June 26, 1945. J. YOUNG, JR 2,379,394

PACKER HOLDING DEVICE

Filed Nov. 12, 1940

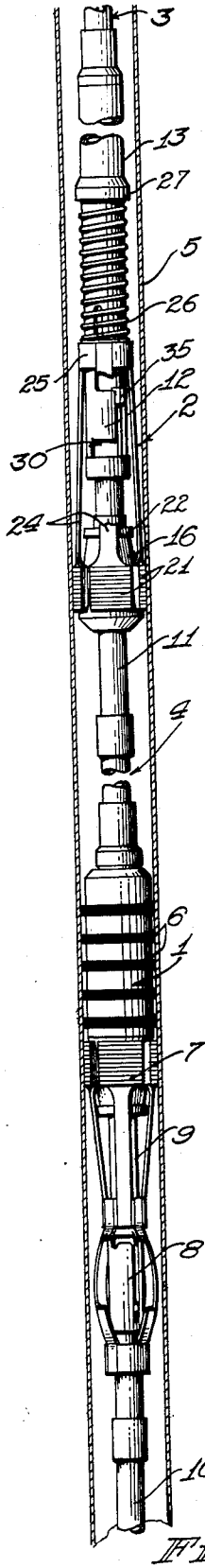


FIG. 1

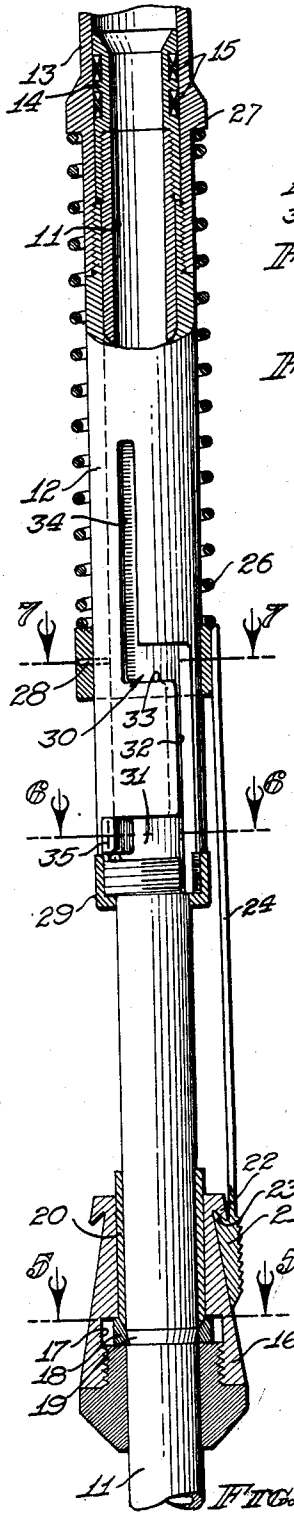


FIG. 2

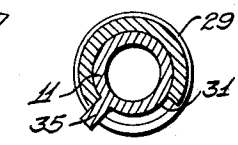


FIG. 6

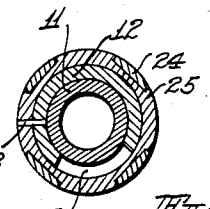


FIG. 7

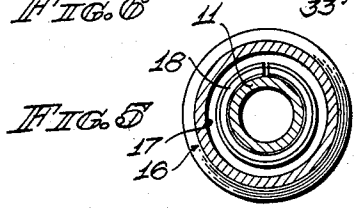


FIG. 5

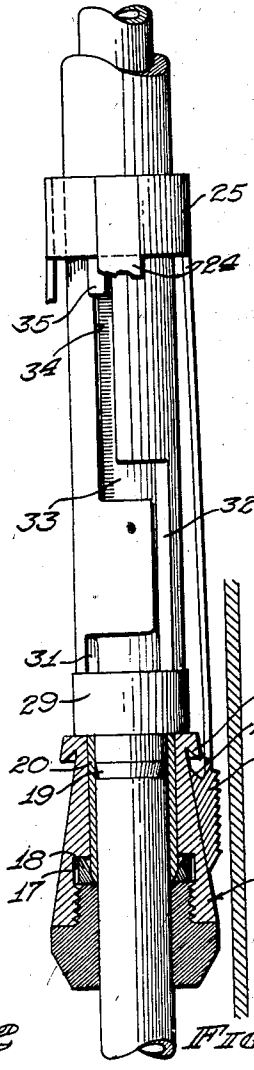


FIG. 3

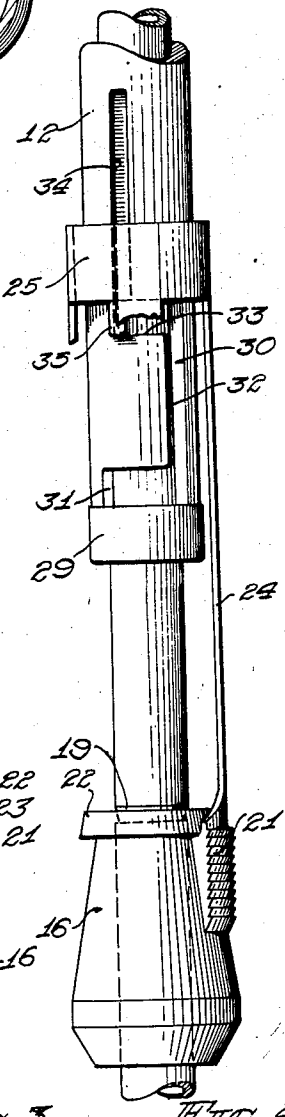


FIG. 4

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Patented June 26, 1945 2,379,394

UNITED STATES PATENT OFFICE

2,379,394

PACKER HOLDING DEVICE

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Application November 12, 1940, Serial No. 365,277

9 Claims. (Cl. 166—12)

My invention relates to packer holding devices. Packers comprise one or more packing elements and an abutment-forming means, such as slip and cone assemblies, which grip the casing. Pack-off is effected between a tubing string, from which the packer is suspended, and a surrounding casing by compression of the packing elements. This is normally accomplished by applying the weight of the tubing string after the slip and cone assembly has gripped the casing. The tubing, being under compression, tends to bend within the limits of the casing and renders difficult the movement of tools, sucker rods, pump assemblies or other devices through the tubing. Among the objects of my invention are:

First, to provide a packer holding device which is mounted on the tubing above a conventional packer and which is adapted to grip the casing in such a manner that after the packer is set the tubing weight may be lifted from the packer so that the tubing may hang free and, therefore, as straight as the casing permits;

Second, to provide a packer holding device which is particularly adapted for use in conjunction with various gas lift apparatus, whether the lifting gas is supplied from the well mouth or from a gas zone located above the packer, such as the systems known commercially as the "Otis side door choke" or the "Nixon gas lift system";

Third, to provide a device of this class which is readily set or released by manipulation of the tubing string but which in no manner interferes with the normal tubing manipulation required to set or release a conventional packer; and

Fourth, to provide a device of this character which is particularly simple and economical of construction, virtually fool-proof, sturdy and fully capable of withstanding the hard use and abuse to which tools of this character are subjected.

With the above and other objects in view, as may appear hereinafter, reference is directed to the accompanying drawing, in which:

Figure 1 is an elevational view of my packer holding device shown in association with a conventional packer, both set within a well casing;

Figure 2 is an enlarged partial elevational, partial sectional view of my packer holding device when the parts are in their initial position assumed when the device is lowered into the oil well;

Figure 3 is a similar partial sectional, partial elevational view showing the packer holding device in the position assumed as it is released from its securing position;

Figure 4 is a similar elevational view showing the packer holding device in its final position assumed when the packer holding device and packer are being removed from the well; and

Figures 5, 6 and 7 are transverse sectional views through 5—5, 6—6 and 7—7, respectively, of Figure 2.

As shown in Figure 1, a conventional packer 1 and my packer holding device 2 are suspended from a tubing string 3 with the packer holding device positioned above the packer and, if desired, a gas lift unit 4 interposed between the packer holding device and packer. For example, the gas lift may be a gas intake valve adapted to introduce gas into the tubing string. The gas may be supplied from the well mouth between the tubing and casing 5 in which the tubing and packer are set, or may be introduced through perforations provided in the casing 5 at some point above the packer, preferably at a point between the packer and packer holding device.

A conventional packer, such as illustrated in Figure 1, comprises packing elements 6 and a slip and cone assembly 7 which are mounted on a mandrel 9. A pin and bayonet slot joint 8 is incorporated in the slip and cone assembly and is so arranged that by turning the mandrel 9 the slip and cone assembly may be released to grip the walls of the casing and form an abutment for the packing element or elements, so that when the weight of the tubing is applied to the packer the elements will be expanded against the surrounding casing. Below the packer there is suspended from its mandrel 9 an intake tube or strainer 10. Thus the packer serves the purpose of isolating the gas introduced into the gas lift unit 4 from the casing below the packer.

The purpose of the packer holding device is to hold the packing elements in their expanded position even though the weignt of the tubing string above may be removed. The packer holding device comprises a mandred 11 which is connected at its lower end to the gas lift unit 4. The mandrel extends upwardly through a lower sleeve 12 and into an upper sleeve 13. The upper sleeve 13 has a larger bore than the lower sleeve, forming therewith a shoulder. The upper end of the mandrel 11 is provided with a head 14 fitting the enlarged bore of the upper sleeve and adapted to engage the shoulder between the two sleeves so as to limit downward movement of the mandrel. The head 14, which is screwthreaded to the mandrel, is in the form of a short tubular section and is provided with external grooves in which are fitted sealing rings 15; these ride against the interior surface of the upper sleeve to form a fluid-

tight but sliding connection between the mandrel and upper sleeve.

A cone 16 is fitted on the mandrel below the lower sleeve 12, in spaced relation therewith, when the mandrel is in its lower position. The cone 16 is in the form of a sleeve with an upwardly converging conical outer surface. The cone is provided with an internal channel 17 which receives a slip retainer ring or locking ring 18 adapted to fit, initially, into a groove 19 provided around the mandrel 11, the groove and locking ring forming a locking or latching means. Above the channel 17 the bore of the cone is enlarged so as to accommodate a spreader sleeve 20 which fits around the mandrel. The lower end of the spreader sleeve and the inner periphery of the retainer ring are beveled so that upon downward thrust of the spreader sleeve the retainer ring 18 is expanded free of the groove 19, so that the cone may move downwardly on the mandrel from the position shown in Figure 2 to the position shown in Figures 3 and 4.

The cone 16 is adapted to receive a plurality of slips or segmental wedges 21 which are provided with teeth in their outer periphery for engagement with a surrounding casing. The upper or smaller end of the cone 16 is provided with an undercut flange 22 which coacts with tongues 23 provided on the upper or larger end of the slips to hold the slips in a retracted position.

The slips 21 are connected to reins 24 in the form of straps which extend upwardly to a collar 25 slidably mounted upon the lower sleeve 12. The collar is urged downwardly by a spring 26 fitting around the sleeves 12 and 13, a shoulder or abutment 27 being provided on the upper sleeve 13 for the upper end of the spring 26. Initially, however, the spring is restrained from action by means of a shear pin 28 extending through the collar into the lower sleeve 13.

The lower end of the lower sleeve may be screwthreaded to receive a cap 29. The lower sleeve 12 is provided with a slot 30 which comprises a lower arcuate or horizontal portion 31 which is joined at its right-hand side, as viewed in the figures, by a lower vertical portion 32 which extends upwardly until it joins an upper horizontal portion 33 extending arcuately to the left as viewed in the figures. An upper horizontal portion 33, in turn, joins an upper vertical portion 34. The mandrel 11 is provided with a key bar 35 which fits the slot 30 and is adapted to travel in the various portions thereof. The lower vertical portion 32 constitutes the initial or first vertical portion of the slot and coacts with the key bar 35 to permit an initial or first movement of the sliding joint, while the upper vertical portion 34 constitutes a final or second portion of the slot and coacts with the key bar 35 to permit a second or final movement of the sliding joint.

My packer holding device operates as follows: The packer holding device and packer are made up on the tubing string with the packer holding device above the packer and, if desired, a gas lift unit between. A strainer depends from the packer. Initially, the packer holding device is arranged with its parts in the position shown in Figure 2, that is, the key bar 35 is in the lower horizontal portion 31 of the slot 30. The collar 25 is held by the shear pin 28 and the slips 21 are retracted on the cone 16. The packer is arranged with its pin in the upper cross portion of the bayonet slot, which it will be noted is in the form of an inverted J. Its slips likewise are retracted and the packing elements are also retracted.

When the desired location is reached the tubing string is rotated to the right, as viewed in the figures, which moves the pin of the packer from the cross portion of the bayonet slot to the vertical portion thereof. In this connection, it should be noted that the force is transmitted from the sleeve 12 to the key bar 35 so that the key bar does not move from its horizontal portion 31 by rotation to the right. Weight is applied to the packer by lowering the tubing, which causes the slips of the packer to ride up on the packer cone and engage the casing. Further compression expands the packing element.

However, before weight is applied to the packer the tubing is again lifted just sufficiently to take the weight of the tubing off the packer and, consequently, the weight of the tubing off the key bar 35. When this weight is removed the tubing and sleeve 12 are rotated to the left, as viewed in the drawing, moving the lower vertical portion 32 of the slot 30 in alignment with the key bar 35.

The sleeve 12, collar 25, reins 24 and slips 21 may now move as a unit downwardly, the vertical portion 32 of the slot 30 accommodating the key bar 35. This movement wedges the slips between the cone 16 and casing.

When the slips 21 are wedged between the cone 16 and casing, further movement of the sleeve shears the pin 28 and the spring 26 then supplies the force tending to hold the slips in their wedging position. Continued downward movement of the tubing and sleeve 12 brings the key bar 35 to the upper end of the vertical portion 32 of the slot 30, so that continued application of the weight of the tubing transmits downward force to the key bar and, consequently, to the packer.

Sufficient force is applied to fully set the packer, that is, expand the packing elements tightly against the casing. The sleeve 12 and tubing 3 are then raised just sufficiently to remove the weight of the tubing from the packer. The packer, however, is prevented from releasing by the fact that the cone 16 is held against upward movement by its slips 21. The key bar 35, when such condition obtains, occupies some position along the length of the lower vertical portion 31, as shown in Figure 1, and the tubing 3 hangs in suspension, entirely free of any compression load, although the comparatively short mandrel 11 between the cone 16 and packer remains under compression. If desired, an upward strain may be taken on the tubing 3 in excess of its weight, so that the entire tubing string 3 is under tension, for, as shown in Figure 1, the tubing 3 and sleeve 12 may be raised until the horizontal portion 31 of slot 30 engages the bar 35 to transmit an upward thrust to the cone 16 without disturbing the slips 21.

To release the holding device and packer the tubing is lowered and rotated to the right, as viewed in the drawing, so that the key bar 35 moves into the upper horizontal portion 33 of the slot 30 until it aligns with the upper vertical portion 34. Continued downward movement of the tubing and sleeve causes the cap 29 at the lower end of the sleeve 12 to engage the spreader sleeve 20 extending above the cone 16. The upper vertical portion 34 of the slot 30 is sufficiently long to enable the spreader sleeve 20 to be forced

downwardly and spread the retainer ring 18 so that the cone 16 may be forced downwardly from the position shown in Figure 2 to the position shown in Figure 3. As the key bar 35 reaches the upper end of the upper vertical portion 34 of the slot 30 it engages the collar 25 and prevents the slips from traveling downwardly under urge of the spring 26. Consequently, when the cone 16 is forced downwardly the slips move inwardly away from contact with the casing. The cone, being free, tends to drop down until the cone and slips occupy their initial relative position, although both are located lower with respect to the mandrel than the initial position shown in Figure 2.

After the continued downward movement of the tubing and sleeve 12 has been completed the tubing is raised, which again returns the key bar 35 to the upper horizontal portion 33, both the slips and cone, as well as the pin, remaining stationary. Continued upward movement of the tubing releases the packer and the whole assembly may be removed from the well.

Various changes and alternate arrangements may be made within the scope of the appended claims, in which it is my intention to claim all novelty inherent in the invention as broadly as the prior art permits.

I claim:

1. A well tool comprising: a mandrel; a slip expander slidable thereon and having downwardly diverging operating faces; a releasable locking means connecting said expander and mandrel; a sleeve slidable on said mandrel above said slip expander; slips suspended from said sleeve and movable thereby downwardly for wedging action between said slip expander and a surrounding casing; yieldable means operatively connecting said sleeve and slips whereby said sleeve is capable of additional downward movement while said slips remain wedged; and means operatively connecting said sleeve with said locking means, upon such additional movement, to disengage said locking means and free said slip expander for sliding movement on said mandrel, thereby to free said slips from wedging engagement with the surrounding casing.

2. A construction, as set forth in claim 1, wherein said slips are connected to said sleeve by a shearable means initially restraining said yieldable means, and wherein said sleeve is provided with a longitudinally extending circumferentially stepped slot, and said mandrel is provided with a coacting key to control said slip wedging movement and additional downward movement of said sleeve.

3. The combination with a tubing string and a well packer, wherein the well packer requires a material downward thrust, normally supplied by the weight of the tubing string, in order to remain in a packing position, of a hold-down tool for maintaining such downward thrust irrespective of the application of the weight of said tubing string, said hold-down tool comprising: a mandrel extending upwardly from the packer; a slip expander slidable on said mandrel; a releasable locking means connecting said expander and mandrel; a sleeve connected with said tubing string and slidable on said mandrel above said slip expander; slips suspended from said sleeve and movable thereby downwardly for wedging action between said slip expander and a surrounding casing to hold said mandrel against upward movement; yieldable means operatively connecting said sleeve and slips whereby said sleeve is capable of additional downward movement while said slips remain wedged; and means operatively connecting said sleeve with said locking means upon such additional movement to disengage said locking means and free said slip expander, thereby to release said slips.

4. A well tool comprising: a mandrel element; a slip-expander element slidable thereon; a locking means carried by one of said elements and initially interlocking with the other of said elements for securing said expander element in fixed longitudinal position on said mandrel element; and a releasing member positioned between said mandrel element and said slip-expander element and slidable on said mandrel element for engaging and actuating said locking means, thereby to free said slip-expander element for slidable movement on the said mandrel element.

5. A well tool comprising: a mandrel element; a slip-expander element slidable thereon; a locking ring carried by one of said elements and engaging a groove in the other of said elements for securing said expander element in fixed longitudinal position on said mandrel element; and a sleeve slidable between said elements on said mandrel element into operative contact with said locking ring to disengage said locking ring from said groove to free said slip-expander element for slidable movement on said mandrel element.

6. A well tool comprising: a mandrel element; a slip-expander element slidable thereon; a chamfered locking ring carried by one of said elements and engaging a groove in the other of said elements for securing said expander element in fixed longitudinal position on said mandrel element; and a releasing member slidable between said elements on said mandrel element into operative contact with the chamfer of said locking ring to expand said locking ring from engagement with said groove to free said slip-expander element for slidable movement on said mandrel element.

7. A well tool comprising: a mandrel element; a slip-expander element slidable thereon; a locking ring carried by one of said elements and engaging a groove in the other of said elements for securing said expander element in fixed longitudinal position on said mandrel element; a sleeve slidably interposed between said elements and positioned to make operative contact with said locking ring; and means slidable on said mandrel element for engaging and moving said sleeve to disengage said locking ring from said groove to free said slip-expander element for slidable movement on the said mandrel element.

8. A well tool comprising: a mandrel element; a slip-expander element slidable thereon and having downwardly diverging operating faces; locking means carried by one of said elements and interlocking with the other of said elements to secure said expander element in fixed position against longitudinal movement relative to said mandrel element; slips supported slidably on said mandrel element and movable expandibly downward over said slip-expander element to set by wedging action between said expander element and a surrounding casing; a releasing member slidable on said mandrel element between said slip-expander element and said mandrel element for engaging and actuating said locking means to free said slip-expander element for slidable movement downward on said mandrel element; and thereby to release and retract said slips from

wedging action between said expander and a surrounding casing.

9. A well tool according to claim 8, in which said slips are slidably supported on said mandrel by means of a sleeve slidable on said mandrel element and connected with said slips, and said sleeve having a stepped keyway formed by a pair of longitudinally extending and circumferentially offset slots interconnected at their adjacent ends by an intermediate circumferentially directed slot forming an intermediate step; a coacting key on said mandrel adapted to move in said stepped keyway, said keyway and key being thus adapted to prevent relative rotation but to permit an initial limited longitudinal movement of said sleeve relative to said mandrel sufficient to set said slips and, upon movement of the key through the said intermediate circumferential slot, to permit an additional limited movement of said sleeve relative to said mandrel sufficient to actuate said releasing member.

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