April 19, 1949. C. M. KING 2,467,833

WELL PACKER

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Fig. 1.

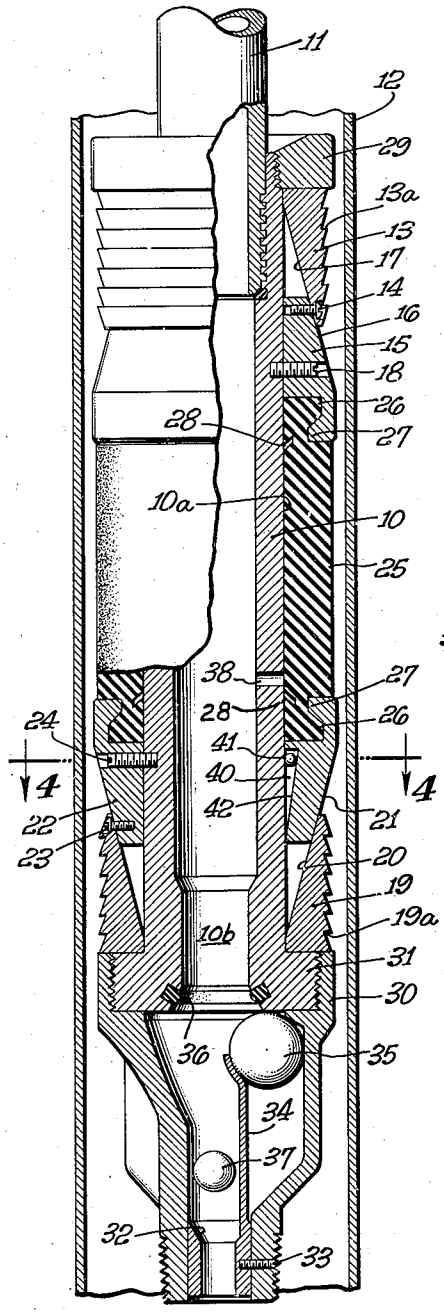


Fig. 2.

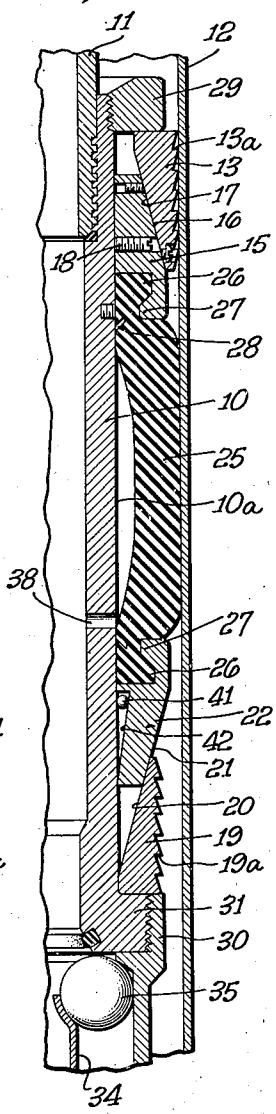
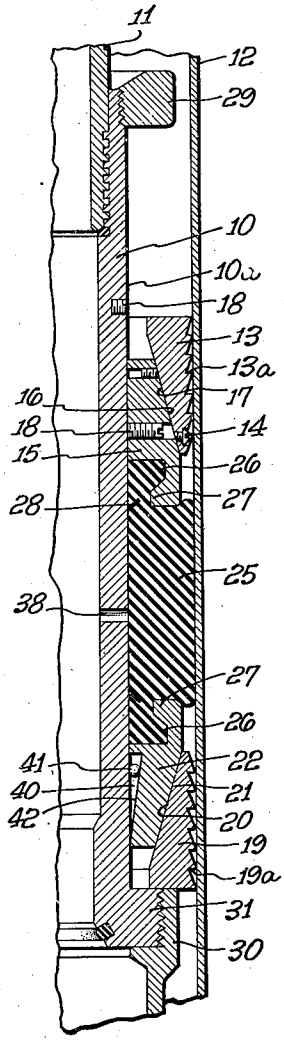


Fig. 3.



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Fig. 4.

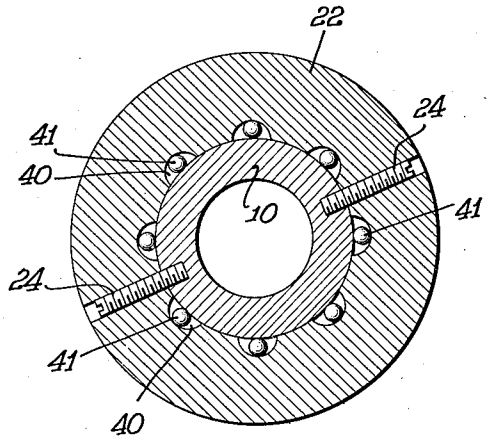


Fig. 5.

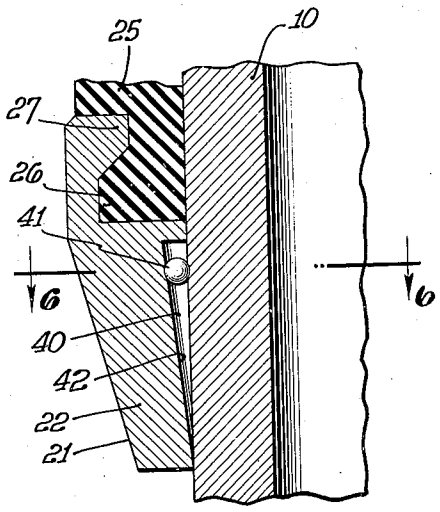


Fig. 7.

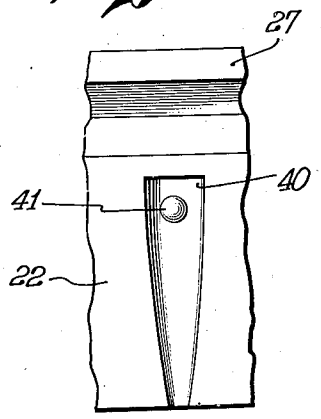
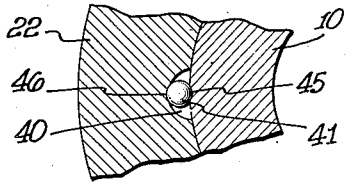


Fig. 6.



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WELL PACKER

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Application July 31, 1945, Serial No. 607,991

6 Claims. (Cl. 166—12)

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This invention relates to well devices, and more particularly to well packers designed to be lowered within and secured to well casings and liners for the performance of desirable functions therein.

Well packers are provided with packing members for effecting a seal between the packer body and the well casing, and also with slips for anchoring the body and other packer parts to the casing. In some forms of packers, such as disclosed in United States Patent No. 2,121,051, setting is effected by relative longitudinal movement in one direction between the body and the slips and cooperable slip expander, longitudinal movement in the other direction being prevented by a suitable lock device. Heretofore, the lock arrangement has been such as to transmit the locking force indirectly to the slips and casing, which tends to loosen the packer and produces its improper anchoring in the casing.

It is, therefore, an object of the present invention to overcome the disadvantage noted by providing a lock arrangement in which the thrust is transmitted directly from the body to the casing engaging slips.

Prior types of lock devices allow a space through which packing materials may flow or be dissipated upon subjecting the packer to high pressure and temperatures. Accordingly, it is a further object of the invention to provide a lock arrangement in a well packer which permits the maintenance of a close fit between the parts, and thus allows no appreciable space through which the packing material may flow.

A further object of the invention is to provide a well packer lock arrangement which not only serves to prevent movement of the packer body with respect to other packer elements in one direction, but also keys the body to such elements to prevent rotation of the body when the well packer is to be removed from the casing by a drilling operation.

Still a further object of the invention is to provide a lock arrangement in a well packer which enables a stronger and sturdier packer to be constructed.

Well packers, wherein the setting or tripping of the slips is performed by inflation of the packing, may include inner lip seals to prevent leakage between the packing and the packer body during the tripping operation. It is another object of the invention to provide a well packer of such characteristics as to prevent leakage between such lip seals and the packer part with which they engage.

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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 to illustrate the general principles of the invention, 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 partly sectional and elevational longitudinal view of a well packer in a well casing, with its parts in retracted position;

Figure 2 is a partial longitudinal section of the well packer in partly tripped condition;

Figure 3 is a partial longitudinal section of the packer fully anchored in packed off condition within the casing;

Figure 4 is a cross-section, taken along the line 4—4 in Figure 1;

Figure 5 is an enlarged fragmentary section of the lock device in locked position;

Figure 6 is a cross-section, taken along the line 6—6 in Figure 5; and

Figure 7 is a fragmentary side elevation of part of the lock device.

The well packer disclosed in the drawings is of the general type shown in United States Patents Nos. 2,121,051, 2,189,703, and 2,222,014. Essentially, it consists of a central tubular body 10 secured to a string of tubing or drill pipe 11, by means of which it is lowered through the well casing 12 to the desired point at which it is to be anchored in packed off condition. The packer is anchored against movement in an upward direction by a set of upper segmental slips 13 initially held in retracted position by shear screws 14 threaded into a conical-like expander 15 slidable on the exterior of the body 10. This expander, whose outer surface 16 tapers in an upward and inward direction to conform to the inner taper 17 on the slips 13, is also initially secured to the body by one or more shear screws 18.

Downward movement of the well packer is prevented by a plurality of segmental lower slips 19 having tapered surfaces 20 inclined downwardly and inwardly and adapted to slide along a companion external tapered surface 21 on the exterior of a lower conical expander 22 which is slidable on the body 10. The lower slips are initially held in retracted position by shear screws 23 securing them to the lower cone 22, and the lower cone is also held in an initial upward posi-

tion with respect to the lower slips by one or more shear screws 24 secured to the body. The lower screws 23, 24 have a greater shear value than the upper screws 14, 18, for reasons hereinafter brought out.

A packing sleeve 25 is provided between the two expanders 15, 22, having external end flanges 26, 26 interlocking with inwardly extending flanges 27, 27 on the expander cones. The sleeve 25 is also provided with internal lip seals 28, 28 at its ends adapted to slidably seal with the external surface 10a of the body 10.

The upper slips 13, when in retracted position, are contained within the circumferential confines of a trip ring 29 secured to the upper end of the body. Similarly, the lower slips 19 are contained initially within the peripheral confines of an abutment at the lower end of the body, defined by a valve housing and guide 30 threaded on a lower body flange 31. This valve guide 30 depends from the body 10, and has a tripping ball seat 32 secured in its lower end by a shear screw 33. An arm 34 extends upwardly from the seat to hold a buoyant back pressure valve ball 35 in ineffective position to one side of the passage 10b through the packer body, in order to prevent its engaging a valve seat 36 at the lower end of the body while the tool is being lowered through the fluid in the well casing.

The tool is run in the well bore with the parts in retracted position, as shown in Figure 1. When the setting point is reached, a tripping ball 37 is lowered or pumped down through the tubular string 11 until it engages the trip ball seat 32, closing the pasage 10b against flow of fluid therethrough. Pressure can then be built up in the tubing string and body to force fluid under pressure through lateral ports 38 in the body into the elastic packing sleeve 25, inflating the latter against the casing and then elongating it in an upward direction to shear the screws 18, 14 holding the upper expander 15 to the body and the upper set of slips 13 to this expander. Such upward movement of the cone 15 causes it to move within the slips 13 and forces the latter radially outward along the abutting trip ring 29 into engagement with the casing 12 (see Figure 2). The tubing string 11 and connected packer body 10 are then elevated to move the body, lower slips 19 and lower cone 22 upwardly with respect to the upper expander 15 and slips 13, foreshortening or compressing the packing unit 25 in a longitudinal direction and thereby expanding it outwardly against the casing to form a leak-proof seal between the body and casing.

After the packing has been thus engaged with the casing, a continuation of the upward strain and movement on the packer body 10 shears the screws 24, 23 holding the lower expander 22 to the body and the slips 19 to the expander 22, the lower abutment 30, 31 shifting the slips 19 longitudinally in an upward direction along the outer surface 21 of the expander and radially into anchoring engagement with the casing 12 (see Figure 3). Such action occurs because the lower expander 22 is prevented from moving upwardly by the casing engaging upper slips 13 and sealed off packing 25. It is to be noted that the wickers 13a on the upper slips 13 face in an upward direction and the wickers 19a on the lower slips in a downward direction, preventing upward movement of the upper cone 15 and downward movement of the lower cone 22, and also precluding shifting of the intervening packing 25.

After both sets of slips have been firmly anchored to the casing, the packer body 10 is incapable of moving in an upward direction because of the engagement of its abutment 30, 31 with the lower slips 19, and a transmission of such upward force through the lower slips 19, lower expander 22, packing member 25, upper expander 15 and upper slips 13 to the wall of the casing 12. Downward movement of the packer body 10 is prevented by providing a one-way type of lock between the lower expander 22 and the body. As shown in the drawing, such lock comprises a plurality of space tapered, longitudinally extending grooves 40 containing rolling elements in the form of balls 41. The base 42 of each groove tapers in the same general direction as the expander surfaces 21, 20 on the lower cone 22 and slips 19, and converges in a downward direction toward the axis of the body and its cylindrical surface 10a. Upward movement of the body 10 with respect to the lower cone 22 is permitted by the automatic upward shifting of each ball locking element 41 into the wide space existing between the exterior 10a of the body and the tapered base 42 of the groove 40. However, downward movement of the packer body 10 causes a wedging of the balls 41 between the packing body and the lower expander 22, the force of such movement being transmitted directly from the body 10, through the expander 22 and lower slips 19, to the casing 12.

In view of the lock and slip arrangement described, the packer body 10 cannot move in an upward direction, because such upward thrust is transmitted through the lower slips 19, lower cone 22, packing element 25, upper cone 15 and upper slips 13 to the casing 12. It cannot move in a downward direction because downward thrust is transmitted directly through the ball lock 41, conical expander 22, and slips 19, to the casing 12. It is to be noted that the lock does not prevent upward longitudinal movement of the body with respect to its surrounding elements, in order to effect a packoff between the body 10 and casing wall 12 and setting of the lower slips 19 firmly against the wall of the casing.

After the upper slips 13 have been tripped and anchored to the casing, additional pressure imposed on the fluid in the tubing string 11 and packer body 10 shears the screw 33 holding the trip ball seat 32 to the valve guide 30 and forces it down out of the guide, releasing the back pressure ball valve 35 and permitting it to engage its seat 36 and prevent return flow of fluid back into the packer body 10.

By positioning the friction ratchet type of lock between the body 10 and the lower expanding member 22, downward force on the body is transmitted directly to the casing through the lower slips without interfering with the packing member 25 or tending to release the upper cone 15 by moving it downwardly with respect to the upper slips 13, as in some prior art devices. There is a further important advantage to locating the lock device between the lower expander 22 and the packer body 10. The direction of the taper of the wedge surfaces 42 in the expander is generally the same as the external tapered surface 21 on the expander, which design permits the cross-section of the material in the expander to be maintained at a maximum amount. For example, if the tapered surface were provided in the upper conical expander, it would have to face in an upward and outward direction, or opposite to the direction in which the outer surface 16 on the upper conical expander faces. Since these two

surfaces would converge towards one another the cross-sectional area would be decreased, causing potential failure of the upper expander under heavy loads.

In view of the location of the locking device at the lower portion of the packer body, the lip seals 28 in the packing member 25 at all times engage along a smooth cylindrical surface 10a on the exterior of the packer body, reducing the chance of leakage therebetween. Moreover, after the packer body 10 has been elevated in order to anchor the packer against movement in both directions with respect to the casing, the only space available at both ends of the packing member through which the packing material might tend to flow under high pressure and temperature conditions is the normal running clearance which is required to permit sliding movement of the packer body 10 within the conical expanders 22, 15. This space is extremely small and is insufficient in extent for dissipation of the packing material from its position between the casing 12 and body 10. In addition, the provision of a friction type of ratchet leaves the entire surface 10a on the exterior of the packer body smooth and cylindrical. It does not provide any external grooves or depressions through which the packing material might flow.

Packers of the type described are usually made of readily drillable material, such as cast iron, aluminum or magnesium, in order that they can be removed from the casing after having accomplished their purpose. Sometimes delays are encountered in completing the drilling operation, because of the rotation of the packer body within the conical expanders. The latter are held against rotation by their wedging action in the slips and anchoring engagement of the latter in the wall of the casing. However, the body member tends to rotate with the drill bit, causing some difficulty in reducing it to small particles which can be washed to the top of the well bore.

The type of locking device disclosed prevents such rotation. The rolling elements 41 are preferably made of steel, being in the nature of ball or roller bearings. Such elements will imbed themselves to a certain extent in both the base 42 of the tapered groove 40 and the external surface 10a of the packer body. The depressions 45, 46 produced in the body 10 and interior of the conical expander 22 by such imbedding serves as a keyway or groove, with the ball 41 locking the body to the expander. This locking action prevents rotation of the body 10 with respect to the lower conical expander 22, and facilitates drilling up of the body under the action of a drill bit.

It is, accordingly, apparent that a well packer has been provided in which movement of the body 10 is prevented in both directions after the packer has been anchored to the casing, in which leakage between the packing member 25 and body is prevented, in which the flowing of the packing material along the exterior of the body is reduced to a minimum, and in which rotation of the drillable body under the action of a drill bit is prevented.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A well tool adapted to be set in a well casing, including a body, an expander slidably mounted on said body and having an external tapered surface inclined downwardly toward the axis of the body, a casing engageable packing at the upper end of said expander, slips movable along said tapered surface to casing anchoring position to prevent downward movement of said expander, said expander having an inner tapered surface inclined downwardly toward the axis of the body, and an element within said expander adapted to be wedged between its inner tapered surface and said body.

2. A well tool adapted to be set in a well casing, including a body, an upper expander slidably mounted on said body, an upper set of slips movable by said expander to casing anchoring position to prevent upward movement of said expander, a lower expander slidable on said body, a lower set of slips movable upwardly by said body along said lower expander to casing anchoring position to prevent downward movement of said lower expander, packing means secured to and between said expanders for effecting a seal between said body and casing, and locking means engageable with said lower expander and body to prevent downward movement of said body within said lower expander after anchoring of said lower slips to said casing.

3. A well tool adapted to be set in a well casing, including a body, an upper expander slidably mounted on said body and having an external tapered surface inclined upwardly toward the axis of the body, an upper set of slips movable along said surface to casing anchoring position to prevent upward movement of said upper expander, a lower expander slidable on said body and having an external tapered surface inclined downwardly toward the axis of the body, a lower set of slips movable upwardly by said body along said lower expander surface to casing anchoring position to prevent downward movement of said lower expander, packing means secured to and between said expanders for effecting a seal between said body and said casing, said lower expander having an inner tapered surface inclined downwardly toward the axis of the body, and an element within said lower expander adapted to be wedged between its inner tapered surface and said body.

4. A well tool adapted to be set in a well casing, including a body having an uninterrupted external cylindrical surface, an expander slidably mounted on said surface and having an external tapered surface inclined downwardly toward the axis of the body, a packing at the upper end of said expander for sealing engagement with the casing and the cylindrical surface of said body, slips movable along said tapered surface to casing anchoring position to prevent downward movement of said expander, said expander having an inner tapered surface inclined downwardly toward the axis of the body, and an element within said expander adapted to be wedged between its inner tapered surface and said body.

5. A well tool adapted to be set in a well casing, including a body having an uninterrupted external cylindrical surface, an expander slidably mounted on said surface and having an external tapered surface converging toward the axis of the body in one longitudinal direction, a packing at the large end of said expander for sealing engagement with the casing and the cylindrical surface of said body, slips movable along said tapered surface to casing anchoring position to prevent movement of said expander in said longitudinal direction, said expander having an inner tapered surface converging toward the axis of the body in the same longitudinal direction as said external surface, and an element within said expander adapted to be wedged between its inner tapered surface and said body.

6. A well tool adapted to be set in a well casing, including a ported tubular body having an uninterrupted external cylindrical surface, an upper expander slidably mounted on said cylindrical surface and having an external tapered surface inclined upwardly toward the axis of the body, an upper set of slips movable along said surface to casing anchoring position to prevent upward movement of said upper expander, a lower expander slidably mounted on said cylindrical surface and having an external tapered surface inclined downwardly toward the axis of the body, a lower set of slips movable upwardly by said body along said lower expander surface to casing anchoring position to prevent downward movement of said lower expander, a packing sleeve secured to and between said expanders and having opposed inner lips engageable with said cylindrical surface on opposite sides of the body ports, said lower expander having an inner tapered surface inclined downwardly toward the axis of the body, and an element within said lower expander adapted to be wedged between its inner tapered surface and said body.

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