ABSTRACT: A well packer, which includes upper and lower slips and cones for permanent anchorage in a casing or the like, is provided with means for releasing the slips and retrieval of the packer without damage to either the casing or the packer. The upper cone is collapsible and is wedged between the upper slip and supported by a laterally shiftable support ring slidably positioned on a mandrel having an annular recess adjacent the ring. The upper slip is disengaged by shifting the mandrel until the support ring drops into the recess, allowing collapse of the cone and release of the slip. Thereafter, the mandrel is lifted to carry the upper slip away from the upper cone.
3,631,925

1 RETRIEVABLE PERMANENT WELL PACKER
BACKGROUND OF THE INVENTION

This invention relates to well packers and the like, and more particularly relates to permanently anchored packers which are adapted to be retrieved without damage to either the well or the packer.

There are many instances such as well production operations wherein it is desirable to define and segregate one portion of a borehole from another. In those instances wherein the borehole is lined with a steel casing or the like, this is achieved by setting a packer assembly in the casing at such depth as may be desired. In some instances, it may be desired that the well be "packed off" only temporarily, wherein in many other instances it is intended that the packer be permanently set in the well. So-called "temporary packers" are usually designed to be wedged in the casing in such manner as to resist movement in only one direction. This is because retrieval of a temporary packer is usually achieved by shifting in the opposite direction to disengage it from the interior of the casing. On the other hand, "permanent" packers are wedged in the casing in a manner opposing movement in either direction. Hence, most permanently anchored packers cannot be dislodged without damage to either the casing or the packer.

It is common occurrence for it to become desirable to remove a packer that has been permanently installed. Since this usually requires a drilling operation with consequent destruction of the packer, the cost can be quite costly. Moreover, it has become common to construct permanent packers of drillable materials so that they can be easily shattered by the drill bit. Although this provides a substantial saving insofar as drilling time is concerned, it has the disadvantage in some cases that a fragile packer may be an inherently weaker packer. Furthermore, the fragments and other debris from the shattered packer tend to clutter the bottom of the borehole and may interfere with subsequent operations. In addition, a permanent packer is an expensive piece of equipment as such.

There have been many attempts to provide a packer which is adapted to be anchored immovably in the borehole, but which is also adapted to be retrieved whenever desired without damage to either the packer or the interior of the borehole or casing. However, none of these retrieval permanent packers have met with complete acceptance by the oil and gas industry.

In many cases, the packers have been both anchorable and retrievable, but either special setting techniques or equipment have been required to install the packer, or else special retrieval techniques and equipment have been necessary. In these cases, it has often cost more to retrieve such a packer than it would have cost to drill through and destroy it. Other packers such as that depicted in U.S. Patent No. 3,398,795, have been capable of being installed and retrieved by special setting and removal of equipment, however such equipment and the packer itself are quite expensive.

These and other advantages of the prior art are completely overcome with the present invention, and novel packer means is provided herein which is adapted to be anchored immovably in a well casing or the like by convention setting techniques, and which is also adapted to be selectively retrieved by conventional retriever techniques and equipment without damage to either the packer assembly or the casing.

THE INVENTION

In a preferred embodiment of the invention, a packer assembly is provided which has a conventional elastic packing body located intermediate of upper and lower slips and conventional generally conventional design and function. Thus, the packer may be anchored permanently in a well casing or the like by setting the upper slips in a conventional manner to oppose upward movement of the packer, and by setting the lower slips in a conventional manner to oppose downward movement of the packer in the casing.

In the subject well packer, there is provided a mandrel having an annular groove of suitable size which is located below the position assumed by the upper expander assembly when the packer has been "set" in the casing or tubing. The upper expander assembly is constituted by laterally shiftable segments that are normally supported in outer positions for coaction with the slips. A suitable slip or support ring is slidably located about the mandrel and positioned so as to be located between the mandrel and the upper tips or toes of the expander segments to support them against the upper slips which are wedged between the upper cones and the inside surface of the casing.

When the packer is sought to be retrieved, the mandrel is released relative to be lower slip and expander and then lifted until the aforementioned recess is brought beneath the support ring. The support ring then compresses or snaps into the recess to remove support from the toes of the expander segments, and the toes can collapse inwardly against the surface of the mandrel to release the upper slips from the inside surface of the mandrel to release the upper slips from the inside surface of the casing.

When the mandrel is lifted further through the casing, this will draw the upper slips entirely free of the casing without the least scoring of its surface. The resilient packing body, which was previously compressed between the upper and lower cones when the packer was anchored, was released by disengagement of the upper slips. Thus, the lower cone is effectively released from the lower slips when the upper cone assembly is collapsed from under the upper slips. Accordingly, further upward travel of the mandrel initially engages and draws the lower cone from under the lower slips, and thereafter the lower slips are drawn from engagement with the casing.

It will be seen that in a packer assembly such as that depicted in the aforementioned U.S. Patent No. 3,398,795, the upper cone is disengaged from the upper slip or slips by dragging the support ring out from under the upper cone or cones which are wedged therebetween. This is extremely disadvantageous for several reasons. In the first place, the ring is wedged very tightly between the mandrel and the upper cone or cones, and thus the ring is often damaged beyond repair when the packing assembly is retrieved. The cost of a new support ring is relatively small. However, it is necessary to completely disassemble the packing assembly before a new support ring can be installed, and this is quite expensive.

Another more critical aspect is the fact that the toe portion of the upper cone is the weakest portion of this component. When the support ring is dragged upwardly past the toe of the upper cone, this applies a distorting force directly to this weak spot of the cone, and this frequently damages a relatively much more expensive portion of the packing assembly.

In the present invention, there is no binding between the ring and the upper cone since these two components remain stationary with respect to each other, until after the upper cone and slip are effectively disengaged from each other and the upper slip is effectively released from the casing. This is because, in the present invention, the recess is brought to the support ring whereas, in the prior art hereinbefore mentioned, the support ring is dragged from between the mandrel cone and before the cone is disengaged from the slip, and before the upper slip is disengaged from the casing. Therefore, the support ring can be completely withdrawn from between the upper cone and the mandrel without any significant binding between these components. Accordingly, the arrangement which is embodied in this aspect of the present invention provides for a more positive release of the upper slips from the casing than can be obtained with the apparatus of the prior art.

In another feature of the present invention, there is included provision for a positive latch between the lower ends of the mandrel and the lower slip carrier. More particularly, there may be included a suitable bail- and detent-locking assembly for this purpose, whereas in the prior art such as in the aforesaid U.S. Patent No. 3,398,795, this function is performed.
by a collet lock assembly. In this prior art, there is no provision for keeping the lower slip carrier locked or otherwise secured to the mandrel after the production string has been removed. In the present invention, however, the mandrel and the lower slip carrier are locked together at all times until specifically released as will hereinafter be explained.

Accordingly, it is an object of the present invention to provide an improved packing assembly which is adapted to be immovably or permanently anchored in a casing or the like, and which is also retrievable without damage to or loss of any portion of the assembly and without damage to the casing. It is further an object of the present invention to provide an improved packing assembly which is adapted to be immovably or conventionally retrieved and equipment without damage to or loss of any portion of the packing assembly and without damage to the casing.

These and other objects and features of the present invention will become apparent from the following detailed description, wherein reference is made to the figures in the accompanying drawings.

IN THE DRAWINGS

FIGS. 1A and 1B are pictorial representations, partly in cross section, of the upper and lower portions of a packing assembly which exemplifies the present invention, and which is disposed in a relaxed condition prior to being anchored in a casing or tubing.

FIGS. 2A and 2B are similar pictorial representations of the apparatus depicted in FIGS. 1A and 1B, respectively, wherein the packing assembly illustrated therein has been anchored in the casing.

FIGS. 3A and 3B are also pictorial representations of the apparatus depicted in FIGS. 1A and 1B, respectively, wherein the packing assembly illustrated therein is shown in a disengaged condition for retrieval from the casing.

DETAILED DESCRIPTION

Referring now to FIGS. 1A and 1B, there may be seen a pictorial representation, partly in cross section, of the upper and lower portions of a production packer exemplifying the concepts of the present invention. More particularly, the packing assembly may be seen to include a suitable mandrel 13 with a suitable collar 10 secured to its upper end by threads 12 and having internal ratchet threads 11 and an inside annular latching recess 50. An upper slip carrier 14 is preferably slidable and pivotable on the upper end of the mandrel 13, and may be temporarily secured to the collar 10 by a shear pin 16 or other suitable tangible device. A conventional locking ring 17 having internal teeth or ratchet threads may be disposed within the annular recess 18 for opposing upward movement of the upper slip carrier 14 about the mandrel 13, and a snap ring 19 or other suitable means of conventional design may also be included to retain the locking ring 17 in the recess 18.

As may further be seen in FIG. 1A, an upper slip 20 of generally conventional configuration may be secured to the lower end of the upper slip carrier 14 by means of a suitable lock pin 21. Accordingly, the upper slips 20 are arranged to be downwardly and outwardly urged into engagement with the tubing or casing 2 by an upper expandable cone 24 which is preferably provided with an inside annular shoulder portion 25 slidable abutting the surface of the mandrel, whereby the upper tapered edge or "toe" portion of the cone 24 is suitable spaced from the surface of the mandrel 13. The toe portion of cone 24 has its outer surface in contact with slip 20 thereby forming an expander portion. The shoulder portion 25 of cone 24 is longitudinally spaced from the toe portion and thus defined a pivot region. A resilient support ring 22, which is preferably contractable about the surface of the mandrel 13, is preferably located between the mandrel 13 and the toe portion of the cone 24, and a shear pin 23 or other suitable frangible means may be provided for securing the support ring 22 to the cone 24.

A plurality of elastic annular packing bodies 30 may be mounted centrally on the mandrel 13. Detent rings 26 and 31 are disposed in annular grooves 28 and 34 in order to prevent premature setting in a typical manner. As may further be seen in FIGS. 1A and 1B, the exterior portion of the detent ring 26 extends into the annular recess 27 in the base of the upper cone 24 and engages the tip packing ring 30, and the detent ring 31 extends outwardly from the mandrel 13, and into the recess 33 in the top of the lower cone 32. Accordingly, during running the rings 26 prevents the packing 30 from moving the expander cone 24 upwardly, and the ring 31 prevents the lower expander 32 from moving upwardly against the packing.

It will be noted, however, that the lower edge of both recesses 28 and 34 are located at an angle relative to the axis of the mandrel 13. Accordingly, upward movement of the mandrel 13 can occur during compression of the packing bodies 30 into fluidtight engagement with the casing 2.

An annular snap ring 35 may be seen to be disposed centrally in the lower cone 32, and adjacent the mandrel 13. This ring 35 is cooperative with an annular groove 49 in the mandrel 13 in a manner to be more fully described hereinafter. In addition, lower slips 36 of conventional design may be slidably disposed on the mandrel 13 below the lower cone 32, and may be anchored to the upper end of a lower slip carrier 38 by means of one or more pins 37.

As illustrated in FIG. 1B, a locking collar 42 having an inside annular shoulder 44 is preferably secured to the lower end of the mandrel 13 by means of threads 43 whereby the shoulder portion 44 abuts the end of the mandrel 13. In addition the locking collar 42 may be provided with a ball recess 45 for supporting a suitable locking ball 41 having a diameter slightly larger than the cross-sectional thickness of the locking collar 42. Thus, the ball 41 will be urged into an inside annular recess 40 in the lower end of the lower slip carrier 38, when an appropriate end fitting 46 is slidably disposed within and at the lower end of the locking collar 42 as illustrated in FIG. 1B.

The end fitting 46 may be provided with an external rim or shoulder portion 48 engaging the lower end of the mandrel 13, and a shear pin 47 or other suitable frangible means may be provided for temporarily securing the end fitting 46 to the lower end of the mandrel 13.

The upper slip 20 may be a single annular member having grooves to provide for radial expansion and contraction, as indicated in FIG. 1A. Alternatively, the upper slip 20 may be composed of several separate and independent slip segments of conventional design, and may be maintained circumferentially about the mandrel 13 by any suitable means such as an elastic locking ring (not depicted). Further, the upper cone 24 may be composed of separate expande members of conventional design, or the upper cone 24 may also be composed of a single-slotted annular member such as that depicted in FIG. 1A, and which is adapted to be expanded and contracted about the circumference of the mandrel 13. The lower cone 32 and slip 36 may be generally similar in configuration to the upper cone and slip 20, respectively.

As further depicted in FIGS. 1A and 1B, the packing assembly is illustrated prior to being anchored in the casing 2. Such an assembly may be anchored by any conventional technique, such as by the use of a setting tool 2 having a compression member 4 arranged and adapted to drive the upper slip carrier 14 downwardly along the mandrel 13, and a tension member 5 for drawing the mandrel 13 upwardly through the casing 2. More particularly, the tension member 5 may include a locking sleeve 7 slidably mounted thereon and temporarily secured thereto by a shear pin 15. The locking sleeve 7 may further include a plurality of collet fingers 8 having tips 9 wedged by the locking flange 6 into the annular latching recess 50 in the collar 10 when the setting tool 3 has been inserted in the collar 10.

Referring now to FIGS. 2A and 2B, there may be seen an illustration of the packing assembly depicted in FIGS. 1A and
3,631,925

1 When anchored immovably in the casing 2. As indicated in FIGS. 1A and 1B, the packing assembly is anchored by simultaneously driving the compression member 4 of the setting tool 3 downward against the upper slip carrier 14 and applying tension to the tension member 5. More particularly, the shear pin 16 is severed when the upper slip carrier 14 is driven downwardly along the surface of the mandrel 13, and this, in turn, will permit the upper slip 20 to be shifted outwardly over the upper cone 24 and into gripping engagement with the casing 2. When this occurs, the upper slip 20 and cone 24 are fixed with respect to the casing, and further upward movement of the mandrel 13 will cause the lower slips 36 to be set and the packing 30 to be compressed and expanded against the casing. The lower slip carrier 38 moves upwardly with the mandrel 13 due to the provision of the ball latch 41 which is held in the recess 40 by the end fitting 46.

When the packing 30 and slips 20 and 36 are fully set, the tension force in the member 5 will cause the pin 15 to shear. Upward movement of the flange 6 relative to the latch heads 9 will release the latch heads from the recess 50 and enable withdrawal of the setting tool from the well. The lock ring 17 will trap the mandrel 13 in the highest relative position to which it is moved, so that the packer is immovably set in the casing 2.

In order to retrieve the packer intact from the well bore, a graphtype retrieving tool is used. As indicated in FIGS. 3A and 3B, a particularly suitable retrieval tool 51 may include a tension member 53 adapted to be inserted in the upper end of the collar 10 for the purpose of engaging the ratchet threads 11, and a collecting or engaging member 52 having provision for engaging and supporting the end fitting 46. More particularly, the engaging member 52 may be seen to be composed of an elongated member having an enlarged end portion 54 containing a latch member 55 adapted to securely engage the end fitting 46 after it has been detached from the lower end of the locking collar 42. In particular, the latch member 55 may be positioned in a suitable recess 57 in the supporting portion 54 of the engaging member 52, and is preferably urged outwardly of the recess 57 by a suitable spring 56.

Referring again to FIGS. 3A and 3B, the depicted packing assembly is retrieved by conveniently stabbing or inserting the thread lower end of the tension member 53 into the upper end of the collar 10 as hereinbefore described, and by thrusting the engaging member 52 completely through the mandrel 13 until the latch member 55 engages opposite the end fitting 46. The spring 56 will urge the latch member 55 outwardly into engaged relation with the end fitting 46, and the weight is applied to force the end fitting downwardly to shear the pin 47. When the pin 47 is severed, the end fitting 46 will be slidably driven out of the locking collar 42 to release the ball latch 40. This permits the slip carrier 38 from the mandrel 13 and enables upward movement of the mandrel. The end fitting 46 is kept from falling free of the packing assembly by the latch member 55.

Now the tension member 53 can be used to lift the mandrel 13 and locking collar 42 upwardly a limited distance through the casing 2, and such upward movement will be independent of the upper and lower slips 20 and 36. The inside teeth of the locking ring 17 are preferably directed so as to prevent upward movement of the locking ring 17 along the surface of the mandrel 13, but so as not to oppose upward movement of the mandrel 13 relative to the locking ring 17.

The upper slip 20 will remain in locking engagement with the casing 2 until the mandrel 13 is raised sufficiently to position the recess 29 opposite the collapsible support ring 22. When this is achieved, however, the support ring 22 will collapse or retract into the recess 29. When this occurs, the toes of the upper cone segments 24 will shift inwardly and release the upper slip 20. The inward drifting of the toe portions is a function of the toe positions pivoting laterally with respect to the picot region defined by shoulder portion 25. Thus, further upward movement of the mandrel 13 will carry the supporting ring 22 upward from under the toe of the upper cone 24 to disengage the upper slip 20 from the inside wall of the casing 2.

Referring now to FIG. 3B, it will be noted that when the mandrel 13 travels far enough upward to position the recess 49 adjacent the elastic stop rings 31 and 35, these rings will drop into the recess 49 and will engage and carry the lower cone 32 from under the lower slip 36. This, in turn, disengages the lower slip 36 from the casing 2 and permits the lower slips 36 to be carried upwardly through the casing by the lower slip carrier 38 which is supported by the upper end of the locking collar 42.

It will be noted that the upper slip carrier 14 and upper slip 20 are linked together by the pin 21. Accordingly, upward travel of the upper slip carrier 14 will carry it with the upper slip 20. The upper cone 24 will be lifted through the casing 2 by the packing bodies 30 which are supported on the mandrel 13 by the elastic support ring 31 and the lower cone 32.

It will be apparent from the foregoing that many other variations and modifications may be made in the structures and methods described herein without substantially departing from the essential concept of the present invention. Accordingly, it should be clearly understood that the forms of the invention described herein and depicted in the accompanying drawings, are exemplary only and are not intended as limitations in the scope of the present invention.

What is claimed is:

1. A well packer apparatus comprising: an elongated body member adapted to be disposed in a well casing or the like; annular expansible packing means disposed about said body member; upper slip and expander means disposed on said body member above said packing means; lower slip and expander means disposed on said member below said packing means; one of said expander means being laterally movable between an outer position of supporting engagement with a respective one of said slip means, and an inner position enabling inner movement of said one slip means; laterally movable support means for normally supporting said one expander means in said outer position and release means on said mandrel for enabling lateral inward movement of said support means and said one expander means, thereby enabling inward movement of said one slip means.

2. The well packer apparatus of claim 1 wherein said support means includes an expansible and contractable ring, said release means comprising an annular groove in said mandrel into which said ring is movable.

3. The well packer apparatus for claim 1 further including carrier means on said body member for supporting the other of said slip means, said carrier means being longitudinally movable relative to said body member; and selectively releasable connection between said carrier means and said body member for normally preventing longitudinal movement between said carrier means and said body member.

4. The well packer apparatus of claim 3 further including means for limiting longitudinal relative movement between said carrier means and said body member after release of said releasable connection.

5. A well packer apparatus comprising: an elongated body member adapted to be disposed in a well casing or the like; annular expansible packing means disposed about said body member; upper slip and expander means disposed on said body member above said packing means; lower slip and expander means disposed on said body member below said packing means; one of said expander means having an expander portion and a pivot region spaced longitudinally from said expander portion, said expander portion being adapted to pivot laterally with respect to said pivot region between an outer position of supporting engagement with a respective one of said slip means, and an inner position enabling inward movement of said one slip means; support means for normally preventing pivotal movement of said expander portion about said pivot region; and release means responsive to longitudinal movement of said body member relative to said one slip means for disabling said support means to enable pivotal movement of said expander portion and inward movement of said one slip means.
6. The well packer apparatus of claim 5 further including a carrier member slidably disposed on said body member for supporting the other of said slip means; and selectively releasable means for normally preventing sliding movement between said carrier member and said body member.

7. The well packer apparatus of claim 6 wherein said selectively releasable means comprises laterally movable means on said body member engageable in detent means in said carrier member; means on said body member for retaining said laterally movable means engaged in said detent means; and means for releasably securing said retaining means to said body member.

8. The well packer apparatus of claim 5 wherein pivot region is provided by a shoulder portion on said one expander means that engages the outer surface of said body member.

9. The well packer apparatus of claim 8 wherein said support means includes a laterally shiftable member positioned underneath said expander portion and normally engaged by a first larger diameter portion of said body member, said release means comprising a second reduced diameter portion of said body member adapted to be positioned adjacent said laterally shiftable member.

10. The well packer apparatus of claim 8 wherein said support means comprises an expansible and contractable split ring, said release means including an annular groove on said body member into which said ring is movable.