

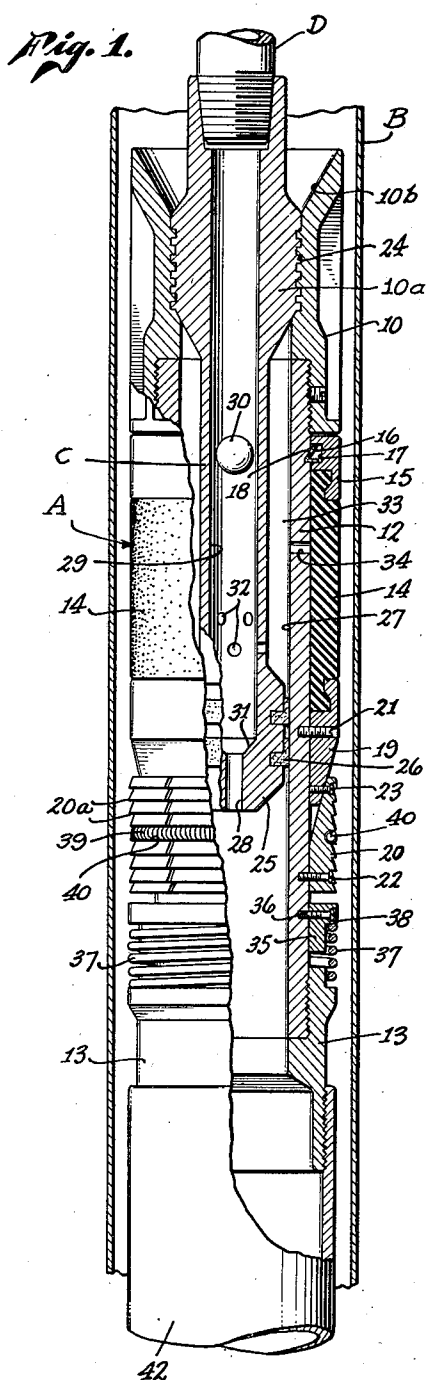
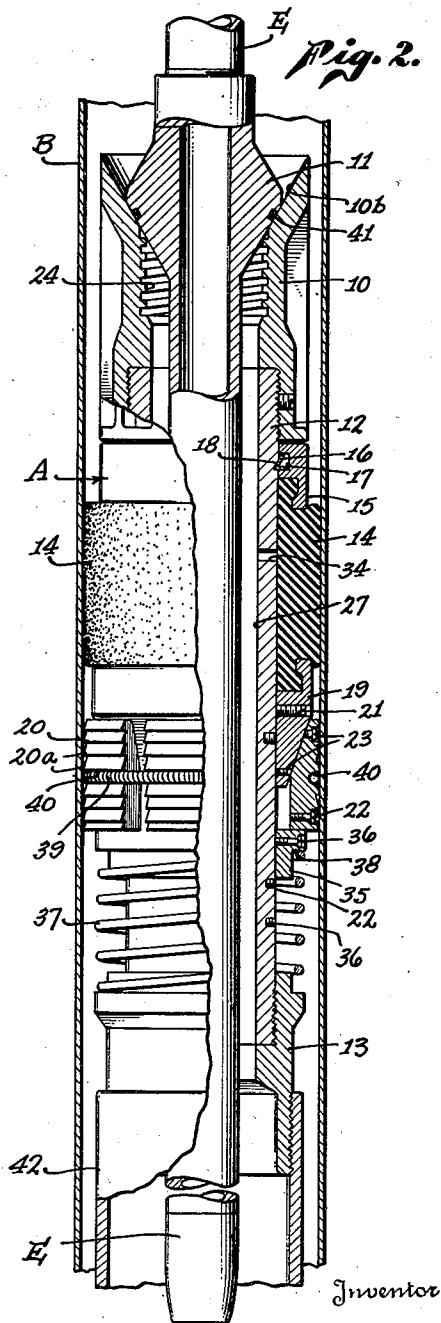
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RETRIEVABLE WELL PACKER

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RETRIEVABLE WELL PACKER

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The present invention relates to well packers, and more particularly to packers which are capable of being retrieved after having been set in the casing.

It is an object of the invention to provide an improved retrievable well packer capable of remaining in set position within a well casing without the necessity of imposing external loading upon it.

A further object of the invention is to provide an hydraulically set well packer adapted to positively support downwardly directed loads only, in order to permit its retrieval from the well bore simply by subjecting it to upwardly directed pulling effort.

This invention has other objects which will become apparent from a consideration of one form in which it is embodied, shown in the drawing 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 appended claims.

Referring to the drawing:

Figure 1 is a longitudinal partially sectional view of a well packer shown in conjunction with a setting tool prior to being anchored to the casing; and

Figure 2 is a longitudinal partially sectional view of the well packer anchored to the casing, shown in conjunction with production tubing.

In the drawing, the well device of the instant invention is illustrated as a production packer A adapted to be set within a well casing B by a setting tool C secured to the head 10 of the packer and to the lower terminus of a tubular string D, by means of which the packer is raised or lowered within the casing. After the packer has been set in position, as later described, the setting tool and tubular string are removed, and production tubing E is run into the casing from the surface of the well bore until its lower head 11 makes sealing contact with the setting head 10 of the packer.

The packer is of the retrievable type, and comprises a main body, including a central, tubular portion 12, having the aforementioned setting head 10 threadedly or otherwise secured to its upper end, and a guide 13 threadedly or otherwise secured to its lower end. Circumscribing the body is a packing sleeve 14, preferably of rubber, its upper end interlocking with a packing anchor 15, prevented from moving upwardly by abutting the lower portion of the setting

head, and from moving downwardly by a split lock ring 16, positioned within an internal groove 17 in the packing anchor, with its pawl-like lower inner edge received within a V-shaped groove 18 on the exterior of the body.

The lower end of the packing sleeve 14 is secured to an expander cone 19 slidably mounted on the body and having its downwardly converging outer surface slidably engaging companion surfaces on a plurality of segmental slips 20. Relative longitudinal movement between the cone 19 and slips 20 will result in radial movement of the slips either into or out of contact with the casing B.

As the packer is being lowered through the casing, both the cone and slips are held in ineffective position by sets of shear screws 21, 22, 23. The shear screws 21 securing the cone to the main body require a lesser shearing force to disrupt them than the screws 22 securing the slips to the main body. The shear screws 23 attaching the upper ends of the slips to the cone have a higher shear value than the first two mentioned sets of screws.

The packer A is lowered to the desired point within the casing through the agency of the tubular string D and setting tool C, the latter being suitably disconnectably secured to the packer head 10 by the left hand threads 24. The setting tool has a lower head 25 carrying a plurality of packing rings 26 for making sealing contact with the inner cylindrical surface 27 of the central body portion 12. This head also has an axial bore 28 extending therethrough into communication with the interior of the tubular setting tool portion 29, to permit passage of fluid through the tubing string D as it is being lowered in the bore. However, upon reaching the desired point in the casing, a tripping ball 30 or the like is allowed to gravitate or is pumped down the tubular string into seating engagement with a tripping ball seat 31 surrounding the axial bore. After such engagement occurs, the pressure of the fluid can be built up within the tubular string through suitable operation of a pump at the surface, this fluid leaving the interior of the setting tool through a plurality of lateral ports 32 and entering the cylindrical space 33 between the setting tool head and the packing rings 26. From this space, the fluid under pressure passes through lateral fluid ports 34 extending from the interior of the body into communication with the interior of the packing sleeve 14. When sufficient pressure has been built up, the fluid will first engage the packing sleeve 14 with

the walls of the casing and then elongate it in a downward direction to shear the various screws 21, 22, 23 and slide the cone 19 downwardly along the body to produce radial outward movement of the slips 20 into gripping engagement with the walls of the casing, due to the cooperable inclined surfaces provided on the cone and slips.

As aforementioned, the force required to shear the screws 21 holding the cone to the body is less than that of the screws 22 holding the slips to the body, and the shear value of the screws 23 initially attaching the slips to the cone is greater than that of the other two sets of screws. For this reason, the shear screws 21 holding the cone to the body will first be ruptured by the force of the fluid and then the shear screws 22 holding the slips to the body, but the connecting screws 23 between the cone and the slips will not be sheared until the cone and slips as a unit have been moved downwardly into engagement with an abutment, in the form of a slidable sleeve 35 initially secured to the main body portion 12 by shear screws 36, and thereby retaining a helical spring 37 under compression between a flange 38 on the sleeve and the lower guide 13 of the main body of the packer. Assuming for the present that this abutment 35 is rigidly secured to the body and incapable of sliding movement thereon, the downwardly moving slips 20 will engage it, after which further hydraulic effort imposed on the cone will shear the interconnecting screws 23 and allow the cone to move downwardly along the inclined faces of the slips and expand them outwardly into engagement with the casing. Thereafter, downwardly directed weight imposed on the packer body through the tubular string D will move the packer downwardly and compress the rubber packing sleeve 14 between its body portion 12 and the casing B, thus providing a leakproof seal therebetween (as shown in Figure 2).

It is to be understood that the wickers or teeth 20a on the slips are directed downwardly to prevent the packer from moving in that direction after it has been set within the casing. However, the entire packer A can be moved upwardly since the teeth or wickers on the slips will merely ratchet freely over the surface of the casing. After having been released from a set position by an upward pull on the tubular string D and packer body 10, 12, 13, which action will also release the packing sleeve 14 from engagement with the casing by again elongating it, an encircling coil spring 39 or other elastic member received within external grooves 40 in the slips will tend to move the slips inwardly away from the sides of the casing.

Upon being set within the casing, the setting tool C is removed from the bore by first turning the tubular string D to the right and unscrewing the setting head 10a from the packer head 10. The tubular production string E can then be lowered through the casing until its inclined head 11 engages a companion inclined portion 10b at the upper end of the packer head 10, a sealing ring 41 being carried by the tubing head to ensure that leakage will not occur between the two mating head portions. The subjection of the packed body to the weight of the string E will again compress the packing 14 into sealing contact with both the casing and packer body and also urge the slips more strongly into engagement with the casing through the expansion effect of the downwardly movable cone 19.

If desired, the lower guide member 13 attached

to the packer body can be externally threaded to permit the connection of a tail pipe 42 thereto. If this tail pipe is of sufficient length, its weight will be adequate to maintain the rubber sleeve 14 in packed-off condition and the slips 20 embedded in the casing wall during the interval between removal of the setting tool C and the running-in of the tubular production string E and its engagement with the packer setting head 10. But if a tail pipe of sufficient weight is not employed, upon removing the setting tool the compressed packing will inherently tend to elongate and move the body portion 12 and cone 19 away from the slips, permitting the encircling coil spring 39 to retract the latter members from the casing, whereupon the packer A would gravitate to the bottom of the hole.

To obviate this possibility, the above described slidable sleeve 35, helical spring 37, and shear screws 36 are employed. The screws 36 have a greater combined shear value than the screws 21, 22 attaching the cone and slips to the body, but a lesser shear strength than the screws 23 connecting the cone and slips together. Accordingly, during the setting operation, the packing sleeve 14 will elongate to move the cone 19 and slips 20 downwardly as a unit, after first shearing the screws 21, 22, until the slips engage the slidable sleeve 35. Further increase of the fluid pressure will urge the slips against this sleeve with a force sufficient to cause failure of the screws 36 securing the sleeve to the body and move it downwardly until the spring 37 is either compressed to its fullest extent, or until the lower end of the sleeve abuts the packer guide 13. Additional increase in the fluid pressure will thereafter shear the screws 23 connecting the cone and slips together and allow the cone to move downwardly with respect to the slips and force them radially outwardly into engagement with the casing.

With the employment of the helical spring 37, the removal of the setting tool does not result in release of the slips since the spring is constantly tending to move the slips and cone toward each other and maintain the former members wedged outwardly into engagement with the casing. This action on the cone is obtained through the intermediary of the guide 13, tubular body portion 12, packing anchor 15 and packing sleeve 14. Although the spring 37 can be made strongly enough and of sufficient length to maintain the rubber sleeve 14 in packed-off condition with no external load imposed on the packer body, this is not essential so long as it is capable of exerting continued effort to ensure engagement of the slips with the casing and thereby prevent the packer from moving downwardly within the casing after it has been set. Its action will not prevent complete retrieval of the packer or its resetting at a higher elevation by any suitable means that might be run into the hole, such as a tubular string with a square left hand threaded sub on its bottom, or some fishing tool or releasing spear. The coupling of any device of this character to the packer will permit an upward pull to be taken on the packer body and its elevation within the casing or entirely therefrom.

Packers of the type illustrated are particularly adapted for use in multiple zone production. A packer will separate two producing zones communicating with a single bore, production from the lower zone passing upwardly through the packer A and the producing string E connected therewith, and flow from the upper zone passing

through the annular space between the casing and the tubular string E.

While the invention has been described with particular reference to a production packer, it is to be understood that it is susceptible to other applications within a well bore, as for example, as a liner hanger.

The arrangement employed for setting the packer is both described and claimed in my invention made jointly with Eugene Graham, Jr., Serial No. 269,120, filed April 21, 1939, entitled "Production packer and liner hanger," now Patent Number 2,189,701.

I claim:

1. A well packer, including a body adapted for attachment to a tubular string for passage through a well casing, slips for securing said body to said casing, an expander having a downwardly converging outer surface cooperable with companion surfaces on said slips, and a packing member for effecting a seal between said body and casing and adapted to be actuated by fluid under pressure to move said expander downwardly of said slips and effect engagement of the slips with the casing.

2. A well packer as defined in claim 1, said slips having external wickers shaped to prevent substantial downward movement of said body upon embedding of said wickers in the casing.

3. A well packer, including a body adapted for attachment to a tubular string for passage through a well casing, slips for securing said body to said casing, an expander having a downwardly converging outer surface cooperable with companion surfaces on said slips, an extensible packing sleeve secured at its upper end to said body and at its lower end to said expander, said body having a port therethrough for the passage of fluid from the tubular string to said packing sleeve, whereby fluid under pressure can extend said sleeve and move said expander downwardly to effect engagement of said slips with the casing.

4. A well packer including a body adapted for attachment to a tubular string for passage through a well casing, slips for securing said body to said casing, an expander having a downwardly converging outer surface cooperable with companion surfaces on said slips, frangible means for securing said slips and cone to the body in retracted position, and a packing member for effecting a seal between said body and casing and adapted to be actuated by fluid under pressure to disrupt said frangible means and move said expander downwardly of said slips to produce their engagement with the casing.

5. A well packer, including a body adapted for attachment to a tubular string for passage through a well casing, means for securing said body to said casing against substantial movement in a downward direction, means responsive to fluid under pressure for moving said means into engagement with said casing, and means for yieldably maintaining such engagement.

6. A well packer, including a body adapted for attachment to a tubular string for passage through a well casing, slips for securing said body to said casing against substantial movement in a downward direction, an expander cooperable with said slips, hydraulically operable means for producing relative movement between said slips and expander to move the slips outwardly into engagement with said casing, and spring means for urging said expander and slips with respect to each other to maintain such engagement.

7. A well packer, including a body adapted for

attachment to a tubular string for passage through a well casing, slips for securing said body to said casing against substantial movement in a downward direction, an expander cooperable with said slips, hydraulically operable means for producing relative movement between said slips and expander to move the slips outwardly into engagement with said casing, and normally ineffective spring means adapted to be rendered effective by relative movement of said expander and slips to tend to move them with respect to each other and maintain the engagement of the slips with the casing.

8. A well packer, including a body adapted for attachment to a tubular string for passage through a well casing, slips for securing said body to said casing against substantial movement in a downward direction, an expander cooperable with said slips, hydraulically operable means for producing relative movement between said slips and expander to move the slips outwardly into engagement with said casing, a sleeve slidable on said body, a spring between said sleeve and body, means fixedly securing said sleeve to said body to hold said spring in ineffective position, said means being disconnectable to render said spring effective to urge said sleeve against said slips and maintain their engagement with the casing.

9. A well packer, including a body adapted for attachment to a tubular string for passage through a well casing, slips for securing said body to said casing, an expander having a downwardly converging outer surface cooperable with said slips, hydraulically operable means for moving said expander downwardly with respect to said slips to move them downwardly and radially outwardly into engagement with said casing, a sleeve slidable on said body, spring means between said sleeve and body, frangible means normally securing said sleeve to said body to hold said spring means in ineffective position, said frangible means being disrupted by downward movement of said expander and slips to permit said spring means to urge said sleeve against said slips and maintain their engagement with the casing.

10. A well packer, including a body adapted for attachment to a run-in string for passage through a well casing, slips for securing said body to said casing, an expander cooperable with said slips, spring means for moving said slips and expander longitudinally with respect to each other to hold said slips in engagement with said casing, means normally securing said spring means to said body in ineffective position, and means movable externally along said body for disconnecting said securing means and rendering said spring means effective.

11. A well packer, including a body adapted for attachment to a run-in string for passage through a well casing, slips for securing said body to said casing, an expander cooperable with said slips, spring means for moving said slips and expander means longitudinally with respect to each other to hold said slips in engagement with said casing, means normally retaining said spring means in ineffective position, and means movable externally along said body independently of said spring means for releasing said retaining means and rendering said spring means effective.

12. A well packer, including a body adapted for attachment to a run-in string for passage through a well casing, slips for securing said body to said casing, an expander cooperable with said slips, spring means for moving said slips

and expander longitudinally with respect to each other to hold said slips in engagement with said casing, means normally retaining said spring means in ineffective position, and means movable externally along said body for releasing said retaining means and rendering said spring means effective.

13. A liner hanger having a passage there-

through, pipe gripping means externally thereof, and fluid pressure-actuated means for shifting said gripping means including spring means arranged to hold the gripping means lightly in engaged position after release of fluid under pressure against said first named means.

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