

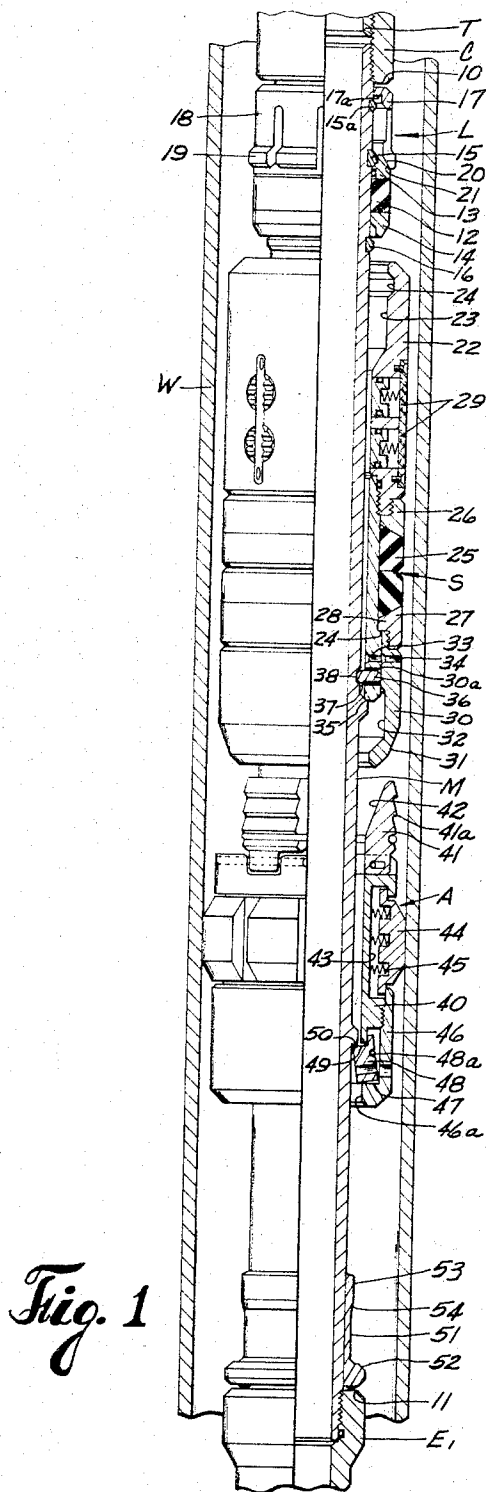
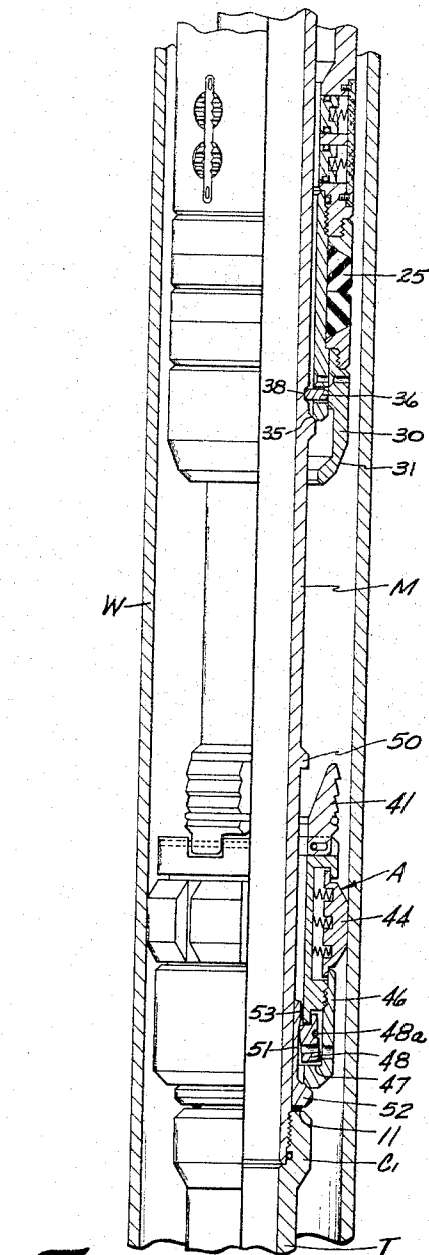
July 4, 1967

C. C. BROWN  
RETRIEVABLE WELL PACKER

3,329,210

Filed May 5, 1966

3 Sheets-Sheet 1



CICERO C. BROWN  
INVENTOR.

BY

ATTORNEY

July 4, 1967

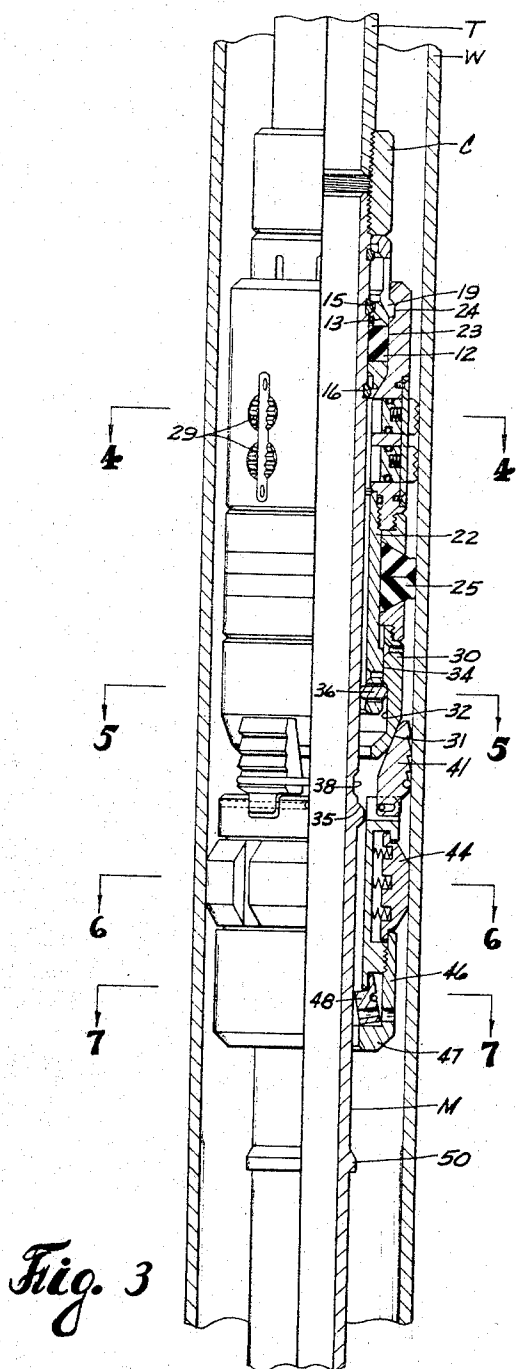
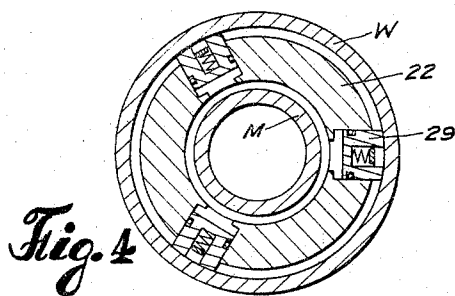
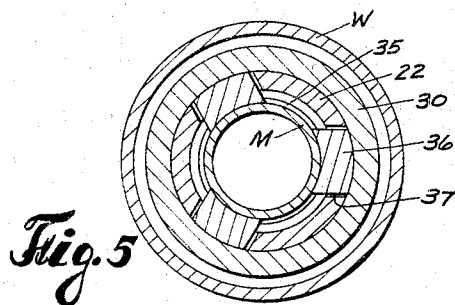
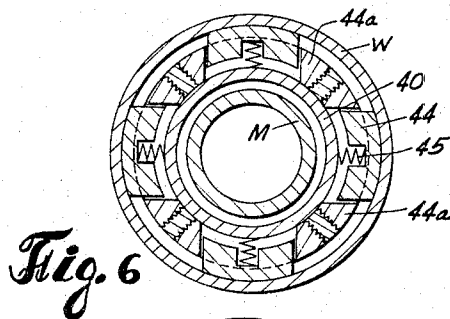
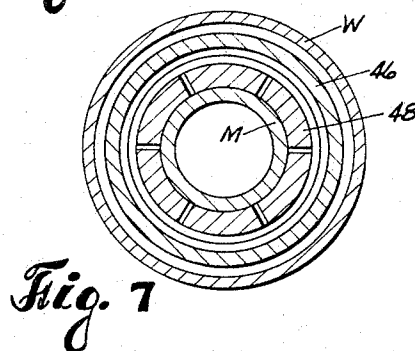
C. C. BROWN

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RETRIEVABLE WELL PACKER

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3 Sheets-Sheet 2



CICERO C. BROWN  
INVENTOR.

BY

*R. W. [Signature]*  
ATTORNEY

July 4, 1967

C. C. BROWN

3,329,210

RETRIEVABLE WELL PACKER

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3 Sheets-Sheet 3

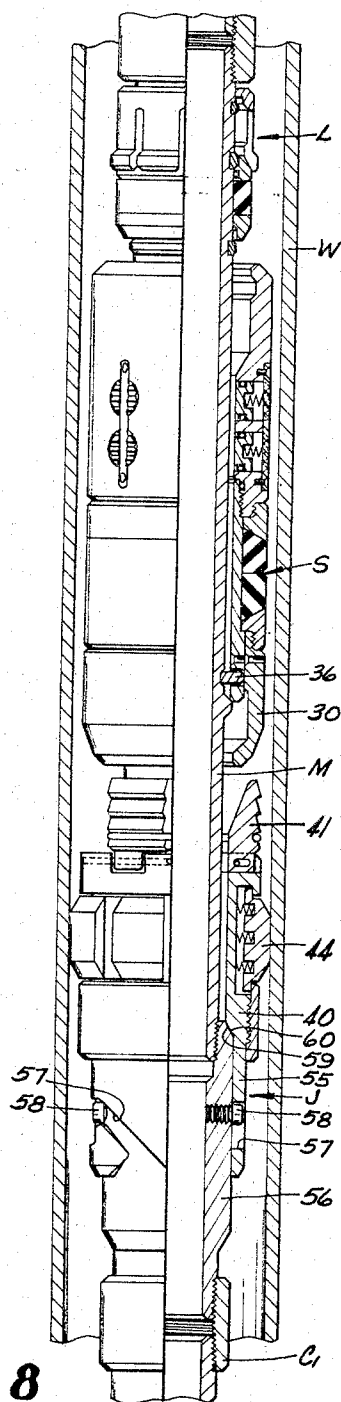


Fig. 8

CICERO C. BROWN  
INVENTOR.

BY

*R. W. L. L.*

ATTORNEY

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3,329,210

**RETRIEVABLE WELL PACKER**  
Cicero C. Brown, % Brown Oil Tools, Inc.,  
P.O. Box 19236, Houston, Tex. 77024  
Filed May 5, 1966, Ser. No. 547,913  
4 Claims. (Cl. 166-129)

This invention relates to well packers and is a continuation-in-part of my copending application Serial No. 299,910, filed August 5, 1963, now Patent 3,253,656 granted May 31, 1966.

In the copending prior application I have disclosed an improved packer designedly of the so-called "straight-set" form which is understood in the art to mean packers which may be set and released solely by longitudinal movements of the setting mandrel.

I have found that certain features of the improved packer are also highly useful in packers of the type which, while set by longitudinal movement of the packer mandrel, are released prior to setting by relative rotational movement between the mandrel and the packer body.

Accordingly, it is a primary object of this invention to provide an improved form of well packer which may be of the completely straight-set type but which may also be of the type in which the setting mandrel and packer body are held in inactive position by latch means which are releasable by limited relative rotation between the mandrel and the packer body.

Other and more specific objects and advantages of this invention will become more readily apparent from the following detailed description when read in conjunction with the accompanying drawing which illustrates useful embodiments in accordance with this invention.

In the drawing:

FIG. 1 is a longitudinal, quarter-sectional view of a packer in accordance with one embodiment of this invention, showing the packer in the unset position as it is run into a casing lining a well bore;

FIG. 2 is a view similar to FIG. 1, showing the packer elements at an intermediate stage during the setting operations;

FIG. 3 is a view similar to FIG. 1, showing the packer in set position;

FIGS. 4, 5, 6 and 7 are cross-sectional views taken, respectively, along lines 4-4, 5-5, 6-6, and 7-7 of FIG. 3; and

FIG. 8 is a view similar to FIG. 1 of a packer in accordance with another embodiment of this invention.

The packer structure illustrated in FIGS. 1 to 7, inclusive, which is insertible into a well casing W, includes a tubular mandrel M adapted to be connected into an operating pipe string T between upper and lower threaded collars C and C<sub>1</sub>, respectively, which form downwardly and upwardly facing shoulders 10 and 11, respectively, at spaced points along the mandrel. A series of sub-assemblies are slidably supported on mandrel M and comprise an upper latch and inner seal assembly L mounted about the upper end of the mandrel, the main packer assembly S positioned about the mandrel below assembly L, and an anchor assembly A disposed about the mandrel below packer assembly S. In their initial positions, the several assemblies are supported in spaced-apart relation on mandrel M by means of releasable latch elements, to be described more fully hereinafter, but are arranged to be interengaged in response to relative vertical movements of the mandrel, as will appear hereinafter.

Latch and inner-seal assembly L, which is of the same general form and arrangement disclosed in my copending application Serial No. 756,552, filed August 28, 1958,

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includes a seal packer 12 molded to upper and lower end rings 13 and 14, respectively, the packing unit being disposed for limited sliding movement on mandrel M between longitudinally spaced upper and lower snap rings forming external shoulders 15 and 16, respectively, about mandrel M. Slidably mounted about the latter above the seal packing is a latch sleeve 17 slotted longitudinally from its lower end to form a series of circumferentially arranged flexible latch fingers 18 terminating at their lower ends in outwardly projecting latching dogs 19. The latter have bevelled inner faces 20 adapted to engage an upwardly tapering conical expander surface 21 formed on upper end ring 13. A third snap ring 15a is mounted in the exterior of mandrel M to form an external shoulder a short distance above shoulder 15 and is adapted to be engaged by an internal shoulder 17a provided at the upper end of latch sleeve 17 to limit downward movement of the latter on mandrel M. Relative upward movement of sleeve 17 on mandrel M is limited by shoulder 10 defined by upper collar C.

Main packer assembly S includes a tubular packer body 22 having a counterbore 23 at its upper end adapted to sealingly receive seal packing 12 and latching dogs 19. Counterbore 23 is provided internally, near its upper end, with a latching groove 24 for latching engagement by dogs 19 when the latch assembly has been inserted in body 22, as will appear subsequently. An annular, flexible, resilient packer or seal element 25 is positioned about an intermediate portion of body 22 and is secured to upper and lower metal end rings 26 and 27, respectively. Upper end ring 26 is fixedly secured to body 22, while lower end ring 27 and seal element 25 are free to slide on body 22, seal elements 25 being radially expansible in response to endwise compression exerted upwardly through lower end ring 27 against the fixedly positioned abutment formed by upper end ring 26. An external upwardly facing shoulder 24 provided near the lower end of body 22, co-operates with a downwardly facing internal shoulder 28 on end ring 27 to limit downward movement of the seal element on body 22. A plurality of generally conventional wickered hold-down buttons 29 will be mounted for radial movement in the wall of body 22 above the seal element and are adapted to be urged outwardly in response to hydraulic pressure interiorly of body 22 for engaging the wall of well casing W.

Lower end ring 27 has attached thereto surrounding body 22 a tubular slip cone 30 having a bore wall 30a and provided at its lower end with a downwardly and inwardly tapering external slip expander surface 31. Bore wall 30a is provided with an internal annular recess 32 extending over its lower portion. The upper portion of bore wall 30a has a diameter such as to have close sliding engagement with the exterior of the portion of body 22 which extends below shoulder 24. A radial port 33 is provided through the wall of body 22 below shoulder 24 and is adapted to communicate with a radial port 34 extending through the wall of slip cone 30 when shoulders 28 and 24 are in engagement, whereby to provide fluid communication between the bore of body 22 and the exterior of the packer assembly.

Mandrel M is provided intermediate its ends at about its mid-point with an external annular shoulder 35 adapted to be engaged by the lower end of body 22 to limit downward movement of the packer assembly relative to the mandrel. A latch means is provided for releasably holding body 22 in the shoulder-engaging position and includes a plurality of circumferentially arranged positioning lugs 36 mounted for radial movement in slots 37 extending through the wall of body 22 just above the lower end thereof. Lugs 36 have a radial length greater than the wall thickness of the lower portion of body 22 so as to

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be projectible from slots 37 into an annular latching groove 38 provided in the exterior of mandrel M just above shoulder 35 when the opposite ends of lugs 36 are engaged by bore wall 30a of the slip cone. It will be evident that when such relative longitudinal movement occurs between slip cone 30 and packer body 22 as to move recess 32 opposite lugs 36, the latter will be freed for retractive movement out of groove 38, thereby releasing mandrel M for longitudinal downward movement relative to packer assembly S.

Anchor assembly A, which is positioned below packer assembly S, includes a tubular slip cage 40 on the upper end of which a plurality of upwardly extending circumferentially arranged pipe-gripping slips 41 are mounted for radial movement. The outer faces of the slips have the usual pipe-gripping teeth 41a and the inner faces of slips 41 are provided with upwardly and outwardly bevelled surfaces 42 for cooperative engagement with tapered surface 31 of slip expander cone 30. Cage 40 is provided with an external annular recess 43 in which are mounted for limited radial movement a plurality of friction pads 44, separated by spacer blocks 44a. Pads 44 are biased outwardly by means of coil springs 45 to frictionally engage the wall of casing W.

The lower end of cage 40 supports still another latch mechanism which comprises a tubular sleeve 46 surrounding mandrel M and having an internal ledge 47 on which a plurality of latch segments 48 are rockably mounted for movement inwardly and outwardly of sleeve 46. A garter spring 48a is mounted to encircle the outer peripheries of the latch segments to bias them toward mandrel M. The upper ends of latch segments 48 define shoulders 49 adapted to engage beneath an external shoulder 50 provided on mandrel M at a suitable spacing below shoulder 35. As in the position illustrated in FIG. 1, it will be seen that latch segments 48 will be engaged beneath shoulder 50 so as to prevent relative downward movement of mandrel M. Mandrel M carries a release mechanism for releasing latching segments 48 from their engagement beneath shoulder 50. This release mechanism comprises a trip sleeve 51 slidably mounted on the mandrel below shoulder 50 and is provided with an external shoulder 52 at its lower end of greater diameter than the bore of ledge 47. In the inactive position seen in FIG. 1, trip sleeve 51 will rest on shoulder 11 defined by lower collar C<sub>1</sub>. At its upper end trip sleeve 51 has a shoulder 53, the external diameter of which is such as to permit it to slide freely through bore 46a of ledge 47. Shoulder 53 merges into a downwardly and inwardly tapering surface 54 extending to the exterior of sleeve 51. Trip sleeve 51 will be operated to release the engagement between the latch segments and shoulder 50 in response to the longitudinal movement of the mandrel, as will be described hereinafter. This last-described latch mechanism, while differing in detail, is of the same general form and function as that described in my U.S. Patent No. 2,884,069 and is intended to be generally illustrative of a form of latch which is releasable by a series of reciprocative longitudinal movements of the operating string and mandrel.

Operation of the described device is as follows: The packer structure, with the parts positioned as shown in FIG. 1, will be run into casing W. As shown, body 22 will be engaged with shoulder 35 on the mandrel and positioning lugs 36 will be seated in latching groove 38. Also, by reason of the frictional engagement of pads 44 with the wall of casing W, which restrains movement of the anchor assembly, shoulder 50 on the mandrel will engage the upper ends of latch segments 48, whereby the several sub-assemblies will be held in the spaced relation illustrated in FIG. 1.

When the structure has been moved to the desired location in casing W, operating string T will be raised, raising mandrel M until trip sleeve 51 seated on shoulder 11 has been drawn upwardly inside sleeve 46 moving shoulder 53 inside the latch segments and forcing them outwardly

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against the resistance of garter spring 48a until shoulder 53 has moved slightly above the upper ends of the latch segments 48. This upward movement will be limited by the engagement of shoulder 52 with the lower end of sleeve 46. This position of the parts is shown in FIG. 2. Thereupon, the operating string carrying mandrel M is lowered and the latter will move downwardly relative to trip sleeve 51 as the latter will be held in the raised position by the frictional engagement of latch segments 48 on tapered surface 54 under the pressure of garter spring 48a. When the string has been lowered to the point where shoulder 50 abuts the upper end of shoulder 53 on the trip sleeve, the latter will be forced downwardly past latch segments 48. Shoulder 50, which will have approximately the same external diameter as shoulder 53 will then move with shoulder 53 below latch segments 48, thereby releasing the mandrel for further downward movement relative to the anchor assembly. As the mandrel is lowered further, slip expander cone 31 will move inside slips 41, as seen in FIG. 3, expanding the latter into gripping engagement with the wall of casing W and stopping further downward movement of the assembly. However, as further weight is applied to the operating string, packer body 22 carrying seal element 25 will move downwardly relative to slip cone 30, causing endwise compression of packer element 25 and expanding it radially into sealing engagement with the wall of casing W. The resulting downward movement of body 22 relative to slip cone 30 will move positioning lugs 36 opposite recess 32, allowing the positioning lugs to retract from latching groove 38 and releasing the mandrel for downward movement relative to the packer assembly. The continued downward movement of the mandrel will move latch and seal assembly L inside counterbore 23 and packing 12 will seal off the annular space between mandrel M and the packer body above hold-down buttons 29. Dogs 19 will move into latching groove 24, being held in latching engagement in the groove by upper end ring 13, which will be in engagement with shoulder 15.

When this series of operations have been completed, the packer will be set, being anchored to the well wall by slips 41 and packed-off through the expansion of seal element 25. At the same time, packing 12 having sealed off the annular space between the mandrel and the packer body, will permit pressure from below to flow through this annular space and actuate holddown buttons 29 to cause them to engage the wall of casing W and hold the packer against upward movement under such pressure from below. Pressure from below the packer, which is acting upward against the mandrel M and packing 12, tending to push the mandrel M and packing 12 out of the packing body 22, will act through the packing 12, end ring 13, and tapered surface 20 to urge the latch dogs 19 outward into latching groove 24, thereby pressure-locking the mandrel M into engagement with packing body 22.

To release the packer, an upward pull is applied to operating string T to lift mandrel M straight upwardly. Through engagement of latch dogs 19 with latching groove 24, body 22 will begin to move upwardly, relieving the weight from seal element 25 which will then partially retract. As body 22 is further elevated it will move upwardly relative to slip cone 30 until the outer ends of positioning lugs 36 engage the upper wall of recess 32 momentarily stopping the relative upward movement of body 22. A continued upward pull on mandrel M will then bring shoulder 15A into engagement with shoulder 17a of the upper latch sleeve and will exert an upward pull on latch dogs 19. The reaction of the latter against the upper wall of latching groove 24 will force the latching fingers inwardly, pushing seal packing 12 downwardly sufficiently to allow the latch dogs to clear groove 24 and permitting further upward movement of mandrel M relative to the packer and pulling the latch and seal assembly L out of counterbore 23. As mandrel M moves upwardly, shoulder 35 will move up against the

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lower end of body 22, placing latching groove 38 in registration with positioning lugs 36 and allowing them to project into groove 38, thereby returning body 22 to its initial inactive position. Shoulder 24 will now engage beneath shoulder 28 on lower end ring 27 of the packer assembly and will exert an upward pull on slip cone 30 as the mandrel continues to be pulled upwardly. This will pull slip cone 30 from under slips 41, releasing the slips from the casing wall. As the mandrel continues its upward movement, trip sleeve 51 will again enter the bore of sleeve 46 and shoulder 52 will engage the lower end of sleeve 46, so that the continued upward movement of the tubing string will pull anchor assembly A and all of the packer structure upwardly out of the casing.

If it is desired to reset the packer at a higher elevation, the structure may now be moved to such elevation and be reset by a sequence of vertical movements exactly as those previously described. If it is desired to reset the packer at a lower elevation, then the tubing string would only be picked up enough to release the cone from the slips and bring shoulder 50 above the latch segments 48, but not enough to bring the trip sleeve 51 up under the latch segments. Then the packer may be lowered through the well and reset by a sequence of vertical movements exactly as those previously described.

From the foregoing it will be seen that all of the packer manipulations, including the operations of releasing the mandrel from the packer body, setting the packer, and releasing the packer, are conducted solely by axial movements of the operating string.

FIG. 8 illustrates an embodiment wherein the initial release of the mandrel from the packer body and reconnection of the same are effected by a limited rotational movement of the operating string, all other operations for setting the packer being performed by longitudinal movements of the operating string and conducted as in the previously described embodiment.

Referring to FIG. 8, the primary structural differences between the embodiment illustrated and that previously described and illustrated comprises the latch structure J which has been substituted for the latch elements 46 to 64 in the previously described embodiment. Latch mechanism J comprises a tubular sleeve 55 forming a downward extension of the lower end of cage 40 and a tubular sub 56 connected between the lower end of mandrel M and collar C<sub>1</sub>. Sleeve 55 is provided with a pair of conventional bayonet or J-slots 57 opening downwardly to the lower end of sleeve 55 and sub 56 is provided with radially projecting J-pins or lugs 58, which extend into J-slots 57. The upper end of sub 56 carries an upwardly facing bevelled shoulder 59 engageable with a downwardly facing complementary shoulder 60 formed in the bore of sleeve 55 at its upper end. In operation of the embodiment illustrated in FIG. 8, it will be evident that when the packer structure has attained the point at which it is to be set in well casing W, then instead of the longitudinal reciprocative movements as were employed in the previously described embodiment for releasing the connection between mandrel M and slip cage 40, the present structure is operated by rotating the operating string in a direction which will cause lugs 58 to be rotated through J-slots 57 while the operating string is also lowered to complete the release between the mandrel and the slip cage. It will be evident that the friction between pads 44 and the wall of casing W will hold the packer structure stationary while the necessary rotation of the operating string and mandrel is effected to release the lugs from the J-slots.

Upon release of latch mechanism J, the operating string may be lowered, thereby lowering mandrel M and effecting the setting of the packer in the identical manner previously described.

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To release the packer for withdrawal from the well, the operating string will be elevated to engage lugs 58 in slots 47 and by reason of the sloping shape of the J-slots and assisted by rotation of the operating string the latch mechanism J will be re-engaged, bringing shoulder 59 against shoulder 60 in the slip cage so that as the operating string is elevated the entire packer structure can be pulled from the well.

With the modified form of latch mechanism initially securing the mandrel to the packer structure, it will be seen that there is retained the advantages of the auxiliary latch means formed by lugs 36 and the slip cone, as well as the upper latch and seal structure L.

It will be understood that various other alterations and changes may be made in the details of the illustrative embodiments within the scope of the appended claims but without departing from the spirit of this invention.

What I claim and desire to secure by Letters Patent is:

1. In a well packer, a tubular mandrel connectible to an operating pipe string, a tubular packer body slidably mounted about the mandrel, an annular radially expandible seal element mounted about the packer body having its upper end fixedly secured to the body and its lower end free for relative longitudinal movement, a slip cone carried by said lower end of said seal element for said movement therewith, a slip cage slidably mounted on the mandrel below the packer body and carrying means for frictionally engaging a surrounding well wall, radially movable wall-gripping slips mounted on the slip cage below said slip cone, cooperating releasable latch elements arranged on the mandrel and the slip cage for initially securing said mandrel against downward movement relative to said slip cage and releasable for said downward movement by movement of the mandrel relative to the slip cage whereby to move said slip cone into expansive engagement with said slips, additional cooperating latch elements arranged between the mandrel and the packer body to initially secure the mandrel against downward movement relative to the packer body and releasable by relative longitudinal movement between the packer body and said slip cone produced by engagement of the latter with the slips whereby to free said mandrel for downward movement relative to the packer body, and seal packing positioned on the mandrel to seal between the latter and the packer body upon completion of said downward movement.

2. A well packer according to claim 1 wherein said first-mentioned releasable latch elements comprise J-type latch means.

3. A well packer according to claim 2 wherein said J-type latch means includes a sleeve secured to the slip cage and provided with J-slots opening to the lower end of the sleeve, and J-lugs projecting radially from said mandrel into said J-slots.

4. A well-packer according to claim 3 wherein said additional latch elements include a latching groove in the exterior of the mandrel, and a plurality of lug members mounted on said packer body for radial movement into and out of latching engagement with said latching groove.

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CHARLES E. O'CONNELL, *Primary Examiner*.

JAMES A. LEPPINK, *Examiner*.