

May 8, 1962

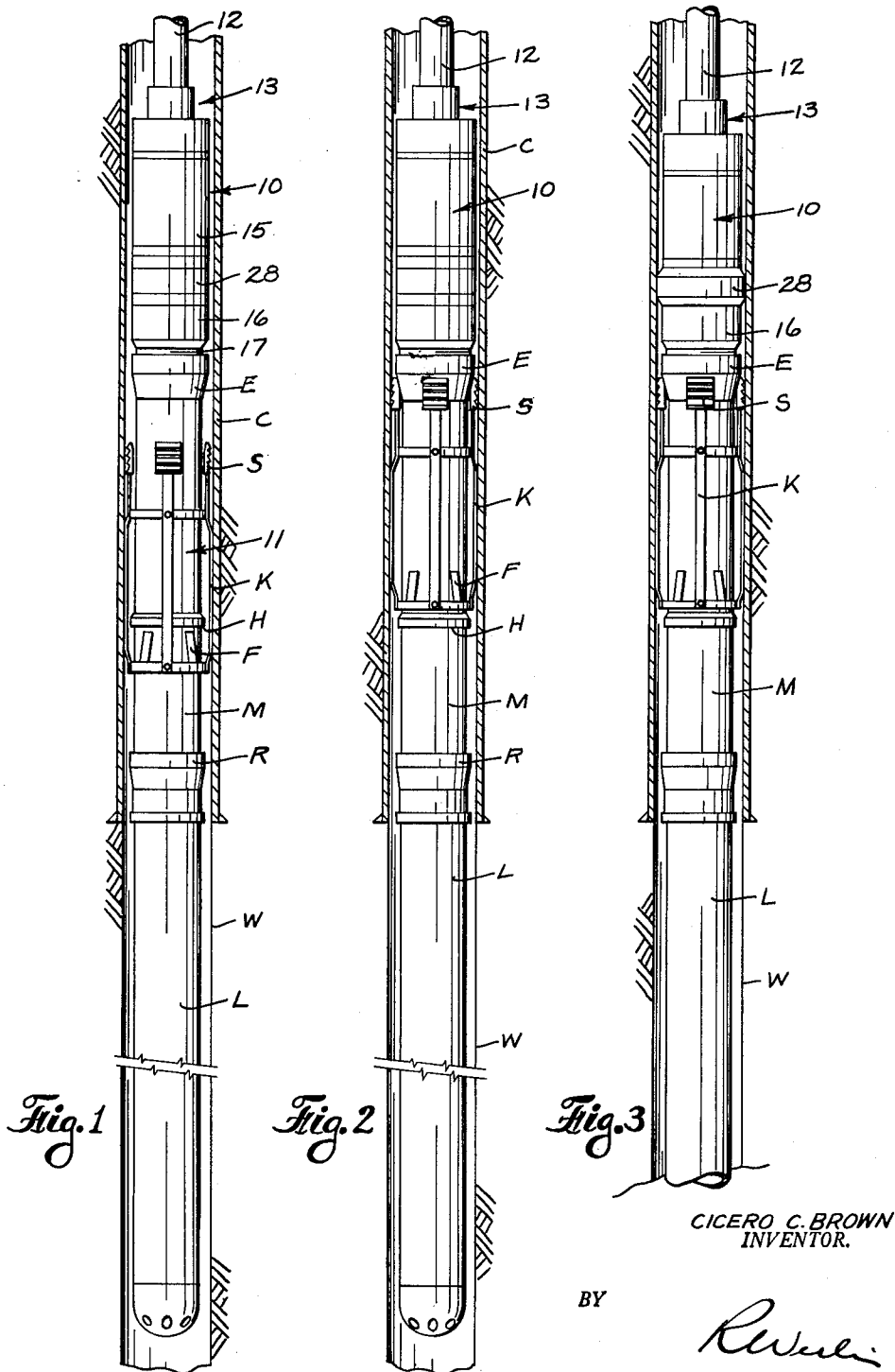
C. C. BROWN

3,033,290

SCREW-SET NON-RETRIEVABLE PACKER

Filed Oct. 1, 1959

3 Sheets-Sheet 1



May 8, 1962

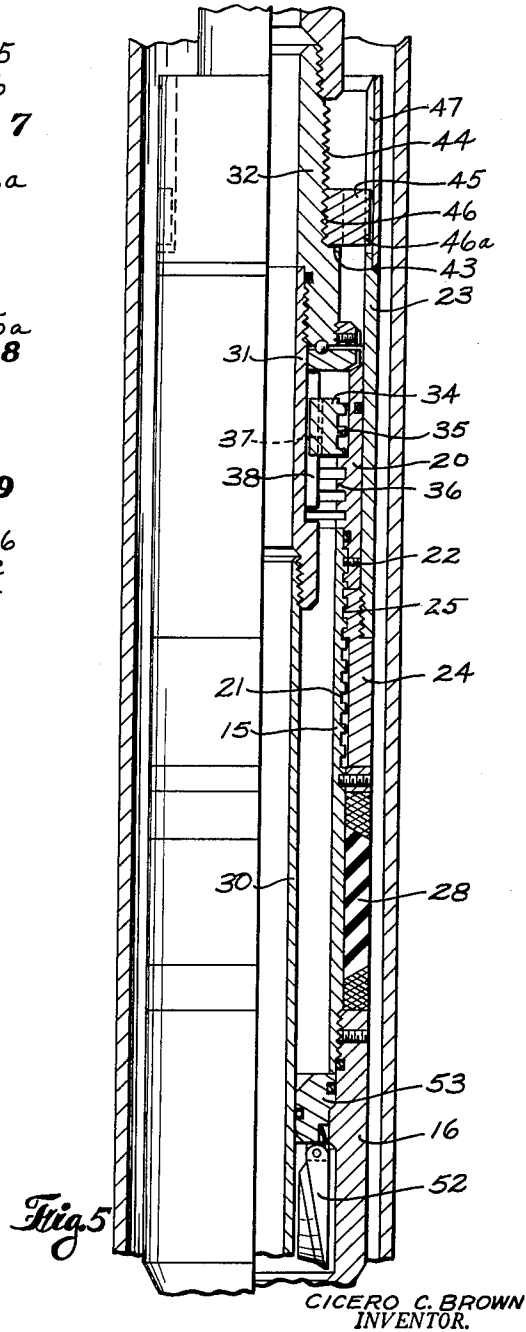
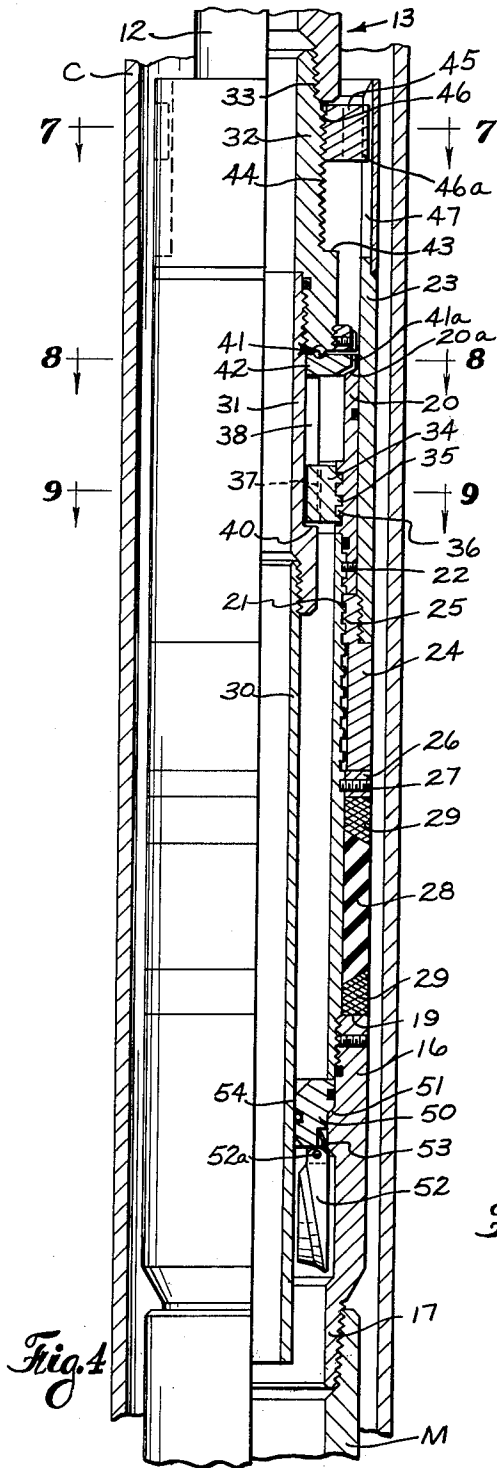
C. C. BROWN

3,033,290

SCREW-SET NON-RETRIEVABLE PACKER

Filed Oct. 1, 1959

3 Sheets-Sheet 2



BY

R. W. ...
ATTORNEY

May 8, 1962

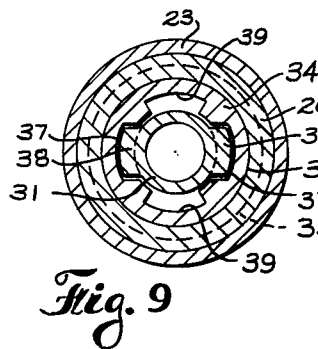
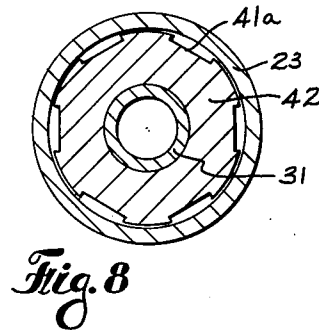
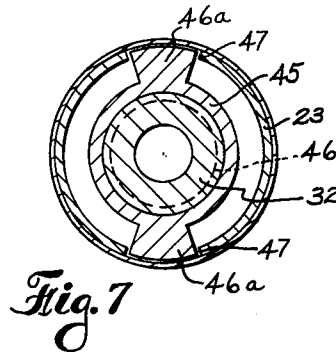
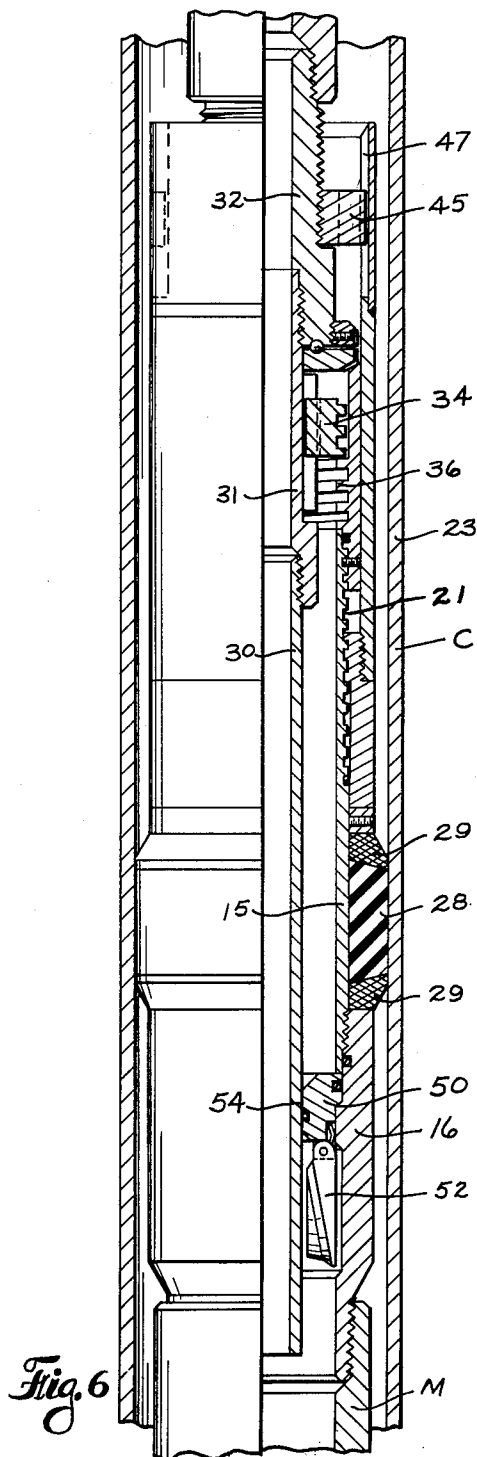
C. C. BROWN

3,033,290

SCREW-SET NON-RETRIEVABLE PACKER

Filed Oct. 1, 1959

3 Sheets-Sheet 3



CICERO C. BROWN
INVENTOR.

BY

Riverton

ATTORNEY

1

3,033,290

SCREW-SET NON-RETRIEVABLE PACKER

Cicero C. Brown, % Brown Oil Tools, Inc.,

P.O. Box 19236, Houston, Tex.

Filed Oct. 1, 1959, Ser. No. 843,711

7 Claims. (Cl. 166—181)

This invention relates to packers for use in oil and gas wells and particularly to packers of the type commonly referred to as "non-retrievable" packers.

Packers of the non-retrievable type are commonly employed in connection with running, setting and cementing of liners or other inner strings of pipe in a well equipped with an outer casing. These packers normally are connected to anchor means by which the packer and inner pipe string may be anchored to the surrounding casing and are equipped with seal elements which are expandable to seal between the packer and the surrounding casing. The tool strings comprising the packer, the connected anchor, the liner or other pipe string, and the setting tool must be run into the well with the various parts in retracted and otherwise inactivated positions and means must be provided to prevent premature release of the parts. Thereafter, various manipulations of the setting tool are normally required to produce the relative movements between the several parts of the tool string which are necessary in order to set the anchor and seal elements to permanently anchor the packer structure with its connected inner pipe string to the casing or well wall, actuate the seal between the packer and the well wall, and to thereafter permit release and withdrawal of the setting tool.

Conventional packer and setting tool strings are subject to numerous difficulties in carrying-in the tools into the well in a manner to assure against premature setting and in performing the manipulative operations required to effectively set the packer, and to thereafter release the setting tool for withdrawal from the well.

The present invention has for its principal object the provision of a packer structure which obviates the noted difficulties common to more conventional constructions; which incorporates improved means for effectively holding the packer parts in inactive position during running-in; which employ a novel combination of screw-thread connections between the various parts arranged to effect positive engagement and disengagement, as required between the parts, all in response to right-hand rotation of the operating stem, in order to permanently set the packer and release the setting tool.

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 a useful embodiment in accordance with this invention.

In the drawing:

FIG. 1 is a partly diagrammatic elevational view of the tool string including the packer structure in accordance with this invention being run into a well, the parts including the anchor elements, being shown in the unset position;

FIG. 2 is a view similar to FIG. 1 showing the anchor elements in the set position;

FIG. 3 is another view similar to FIG. 2, but showing the seal element in expanded and set position;

FIG. 4 is a longitudinal quarter-sectional enlarged view of the packer structure with the parts thereof in the unset or running-in position;

FIGS. 5 and 6 are views similar to FIG. 4 showing the parts in positions occupied at two subsequent stages of operation; and

2

FIGS. 7, 8, and 9 are cross-sectional views taken, respectively, along lines 7—7, 8—8 and 9—9 of FIG. 4.

Referring to the drawing:

FIG. 1 shows a tool string for running and setting a liner L in a well bore W equipped with a casing C, the liner to be set inside the lower end of the casing. The tool string includes a packer structure, designated generally by the numeral 10, constructed in accordance with the present invention, and an anchor structure, designated generally by the numeral 11, by which the liner is anchored to casing C. A running-in pipe string 12 is connected to a setting tool or stem, designated generally by the numeral 13, which extends into the bore of packer structure 10.

Anchor structure 11 is of a conventional type which is actuated by longitudinal movements of the tool string in order to anchor the structure to the well wall, such as casing C. This type of anchor mechanism and its operation are well-known and are described in detail in U.S. Patent 764,769, July 12, 1904, Robinson et al., and is further described in detail in conjunction with Liner Packers in my U.S. Patent 2,884,069, April 28, 1959. While it is believed to be unnecessary to describe this anchor structure in detail, it will be seen that it comprises the central tubular mandrel M which is connected at its lower end to liner L and at its upper end to packer structure 10. The mandrel is provided with a downwardly tapering conical slip expander E adapted to expand slips S which are mounted on the upper end of a slip cage K which is slidable on mandrel M. Cage K carries spring fingers F engageable beneath a shoulder H on the mandrel to hold the slips out of engagement with the expander and are releasable from shoulder H by means of a releasing sleeve R slidably mounted on the mandrel below shoulder H and operable by the longitudinal movements of the operating string. The resultant release of the slip cage will permit relative movement between the tool string and the slips S whereby the latter will engage expander E to thereby anchor the packer structure to casing C, as illustrated in FIG. 2. It will be understood that other types of known anchor devices may be employed and the details thereof do not form a part of this invention.

Referring now to FIGS. 4 to 9, the packer, in accordance with the present invention, comprises a generally tubular body 15, the lower end of which is threadedly received in a tubular valve casing 16 having a threaded pin 17 at its lower end for reception in the upper end of mandrel M of anchor structure 11. The upper end of valve casing 16 forms an upwardly facing annular abutment 19 surrounding the exterior of body 15. A tubular extension 20 has its lower end threadedly secured about the exterior of the upper end of body 15 by means of relatively coarse right-hand threads 21 provided on the exterior of body 15 and extending for a substantial distance along body 15 below the lower end of extension 20. Extension 20 is immovably secured to body 15 by means of set screws 22 (one shown) extending through the wall of extension 20 into body 15. Concentrically mounted about the exteriors of extension 20 and the upper end portion of body 15 and in close-fitting engagement therewith is a tubular setting sleeve 23 to the lower end of which is threadedly connected a tubular extension 24 having a short section of internal threads 25 complementary to, and engageable with, threads 21 on the packer body. In the inactive or retracted position of the parts shown in FIG. 4, the lower end of extension 24 is longitudinally spaced from abutment 19 and is initially fixed against movement toward the latter by means of a lock ring 26 which abuts the lower end of extension 24 and surrounds body 15, and is provided with shear screws 27 (one shown) which extend radially through ring 26 into

the exterior of body 15. Surrounding body 15, between abutment 19 and ring 26, is an annular seal member 28 of flexible resilient construction commonly used in the art. Positioned between the ends of the seal member and the adjacent end surfaces of ring 26 and abutment 19 are lead support rings 29—29.

With the arrangement heretofore described of the setting sleeve 23, seal element 28, and abutment 19, it will be seen that upon right-hand rotation of setting sleeve 23 relative to body 15, the setting sleeve will move downwardly along body 15 and this movement, when sufficient force has been generated, will break shear pins 27 and thereupon the continued downward movement of the setting sleeve will axially compress seal element 28 and supporting rings 29 between ring 26 and abutment 19. This axial compression will result in radial expansion of the seal element to effect sealing between the packer body and casing C.

Setting tool 13 comprises a plurality of co-axially connected tubular parts adapted to extend into and through the bores of setting sleeve 23 and packer body 15. These co-axially connected parts include a nipple 30 which has its upper end threadedly received in the lower end of a nipple 31, herein termed "the carrying-in" nipple, somewhat larger in diameter than nipple 30. Nipple 31, in turn, has its upper end threadedly received in a still larger diameter nipple 32, herein termed the "setting nipple," the upper end of which is provided with an externally threaded pin 33 to which the running-in or operating string 12 is threadedly connected.

Carrying-in nipple 31 has mounted about the exterior thereof a nut 34, termed the "carrying-in nut," which is provided on its exterior with a number of relatively coarse left-hand threads 35, the latter being engageable with complementary threads 36 formed on the inner wall of packer body extension 20. The bore of nut 34 has a pair of diametrically spaced longitudinal spline grooves 37 adapted to receive longitudinal splines 38 provided on the exterior of carrying-in nipple 31 (see FIG. 9). Additional longitudinal grooves 39 are provided in the bore of nut 34 intermediate grooves 37 for by-passing fluid around the nut. An upwardly facing external shoulder 40 on the exterior of carrying-in nipple 31 limits downward movement of nut 34 along the nipple. Left-hand threads 36 are relatively few in number and terminate at a point below the upper end of extension 20 at a distance greater than the length of nut 34, so that when the latter moves upwardly relative to extension 20, as will be subsequently described, it will become completely released from threads 36.

Setting nipple 32 carries at its lower end a roller bearing 41 which includes a bearing ring 42 adapted to rest on the upper end of extension 20, which defines a seat 20a inside the bore of sleeve 23. The bearing so arranged between nipple 32 and the upper end of extension 20 serves to permit rotation of the operating string in the bore of the packer while applying downward weight of the operating string to the packer. Fluid by-pass passages 41a are provided in the periphery of bearing 41 (FIG. 8). The exterior of nipple 32 is reduced somewhat in diameter from an intermediate point thereon to define the upwardly facing shoulder 43 about its exterior. The reduced diameter portion is provided with left-hand threads 44 which are substantially finer than the threads 35—36 of the carrying-in nut and extension 20. A second nut 45, termed the "setting nut" is disposed about nipple 32 and is provided with internal threads 46 engaging threads 44. The lower end of operating string 12 forms an upper stop limiting upward movement of nut 45 along nipple 42, while shoulder 43 forms a lower limit stop for the nut. The exterior of nut 45 is provided with diametrically spaced longitudinal splines 46a slidably receivable in longitudinal spline grooves 47 (see FIG. 7), formed in the inner wall of setting sleeve 23. These spline grooves 47 extend from a point which will be substantially opposite

shoulder 43 when the setting string is inserted to place bearing 41 on seat 20a, to the upper end of setting sleeve 23, so that nut 45 may pass upwardly out of sleeve 23 as will be subsequently described.

A flapper valve structure is positioned in the bore of valve casing 16 and comprises the seat ring 50 mounted in the bore of casing 16 between the lower end of body 15 and a supporting shoulder 51 formed on the wall of casing 16. Depending from the lower end of seat ring 50 is a conventional flapper valve 52 which is pivotally connected at 52a to the seat ring and is equipped with a spring 53 which is arranged between the seat ring and the flapper valve to normally urge the flapper valve to the closed position across the bore 54 of the seat ring. When nipple 30 is in place, while the tool string is being run into the well, as seen in FIG. 4, it extends through bore 54 of the seat ring and holds flapper valve 52 in its open position. Upon withdrawal of the setting string, including nipple 30, as will be subsequently described, flapper valve 52 will move to the closed position under the urging of spring 53.

The operation of the packer structure is as follows: The string will be made up, as best seen in FIG. 1, with the parts of the packer structure and the setting string in the positions illustrated in FIG. 4. As seen in the latter, carrying-in nut 34 will be threadedly engaged with threads 36 on packer body extension 20 and splined to nipple 31 and will be at its lowermost position, while setting nut 45 will be at its uppermost position along threads 44 and splined to setting sleeve 23. Seal member 28 will be in its retracted position, bearing 41 will be resting on seat 20a, and nipple 30 will be projected through bore 54 of seat ring 50 holding flapper valve 52 in the open position.

The tool string will then be run into well W through casing C and when the string has reached the point at which the liner L is to be set, longitudinal movements of the tool string will be effected in the proper sequence to release slip cage K and slips S for movement upwardly along mandrel M, and the entire tool strip may then be lowered relatively to cage K, which will be in frictional engagement with the casing C, to bring expander E into expansive engagement with slips S, thereby anchoring the tool string to the wall of casing C, as will be seen best in FIG. 2.

These movements for effecting anchoring of the tool string may be conducted without effecting any change in the positions of the parts comprising the packer structure, per se, these parts remaining in the positions illustrated in FIG. 4.

Upon anchoring of the string, as described, operating string 12 will then be rotated in the clockwise or right-hand direction, whereupon carrying-in nut 34 and setting nut 45 will be actuated. The former, by reason of the stationary position of packer body 15, will move upwardly, by reason of the left-hand threaded arrangement, along splines 38 until nut 34 has moved above the upper end of threads 36, as seen in FIG. 5. At the same time, the left-hand threaded connection between setting nut 45 and setting nipple 32 will cause nut 45 to move downwardly along splines 47. However, due to the finer character of threads 44 and 46 (greater number per inch), nut 45 will move downwardly as a rate slower than the rate of upward movement of nut 34. As a result of these relative rates of movement, nut 34 will have been released from threads 36 before nut 45 attains the end of its downward travel, which is terminated by engagement of the nut with shoulder 43. The continued rotation to the right of operating string 12 will, therefore, eventually carry nut 45 downwardly into engagement with shoulder 43, whereupon further downward movement of the nut will be prevented. Thereupon further right-hand rotational movement of operating string 12 will be transmitted through the splined connection of nut 45 to setting sleeve 23 and will then

5

cause the latter to rotate in response to the further rotations of operating string 12.

The rotation, in the clockwise or right-hand direction, of setting sleeve 23 will first apply sufficient downward pressure to break shear screws 27 and thereupon allow further rotation and consequent downward movement of setting sleeve 23 relative to packer body 15, effectively compressing seal member 28 and the lead support rings 29 between lock ring 26 and shoulder 19 until seal 28 and the lead rings have been expanded into sealing engagement with the wall of casing C (FIG. 5), thereby sealing off the well bore between the packer structure and the wall of the casing. When this has been accomplished, it will be seen that the string of tools is now effectively anchored to the casing and a fluid-tight seal will have been provided above the anchor point between the packer body and the well casing. The operating string may now be withdrawn from the packer, since carrying-in nut 34 has been fully released from threads 36 and thereby from the packer body, and setting nut 45 will be free to move upwardly out of the open upper ends of spline grooves 47 as the operating string is drawn upwardly from the well. Withdrawal of the operating string, including nipple 30, will release flapper valve 52 which will then swing across bore 54 of seat ring 50 and close the bore of the tool string against back flow of fluids.

Once the packer structure has been anchored in the well, as described, but before the seal has been set, further operations of any desired character which involve circulation of fluids may be conducted through the bore of the packer, as in cementing and the like. When the packer seal has been set other types of operations involving insertion of any of a number of conventional tools through the bore of the packer may be conducted, the entry of such tools and the pressures of such fluids forcing flapper valve 52 to the open position.

From the foregoing, it will be seen first, that the threaded and splined connections provided by the carrying-in nut between carrying-in nipple and the packer body assure against any premature release of the parts during running-in of the string which might otherwise result in premature setting of the tools. Secondly, the threaded and splined connection provided by the setting nut 45 between the operating string and the setting sleeve successively permits release of the carrying-in nut and subsequent transmission of rotational force from the operating string to the setting sleeve. Third, the latter, which has the right-hand threaded connection to the packer body, will, in response to the continued right-hand rotations of the operating string, apply positive compression to the seal in order to assure a positive and permanent seal between the packer and the well casing. It will be seen, therefore, that when the tool string has been anchored, only simple and continued right-hand rotation of the operating string will be required to actuate the seal for the packer and to release the setting tool for withdrawal from the well. Thus, the operation of the tools is effected by positive movements of the parts and in a greatly simplified and safer manner as compared with more conventional designs.

It will be understood that various modifications and alterations may be made in the details of the illustrative embodiment within the scope of the appended claims, but without departing from the spirit of the invention.

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

1. A screw-set packer for wells, comprising, a gen-

6

erally tubular body, means carried by the body for anchoring the same to a well wall, external annular abutment means about the body, a sleeve member surrounding the body above the abutment means and having threaded connection to the body for longitudinal movement relative to said abutment means in response to rotation of the sleeve member relative to the body, a resilient seal element disposed about the exterior of the body between the abutment means and the sleeve member radially expandible by axial compression therebetween in response to said longitudinal movement of said sleeve member, releasable means initially securing said sleeve member to said body in non-compressing relation to said seal element, a tubular operating stem removably insertable into the bore of said body and rotatable therein, first screw-thread means non-rotatably slidable longitudinally on the stem and threadedly connected to said body operable in response to a limited number of right-hand rotations of the stem to release the stem from the body, and a second screw thread means non-rotatably slidable longitudinally on the sleeve member and threadedly connected to the stem operable in response to additional right-hand rotations of the stem to rotate said sleeve member relative to the body whereby to successively release said releasable means and expand said seal element.

2. A screw-set packer according to claim 1 wherein said first screw-thread means comprises an externally threaded nut about the stem having longitudinally slidable splined connection thereto and screw-threaded connection to the body, and said second screw-thread means comprises an internally threaded nut about the stem having screw-threaded connection to the stem and longitudinally slidable splined connection to said sleeve member.

3. A screw-set packer according to claim 2 wherein both said screw-threaded connections comprise left-hand threads and the threads comprising the first-mentioned screw-threaded connection are coarser than those comprising the second-mentioned screw-threaded connection.

4. A screw-set packer according to claim 2 wherein said stem carries stop means limiting the downward movement of said internally threaded nut along the stem.

5. A screw-set packer according to claim 1 having a flapper-valve pivotally mounted in the bore of said body and resiliently biased to the bore-closing position.

6. A screw-set packer according to claim 1 wherein said threaded connection between the sleeve member and the body comprise right-hand threads, said first- and second-mentioned screw-thread means each comprises left-hand threads, and the threads comprising said first-mentioned screw thread means are coarser than those comprising the second-mentioned screw-thread means.

7. In a screw-set packer according to claim 1, an anti-friction bearing disposed between the stem and said body to rotatably support said stem on the body.

References Cited in the file of this patent

UNITED STATES PATENTS

859,304	Larken et al. _____	July 8, 1907
1,690,383	Thomson _____	Nov. 6, 1928
1,734,040	McEvoy _____	Nov. 5, 1929
1,947,262	Howard _____	Feb. 13, 1934
2,092,048	Brown _____	Sept. 7, 1937
2,189,703	Burt et al. _____	Feb. 6, 1940
2,884,069	Brown _____	Apr. 28, 1959