longitudinally along said cam means for disconnecting said coupling means.

6. An apparatus of the character described, including a packer body, a member within said body forming the lower end of a running-in string by which said body is moved through a well casing, slips carried by said body, means comprising an expander for engaging said slips with said casing, means for coupling said body to said member, cam means fixed to said expander, and means slidable laterally through said packer body and engageable with said cam means and coupling means for disconnecting the latter from said packer body.

7. An apparatus of the character described, including a well packer, a member within said packer forming the lower end of a running-in string by which said packer is moved through a well casing, and an expansible ring always tending to expand outwardly for coupling said packer and member together.

8. An apparatus of the character described, including a well packer, a member within said packer forming the lower end of a running-in string by which said packer is moved through a well casing, said packer and member having respective opposed internal and external circumferential grooves, and a split ring within said grooves for coupling said packer and member together.

9. An apparatus of the character described, including a well packer, a member within said packer forming the lower end of a running-in string by which said packer is moved through a well casing, said packer and member having respective opposed internal and external circumferential grooves, an expansible ring within said grooves for coupling said packer and member together, and means for displacing said ring from said packer groove to effect disconnection between the member and packer.

10. An apparatus of the character described, including a packer body, a member within said body forming the lower end of a running-in string by which said body is moved through a

well casing, said packer body and member having respective opposed internal and external grooves, an expansible ring within said grooves for coupling said body and member together, slips carried by said body, an expander for engaging said slips with said casing, cam means fixed to said expander, and means slidable laterally through said packer body and engageable with said cam means and expansible ring to displace the latter from said body groove.

11. An apparatus of the character described, including a packer body, a member within said body forming the lower end of a running-in string by which said body is moved through a well casing, said packer body and member having respective opposed internal and external circumferential grooves, an expansible ring within said grooves for coupling said body and member together, slips carried by said body, a conical expander for engaging said slips with said casing, an axial cam fixed to said expander, and buttons slidable in holes through said body and engageable with said cam and expansible ring to displace the latter from said body groove.

12. An apparatus of the character described, including a packer body, a member within said body forming the lower end of a running-in string by which said body is moved through a well casing, said packer body and member having respective opposed internal and external circumferential grooves, an expansible ring within said grooves for coupling said body and member together, slips carried by said body, an expander for engaging said slips with said casing, a packing sleeve held between said expander and packer body, an axial cam fixed to said expander, and buttons extending through said body for sliding engagement along said cam upon longitudinal movement of said body through said expander to displace said expansible ring from said body groove, such longitudinal movement of said body compressing said packing sleeve between said body and casing.

13. An apparatus of the character described, including a well packer, a member within said packer forming the lower end of a running-in string by which said packer is moved through a well casing, said packer having an internal circumferential groove, and said member having a companion external groove and an adjoining lower circumferential recess providing a shoulder, a lock ring positioned within said internal groove and resting on said shoulder with said external and internal grooves in disalignment, and stop means on said packer and member for positively locating said grooves in alignment to permit displacement of said ring from said internal groove.

14. An apparatus of the character described, including a packer body, a member within said body forming the lower end of a running-in string by which said body is moved through a well casing, said body having an internal circumferential groove and said member having a companion external groove and an adjoining lower circumferential recess providing a shoulder, a lock ring positioned within said internal groove and resting on said shoulder with said grooves in disalignment, said body having a slot, and a pin extending from said member into said slot, said pin engaging the base of said slot to positively locate said grooves in alignment and permit displacement of said ring from said internal groove.

15. An apparatus of the character described,

including a packer body adapted to be moved through a well casing by a tubular string, retracted means carried by said body, spring means for moving said retracted means into engagement with said casing, means for restraining operation of said spring means, and hydraulically operable means within said packer body for moving said restraining means laterally outwardly to ineffective position.

16. An apparatus of the character described, including a packer body adapted to be moved through a well casing by a tubular string, slips carried by said body in retracted position, spring means for moving said slips into engagement with said casing, means for holding said spring means in energized and ineffective position, and hydraulically operable means within said packer body for forcing said holding means in a lateral direction to ineffective position.

17. An apparatus of the character described, including a packer body adapted to be moved through a well casing by a running-in string, retracted means carried by said body, spring means for moving said retracted means into engagement with said casing, means for restraining operation of said spring means, and a cam within said packer body operable to release said restraining means.

18. An apparatus of the character described, including a packer body, a tubular member within said body, slips carried by said body in retracted position, spring means for moving said slips into engagement with a well casing, means for holding said spring means in energized and ineffective position, and means comprising a hydraulically actuated cam member within said tubular member for releasing said holding means.

19. An apparatus of the character described, including a packer body, a tubular member within said body, slips carried by said body in retracted position, spring means for moving said slips into engagement with a well casing, means for holding said spring means in energized and ineffective position, and means for releasing said holding means, comprising a hydraulically actuated cam member slidable within said tubular member, and means extending through said tubular member connecting said cam member and holding means.

20. An apparatus of the character described, including a packer body, a tubular member within said body, slips carried by said body in retracted position, spring means for moving said slips into engagement with a well casing, latching means coupling said spring means to said body for holding said spring means in energized and ineffective position, and means for releasing said latching means comprising a cam member slidable within said tubular member, and a plunger extending through said tubular member into engagement with said cam member and latching means.

21. An apparatus of the character described, including a packer body, a tubular member within said body, slips carried by said body in retracted position, spring means for moving said slips into engagement with a well casing, latching means coupling said spring means to said body in ineffective position, an axial cam slidable within said tubular member, and a plunger device extending laterally through said tubular member into contact with said cam to displace the latching means entirely from said body and release said spring means.

22. An apparatus of the character described,

including a packer body, a tubular member within said body, slips carried by said body in retracted position, spring means for moving said slips into engagement with a well casing, latching means coupling said spring means to said body in ineffective position, a sleeve having a longitudinal passage and an exterior cam surface slidable within said tubular member, a plunger device extending laterally through said tubular member into contact with said cam surface, and means for restricting said passage to enable increase in the fluid pressure above said sleeve to move it downwardly along said plunger device and cause the latter to displace the latching means from the body.

23. An apparatus of the character described, including a packer body, a tubular member within said body adapted to form the lower end of a tubular string, slips carried by said body in retracted position, spring means for moving said slips into engagement with a well casing, slidable latching means received within said body and spring means to hold the latter in ineffective position, a sleeve having a longitudinal passage and an exterior cam surface slidable within said tubular member, a plunger device extending laterally through said tubular member into contact with said cam surface and latching means, and means adapted to be sent down said tubular string to close said passage and enable an increase in the pressure of fluid above said sleeve to slide it downwardly along said plunger device, causing the latter to displace the slidable latching means entirely from the body.

24. An apparatus as defined in claim 22, said sleeve having an opening between its exterior and passage normally closed by the inner wall of said tubular member, but allowing fluid passage through said sleeve upon its downward movement along said plunger device.

25. An apparatus of the character described, including a packer body, a tubular member with-

in said body, slips carried by said body in retracted position, spring means for moving said slips into engagement with a well casing, latching means coupling said spring means to said body in ineffective position, an axial cam slidable within said tubular member, a plunger device extending laterally through said tubular member into contact with said cam to displace the latching means entirely from said body and release said spring means, and cooperable means on said body and tubular member for aligning said plunger device and latching means upon assembly of the apparatus.

26. An apparatus as defined in claim 25, said cooperable means composing a slot at the top of said body and a pin on said tubular member received within said slot.

27. An apparatus of the character described, including a packer body having an internal circumferential groove, a tubular member within said body having a companion external circumferential groove and an adjoining lower circumferential recess providing a shoulder, a lock ring positioned within said internal groove and resting on said shoulder with said external and internal grooves in disalignment, slips carried by said body in retracted position, spring means for moving said slips into engagement with a well casing, latching means coupling said spring means to said body in ineffective position, a cam slidable within said tubular member, a plunger device extending laterally through said tubular member into contact with said cam surface to displace the latching means entirely from said body and release said spring means, and cooperable stop means on said body and tubular member for positively locating said grooves in alignment to permit displacement of said ring from said internal groove, said stop means aligning said plunger device and latching means upon assembly of the apparatus.

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