

June 28, 1960

R. C. DAVIS ET AL

2,942,665

DRILLABLE PACKER

Filed July 2, 1956

3 Sheets-Sheet 1

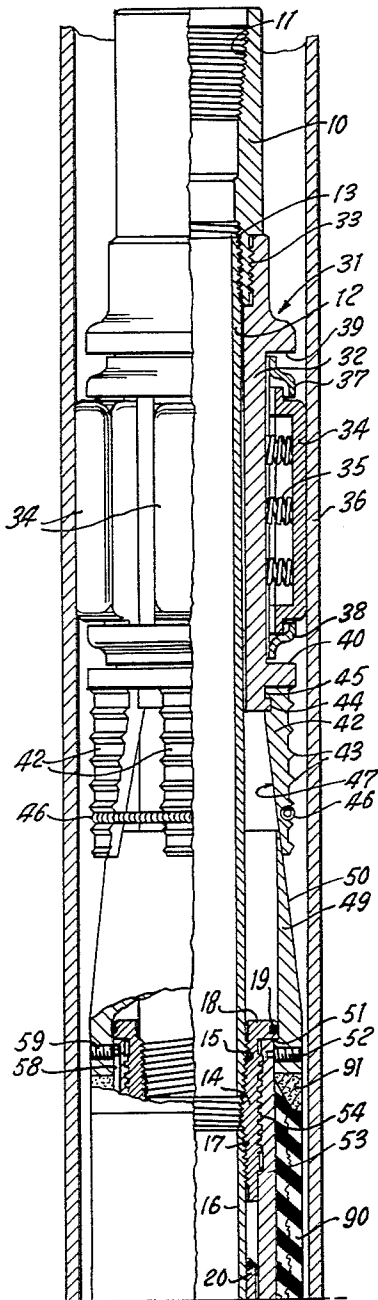


Fig. I

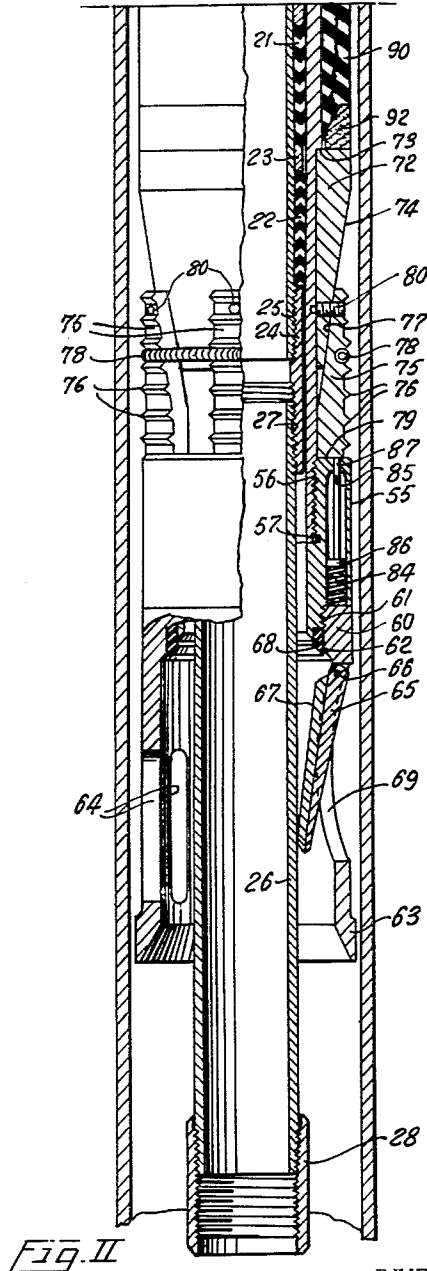


Fig. II

INVENTORS

Roy C. Davis
Roland O. Cox
John J. Lane

BY

Stan Kullier and
Howard E. Moore
ATTORNEYS

June 28, 1960

R. C. DAVIS ET AL

2,942,665

DRILLABLE PACKER

Filed July 2, 1956

3 Sheets-Sheet 2

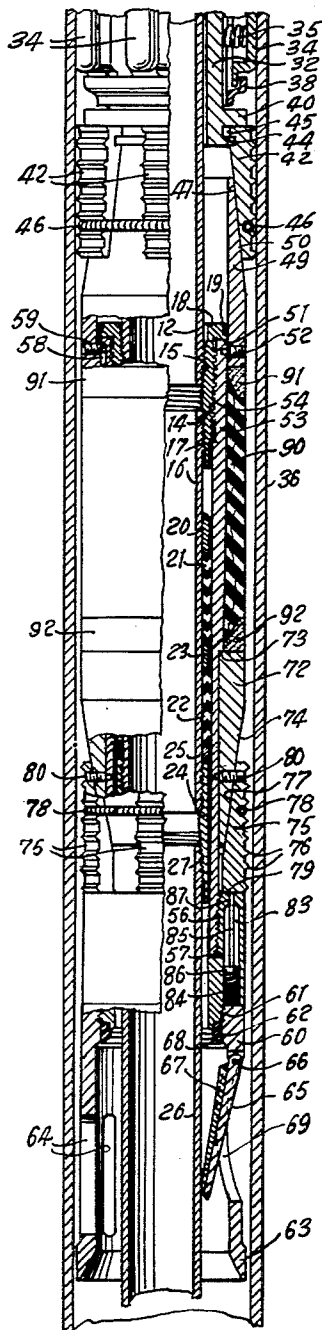


Fig. III

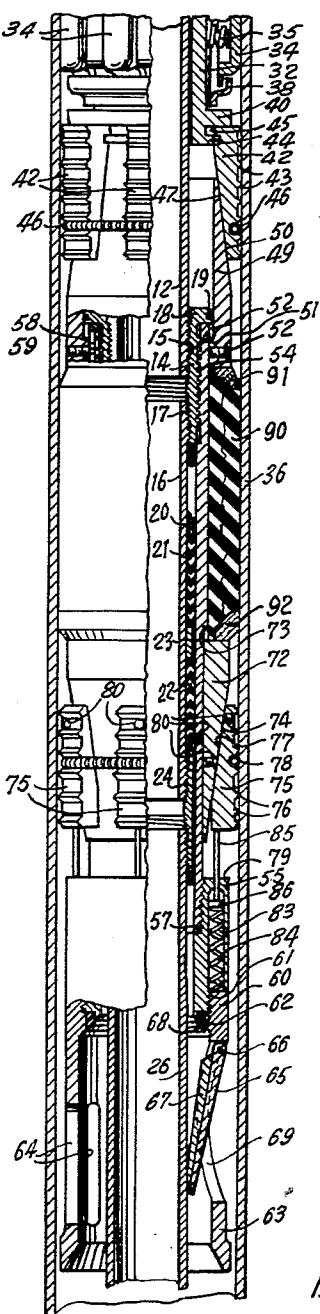


Fig. IV

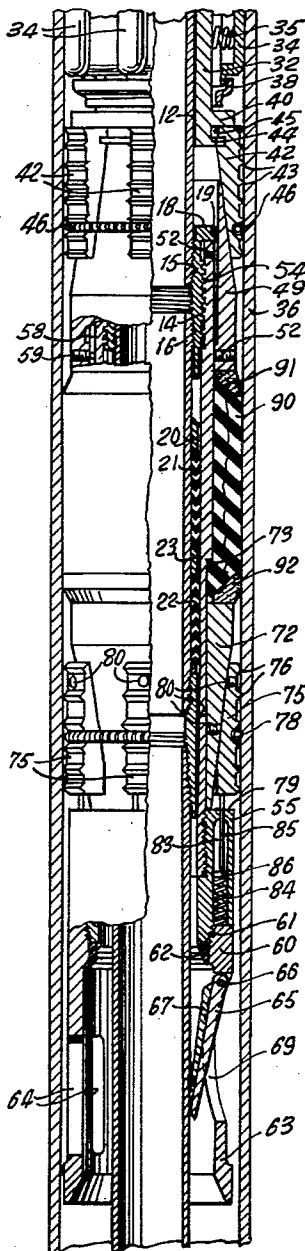


Fig. V

INVENTORS
Roy C. Davis
Roland O. Cox
John J. Lane

BY

Howard E. Moore
Howard E. Moore
ATTORNEYS

June 28, 1960

R. C. DAVIS ET AL

2,942,665

DRILLABLE PACKER

Filed July 2, 1956

3 Sheets-Sheet 3

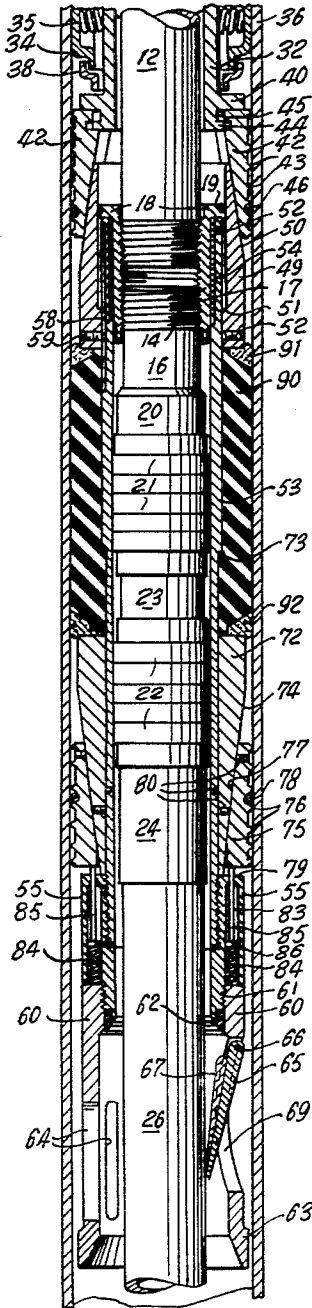


Fig. VI

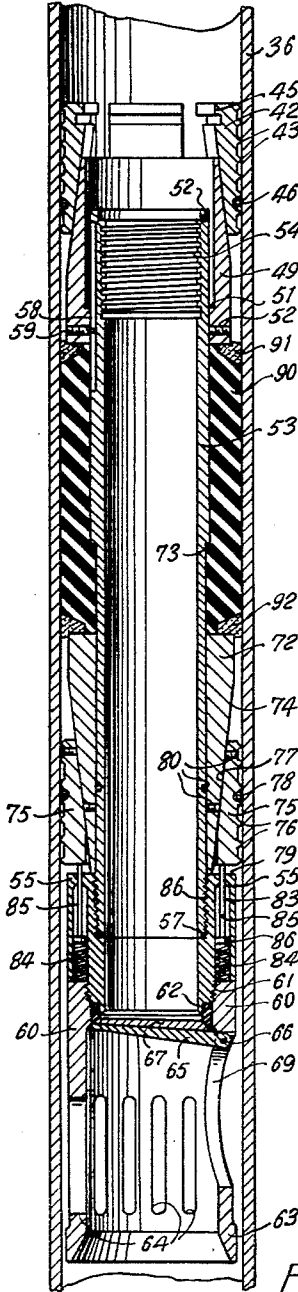


Fig. VII

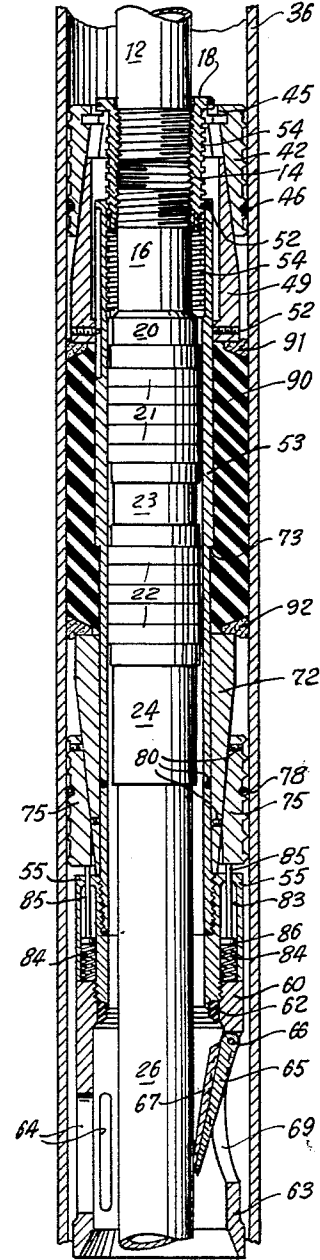


Fig. VIII

INVENTORS

Roy C. Davis
Roland O. Cox
John J. Lane

BY

Stusskullier and
Howard E. Moore
ATTORNEYS

1

2,942,665

DRILLABLE PACKER

Roy C. Davis, Roland O. Cox and John J. Lane, Dallas, Tex., assignors, by mesne assignments, to The Guiberson Corporation, Dallas, Tex., a corporation of Texas

Filed July 2, 1956, Ser. No. 595,455

3 Claims. (Cl. 166—124)

This invention is concerned with a well packer which is employed for closing off a well pipe or for sealing the annular space between a well casing and a tubing or other pipe extending into the casing, for producing oil or gas from a strata below the packer, or for the purpose of carrying out various well operations, such as cementing, acidizing, or otherwise treating the producing formation or formations of the well.

This invention is particularly concerned with improvements in that type of well packer known as a "drillable packer" wherein all parts are made of drillable material so that it can be drilled up by the drill bit for removal, but it will be understood that the improvements described and claimed can be employed in any well packer of the type herein described, whether it be drillable or not.

Well packers of the type designed to be run and set in the casing are usually provided with a sleeve of elastic material, such as natural or synthetic rubber, which is slidably mounted on a tubular support or mandrel. Segmented, toothed slips are provided at each end of the packer sleeve which co-act with conical expander heads to expand the slips into engagement with the casing to form an anchor, and to compress and expand the packer to seal the annulus. The conical expander heads are attached to, or are in contact with, the rubber sleeve, and as the lower slips are moved upwardly along the casing wall they push the lower expander head upwardly against the packer sleeve, causing the resilient packer sleeve to be shortened and expanded radially into sealing engagement with the casing wall.

In prior packers of this type the force for expanding the packer sleeve has been applied by upward pull applied to the lower slips, which are carried on a base shoulder attached to the running tool, and such force was indirectly applied to the packer sleeve through the expander head. Such arrangement resulted in a great loss of force by reason of the fact that the greater amount of the force applied was dissipated in dragging the toothed slips along the wall of the casing a sufficient distance to move the lower expander head upwardly enough to adequately expand the packer sleeve into sealing engagement with the casing. It has been estimated that at least 60% of the force applied by upward pull was dissipated in dragging the slips along the casing wall. This necessitated increased upward movement of the tubing in order to set the packer, which is particularly disadvantageous in deep wells where the amount of upward movement of the tubing is limited by reason of the stretch of the tubing and in many instances resulted in an insufficiently expanded packer. Such increased pull resulted in added strain on the derrick, pipe and surface equipment, and the operator could never be certain that the packer was sufficiently expanded to form a proper seal.

Another defect in such prior packer devices was that the segmented slips did not move upwardly into engagement with the casing uniformly so that they were not evenly spaced and in peripheral alignment under the

2

packer, causing the packer to be off center, resulting in uneven distribution of the rubber material of the packer in the annulus when expanded, and a poor seal.

Still another problem with such prior packers was that the lower expander head and slips were attached to the mandrel, and prevented from moving upwardly thereon, solely by shear pins, with no positive means to prevent the expander head and slips from being disengaged from the mandrel and allowed to move upwardly while being run, often resulting in premature setting of the packer.

In such prior packers the running tool is threadedly engaged with the packer mandrel by left hand threads so that after the packer is set the running tool can be disengaged by right hand rotation of the tubing. Heretofore no positive means has been provided for preventing the rotation of the mandrel while the running tool is being unthreaded therefrom.

This invention is intended to overcome the above-mentioned problems and others.

It is, therefore, a primary object of this invention to provide a well packer wherein substantially all of the force applied by upward pull on the running tool is applied directly to the lower expander head and there-through to the packer sleeve.

Another important object is to provide means in a well packer for uniformly moving the lower slips into engagement with the casing, whereby they are in peripheral alignment under the packer.

A further object of this invention is to provide positive means in a well packer for preventing the lower expander head from moving upwardly to prematurely set the packer while the packer is being run.

A still further object is to provide means in a well packer to positively hold the packer mandrel against rotation while the running tool is being rotated free of the mandrel after the packer has been set.

Still another object is to provide positive means in a well packer to prevent upward movement of the upper expander head of the packer assembly, while the packer is being run, to prevent premature setting of the upper slips.

Another object is to provide a shoulder on the packer mandrel which moves upwardly in the packer sleeve, when expanded, to form a recess between the shoulder and the lower expander head, in which the rubber of the packer sleeve may flow when the packer is expanded, to thereby transfer force, applied from above, directly to the packer, after it is set, to increase the sealing effect thereof.

A still further object is to provide a packer assembly wherein the upper slips are set before the lower slips to provide a firm anchor for setting the lower slips and expanding the packer sleeve.

Other and further objects of this invention will become apparent upon reading the following detailed specification, and by referring to the drawings annexed hereto, and made a part hereof.

A preferred embodiment of the invention is shown in the attached drawings in which,

Figures I and II are a partially sectionalized, elevational view of a well packer assembly incorporating the improvements constituting the invention, showing the packer assembly and attached to the running tool as they would be assembled for lowering into the casing on a tubing string.

Figure III is a partially sectionalized, elevational view of the packer assembly after the running tool has been disengaged from the anchor cage and drawn upwardly to set the upper slips.

Figure IV is a partially sectionalized, elevational view of the packer assembly after the running tool has been further drawn upwardly to shear the upper and lower expander heads from the mandrel and the lower slips

3

from the lower expander head to permit the spring urged pins underneath the lower slips to move said slips upwardly into engagement with the casing.

Figure V is a partially sectionalized, elevational view of the packer assembly after the running tool has been moved further upwardly to permit the lower setting head to contact the base ring, carried by the mandrel, and the packer sleeve has been expanded into engagement with the casing.

Figure VI is a partially sectionalized, elevational view of the packer assembly after the packer sleeve has been fully expanded into sealing engagement with the wall of the casing.

Figure VII is a sectionalized, elevational view of the packer assembly after the running tool has been disengaged therefrom and withdrawn.

Figure VIII is a partially sectionalized, elevational view of the packer assembly after the running tool has been reinserted subsequent to attaching a tailpipe, crossover apparatus or other well producing or treating apparatus.

In the drawings numeral references are employed to designate the various parts, and like numerals indicate like parts throughout the various figures of the drawings.

Packers of the type shown herein are customarily lowered into the well casing, disengageably attached to a running tool, which is suspended to a string of pipe, extending from the earths surface.

Figures I and II show the packer assembly, attached to the running tool, as it would be assembled for lowering into the casing. The packer is relaxed and run with clearance, except for the drag of the spring urged friction pads 34 on the anchor cage 31.

The sub 10 is interiorly threaded at its upper end, as indicated at 11, to permit the threaded engagement of the sub with a tubing string (not shown), extending from the earths surface. An upper tubular member 12 is threadedly engaged to the sub 10 by right hand companion threads 13. The adaptor coupling 14 is threadedly connected to the tubular member 12 by right hand companion threads 15 and to the packing tube 16 by right hand companion threads 17.

An annular outwardly extending flange 18 is formed on the upper end of the adaptor coupling 14, and a resilient sealing ring 19 is disposed about the flange 18 to form a seal between the inner surface of the upper expander head 49 and the flange 18.

A seal retaining abutment collar 20 is affixed about the packing tube 16 by means of welding, or otherwise, and an upper set 21 and a lower set 22 of V-type packing rings, which are separated by a spacer ring 23, are disposed between the abutment collar 20 and the upper end of the coupling 24. The packing rings 21 and 22 are turned in opposite directions, and provide a fluid seal between the packing mandrel 53 and the packing tube 16 when the running tool is disposed in the mandrel.

The coupling 24 is threadedly engaged to the lower end of the packing tube 16 by right hand companion threads 25 and to the upper end of the lower tubular member 26 by right hand companion threads 27.

An interiorly threaded coupling 28 is threadedly engaged by right hand threads to the lower end of the lower tubular member 26 for the purpose of attaching a tubing section for supporting production or well servicing tools therebelow.

The anchor cage assembly 31 includes a tubular body 32, which is threadedly engaged to the sub 10 by buttress threads 33, which are left hand threads, to permit disengagement of the sub 10 from the anchor cage body by right hand rotation of the tubing string.

A plurality of spring urged friction pads 34 are carried about the anchor cage body 32 and are urged into engagement with the wall of the well 36 by the springs 35. The outward movement of the friction pads 34 is limited by upper and lower limit rings 37 and 38, disposed about

4

the body 32. The longitudinal movement of the rings 37 and 38 is limited by the upper and lower limit shoulders 39 and 40, provided on the body 32.

A plurality of upper slip segments 42, having peripheral teeth 43 thereon, are spaced about the lower end of the anchor cage body 32, said slip segments 42 being disengageably interlocked with the body 32 by means of the interlocking shoulders 44 and 45, provided on the body 32 and the slips 42. A garter spring 46 is stretched about the lower ends of the slips 42 to hold the slips in engagement with the upper expander head 49.

The slip segments 42 have interior, tapered surfaces 47 facing downwardly, which are in contact with, and co-act with, a corresponding, upwardly facing, tapered outer surface 50 on the upper expander head 49. The surfaces 47 and 50 co-act to move the slip segments 42 outwardly into engagement with the casing, when the expander head 49 is moved upwardly.

An upwardly facing interior annular shoulder 51 is formed on the inner side of the upper expander head 49 against which the flange 18 is abutted when the packer is assembled on the running tool. The shoulder 51 provides a positioning shoulder for connecting the mandrel 53 to the expander head 49, and also prevents the upward movement of expander head 49 with relation to the running tool in the event the shear screws 52 should become accidentally broken while lowering the packer in the well casing. This positively prevents the premature expansion and setting of the upper slip segments 42.

A plurality of shear screws 52 frangibly connect the upper expander head 49 with the packer mandrel 53. The tubular packer mandrel 53 is threadedly connected to the adaptor coupling 14 by means of buttress threads 54. The threads 54 are left hand threads so that the adaptor coupling may be disconnected from the mandrel 53 by right hand rotation of the tubing string, and such threads 54 are preferably buttress threads so that they will support the axial load of setting and expanding the packer by upward pull on the tubing string.

A base ring 55, forming an upwardly facing annular shoulder 79, is threadedly connected to the mandrel 53 by right hand companion threads 56, and a resilient sealing ring 57 is positioned to seal between the mandrel 53 and the base ring 55.

A vertical, elongated key channel 58 is formed in the outer face of the mandrel 53, and a key screw 59 passes through the wall of the upper expander head 49 and extends into the key channel 58. The key screw 59 is free to move longitudinally in the key channel 58 but prevents relative rotation between the expander head 49 and the mandrel 53.

As shown in Figure I, the key screw 59 is at the upper limit of the key channel 58, when the packer is assembled in relaxed position for running. Thus the key screw 59 prevents upward movement of the expander head 49 with relation to the mandrel to further safeguard against premature setting of the upper slips 42, in the event the shear screws 52 should become accidentally broken while the packer is being run. The key screw 59 also holds the mandrel 53 against rotation after the upper slips 42 are set, to permit the threads 54 to be disengaged by right hand rotation of the tubing string, as will be hereinafter explained. The key channel 58 is long enough to permit the key screw 59 to move downwardly therein sufficient distance to allow the packer sleeve 90 to be fully expanded and set (see Figures VI and VII).

A conventional junk pusher 60 is threadedly engaged to the lower end of the base ring 55 by right hand companion threads 61. A resilient sealing ring 62 is disposed between the base ring 55 and the junk pusher 60, said resilient sealing ring having a tapered outer face 68 thereon arranged to form a sealing surface for the tapered sealing face 67 on the flapper valve 65.

The disc-shaped flapper valve 65 is of conventional construction and is spring urged inwardly by a coil spring

5

(not shown) disposed about a pivot pin 66, by which the flapper valve is pivotally attached to the junk pusher.

The tubular member 26, extending through the packer assembly, holds the flapper valve 65 open, while the packer is being run, but when the tubular member 26 is withdrawn, the flapper valve 65 is permitted to close, by spring action, and the conical seating surface 67 thereon comes into contact with the sealing ring 62 and closes and seals the axial passage through the packer, thereby confining fluid pressure below the packer. When pushed open, the flapper valve 65 may extend into a circular passage 69 provided in the wall of the junk pusher 60.

The junk pusher 60 has a plurality of flow apertures 64 through the wall thereof to permit displacement of fluid therethrough as the packer is lowered in a column of fluid in the casing. An enlarged lower rim 63 is provided on the junk pusher 60 to push debris and other obstructions in the well fluid ahead of the packer, as it is lowered into the casing, to prevent such foreign material from coming in contact with the lower slips 75 and expander head 72, and from becoming lodged about the packer sleeve.

The lower expander head 72, when assembled, as shown in Figure II, is abutted against an external, downwardly facing, annular shoulder 73, formed on the mandrel 53.

The lower expander head 72 has an external, tapered, downwardly facing surface 74 thereon which is arranged to co-act with corresponding, internal, upwardly facing, tapered surfaces 77 on the lower slip segments 75. The plurality of slip segments 75 have peripheral teeth 76 on the outer surfaces thereof arranged to penetratingly engage the wall of the casing 36 when the slips 75 are expanded by sliding coaction between the tapered surfaces 74 and 77.

The tapered surfaces 74 and 77 on the expander head 72 and slip segments 75 are placed in coinciding relationship, with the expander head 72 abutted against the shoulder 73, and the slip segments 75 abutted against the upper face 79 of the base ring 55. After being so positioned, the expander head 72 and slip segments 75 are frangibly connected together, and to the mandrel 53, by shear screws 80. A garter spring 78 is extending about the slip segments 75 to hold them in engagement with the expander head 72, after the shear screws 80 have been broken, in the manner which will be hereinafter described.

The shoulder 73 positively prevents the upward movement of the expander head 72, with relation to the mandrel, while the packer is being lowered, which prohibits the premature expansion of the packer should the lower slip segments 75 become accidentally sheared from the expander head 72. The shoulder 73 has another important function which will be hereinafter explained.

A vertical bore 83 is formed in the base ring 55, under each slip segment 75, and a coil spring 84 is disposed in each said bore with the lower end thereof resting on the upper face of the junk pusher 60. A pin 85, having an enlarged head 86 thereon, is movably disposed in each bore 83, and the upper end of said pin slidably extends through a guide hole 87, formed through the upper face of the base ring 55. The spring 84 contacts the enlarged head 86, and normally urges the pin 85 upwardly and outwardly of the base ring 55, but when the packer is assembled the pin 85 is retracted, in the base ring 55, against the spring 84. The slip segments 75 are abutted against the upper face 79 of the base ring 55 and fixed to the expander head 72, as hereinbefore explained, to thereby retain the pins 85 in retracted position, while the packer is being lowered, as shown in Figure II. The pins 85 remain in retracted position until the shear screws 80 are broken, at which time the springs 84 relax and cause the pins 85 to push the slips 75 upwardly into engagement with the casing, as hereinafter explained.

An elongated tubular packer sleeve 90, which is made

6

of resilient material, such as a natural or synthetic rubber compound, is slidably disposed about the mandrel 53, so that it is arranged to slide on the mandrel and be shortened and radially expanded between the expander heads 49 and 72, as the lower expander head 72 is moved upwardly by upward pull on the tubing string, after the slip segments 42 and 75 have been set against the wall of the casing 36, in the manner herein-after described.

An upper retainer ring 91, made of relatively soft material, such as lead alloy, is disposed between the upper end of the packer sleeve 90 and the upper expander head 49, and a lower retainer ring 92, made of like material, is disposed between the lower end of the packer sleeve 90 and the lower expander head 72. The rings 91 and 92 are arranged to expand upon contraction and expansion of the packer sleeve to prevent the resilient material of the packer sleeve from flowing about the expander heads 49 and 72.

The well packer assembly, illustrated in the drawings, can best be understood by considering the operation and function thereof, which is described as follows:

The packer is assembled and attached to the running tool in the manner illustrated in Figures I and II. The sub 10 is then attached to a tubing section and the tubing string is progressively made up by joining successive joints as the packer assembly, mounted on the running tool, is lowered into the casing 36.

The running tool is made up of the sub 10, the upper tubular member 12, the anchor cage 31, the adaptor coupling 14, the packing tube 16, the coupling 24 and the lower tubular member 26. The running tool may be disengaged and removed from the packer after the packer is set in the casing.

It will be noted that all parts of the packer assembly are rigidly attached to, and carried by, the running tool as it is lowered into the casing. The junk pusher 60 is rigidly attached to the mandrel 53, through the base ring 55, and the mandrel is in turn secured to the running tool by the threads 54 on the adaptor coupling 14. Through the adaptor coupling 14, the tubular member 12 and the sub 10, the mandrel 53 is secured to the tubing string. Therefore, any impact or drag encountered by the junk pusher 60, while the packer is being lowered, will be transmitted to the running tool and therethrough to the tubing string, thereby eliminating the possibility of the mandrel 53 moving upwardly to prematurely set the packer.

The lower slip segments 75 are held in retracted position under the expander head 72 by means of the shear screws 80 which pass through the slip segments 75 and expander head 72 into the wall of the mandrel. The shear screws 80 prevent the slip segments 75 from moving upwardly along the outer face of the expander head 72 and they are prevented from moving downwardly by the upper face 79 of the base ring 55. As so positioned the slip segments 75 hold the follower pins 85 in retracted position.

The lower expander head 72 is held in upward position by the shear screws 80, and is prevented from moving upwardly with relation to the mandrel 53 by the annular shoulder 73. Thus there is no possibility of the packer becoming prematurely expanded while being run, because the expander head 72 cannot move upwardly until the setting tool is released from the anchor cage 31 and pulled upwardly, as will be hereinafter described.

The upper expander head 49 is held against downward movement by the shear screws 52 and against upward movement by the flange 18, which is in engagement with the upwardly facing shoulder 51, and by the key screw 59, which is in engagement with the upper end of the key channel 58.

The upper slip segments 42 are held in retracted position against the expander head 49 by the garter spring 46, and are held against axial movement with relation to the

7

packer assembly by the interfitting engagement between the shoulders 44 and 45 on the anchor cage body 32 and the slip segments 42, respectively.

The anchor cage assembly 31 is disengageably attached to the tubing string by means of the left hand threads 33. The upper slips 42 cannot be expanded free of the anchor cage 31 and into engagement with the wall of the casing until the sub 10 has been disengaged from the anchor cage by right hand rotation of the tubing string, to permit the upper expander head 49 to be raised and interact with the slips 42.

Therefore, it will be seen that all parts of the packer assembly are rigidly held in retracted position as the packer is lowered into the casing, thereby rendering it improbable that any junk or foreign matter in the well, which might have gotten past the junk pusher 60, will cause premature setting of the packer. This is particularly true of the lower expander head 72, which is positively prevented from moving upwardly by the shoulder 73. Any jar or impact on the expander head 72 will be effectively transferred through the shoulder 73 and absorbed by the running tool and the tubing string.

When the packer assembly has been run to the desired depth where it is to be set, the tubing string is rotated to the right to disengage the threads 33. The friction pads 34 are pressed against the wall of the casing, and in frictional engagement therewith, to sufficient extent to hold the anchor cage body 32 against rotation to permit the threads 33 to be disengaged. After disengagement of the threads 33 the tubing string may be pulled upwardly, thus moving the running tool upwardly with relation to the anchor cage 31, the friction pads 34 serving to hold the anchor cage against upward movement.

As shown in Figure III, the upward movement of the running tool, and the packer assembly secured there to, causes the upper expander head 49 to slidably interact with the upper slip segments 42 and push the slips 42 outwardly into anchoring engagement with the casing 36. The interlocking shoulders 44 and 45 are freed of engagement, permitting the anchor cage 31 to be withdrawn with the running tool.

It will be noted that the threads 54, which are also left hand threads, are not disengaged by this initial rotation of the tubing string, because such threads 54 cannot be unscrewed until after the threads 33 have been disengaged and the upper expander head 49 has been forced into tight frictional engagement with the upper slips 42 and expansion ring 91. Until the upper head 49 is thus held against rotation, there is no force for unscrewing the mandrel 53 from the adaptor coupling 14. After the upper expander head 49 has been secured against rotation, the mandrel 53 is held against rotation by the key screw 59 and the key slot 58 to permit the adaptor coupling 14 to be unscrewed from the mandrel.

After the upper slips 42 have thus been permanently set against the wall of the casing 36, further upward movement of the tubing string and the running tool will cause the shear screws 52, holding the upper head 49 to the mandrel 53, to break. Such upward movement of the running tool also causes the shear screws 80, holding the lower slips 75 to lower head 72, and to the mandrel 53, to break, severing the slips 75 from head 72, and head 72 from mandrel 53. The breaking of the shear screws 52 and 80 permits the mandrel 53 to move upwardly with relation to the upper expander head 49, and lower expander head 72, as shown in Figure IV.

When the shear screws 80 break, releasing the lower slips 75 from the expander head 72, and the expander head 72 from the mandrel 53, the springs 84 relax, pushing the follower pins 85 upwardly, simultaneously and quickly moving the lower slip segments 75 upwardly along the expander head 72 into uniform and aligned engagement with the casing 36, as shown in Figure IV.

Continued upward movement of the tubing string, carrying with it the mandrel 53, and the base ring 55, fur-

8

ther raises the slips 75 above the lower end of the expander head 72 which brings the lower end of the expander head 72 into direct contact with the upper face of the base ring 55, as shown in Figure V. This causes further force of upward pull on the tubing string to be applied directly to the expander head 72 and therethrough to the packer sleeve 90. Simultaneously with this operation, the springs 84 are recompressed to some extent as the slips 75 move upward into anchored engagement with the casing. However, the springs 84 are strong enough to cause the follower pins 85 to hold the slips 75 upward above the lower end of the expander head 72 while the head 72 is moved upwardly on base ring 55 to expand the packer sleeve 90; as shown in Figures V and VI.

The resistance of the packer sleeve 90 causes the mandrel 53 to move upwardly with relation to the expander head 72, thereby causing the shoulder 73 and head 72 to separate. The shoulder 73 thus moves upwardly into the body of the packer sleeve 90, and the resilient material of the packer sleeve flows into the annular recess formed between such shoulder and the upper end of the expander head 72, as the packer sleeve is expanded as shown in Figure V.

Thus it will be seen that the entire force applied by upward pull on the tubing string is transmitted directly into expanding the rubber material of the packer sleeve 90, since at all times during the application of such force the lower end of the expander head 72 has been in direct contact with the upper face 79 of the base ring 55.

The lower slips 75 are held upward above the lower end of expander head 72 at all times as the expander head is moved upwardly to expand the rubber material of the packer sleeve. The springs 84 and pins 85 move the lower slips 75 upwardly and maintain them in engagement with both the casing 36 and the lower expander head 72 as the expander head is moved upwardly, but the slips are not used as a means of transmitting the setting force to the rubber material of the packer sleeve. In other words, at all times while the compressive force is being applied to the rubber material of the packer sleeve the lower expander head 72 is in direct engagement with the base ring 55, carried by the mandrel 53. Therefore, no force is wasted in dragging the slips 75 along the casing wall, because the slips are moved upwardly and held in engagement with the casing 36 and expander head 72 by the resilient force applied through the springs 84 and pin 85.

It has been found that where the lower slips are used as a means of transferring the compressive force to the rubber material of the packer, as in previous packers, there is at least a 60% loss of force by reason of the frictional drag between the slips and the casing wall. For instance, a 20,000 lb. pull on the mandrel 53 would result in approximately 8,000 lbs. of actual compressive force applied to the rubber material. In using the present invention the full force of pull applied to the tubing string is transmitted directly to the rubber material of the packer and there is no loss of force, thus resulting in complete expansion of the rubber material, with correspondingly less force and shorter pull.

After the packer has been fully set, as shown in Figure VI, the running tool may be disengaged from the packer by right hand rotation of the tubing string to disengage the threads 54.

It will be noted that as the mandrel 53 is raised to shorten and radially expand the packer sleeve, the key channel 58 has moved upwardly with relation to key screw 59, as shown in Figure VI because expander head 49 is held against upward movement by the set slips 42. Since the upper expander head 49 is now in tight compressive engagement with the upper slip segments 42, it is held against rotation sufficiently to hold the mandrel 53 against rotation through the key screw 59 and key channel 58, to permit the adaptor ring 14 to be unthreaded

from the mandrel 53 to thereby free the running tool from the mandrel, and packing assembly, carried thereon.

The running tool, including the upper tubular member 12, the packing tube 16, with packing thereon, lower tubular member 26 and anchor cage 31, may then be raised upwardly on the tubing string, leaving the packer set in the casing (Figure VII). When the lower tubular member 26 is removed the flapper valve 65 is free to move upwardly to closed position as shown in Figure VII, to close and seal the axial passage through the packer assembly, to thereby confine fluid pressure below the packer.

After the running tool has thus been removed from the packer the well may be conditioned by circulation of fluid through the tubing string, if desired.

Various types of production, flow control and well servicing tools can be attached to the lower end of the running tool, either before the packer is initially run into the well, or they can be attached, and run through the packer, after the packer is set. The axial passage through the packer is of such diameter as to permit such tools to freely pass therethrough. These devices may include seating nipple assemblies, tail pipes, perforated and plain production tubes, chokes, lead-in subs, cross-over equipment and many others.

The running tool, suspended on a tubing string, and with a well production or well servicing device attached to the lower end thereof, may be re-inserted in the packer as shown in Figure VIII, and provides a flow conduit through the packer which is sealed to the interior wall of the mandrel 53 by the sealing rings 21 and 22. The running tool may be held down in the packer against pressure differential from below the packer by weight applied to the tubing string at the surface.

Means could be provided for relatching the running tool in the packer, but same is not illustrated herein as it forms no part of the present invention.

After the running tool has been run back into the packer as shown in Figure VIII, any weight applied to the tubing string will be transmitted from the running tool to the mandrel 53 in downward direction, which will cause the mandrel to move downwardly through the rubber material of the packer sleeve 90. The shoulder 73, in effect, creates a differential piston which works against the flowable rubber material, thus causing the downward movement of the mandrel to result in increased pressure in the rubber, which pressure is transmitted through the rubber to form a tighter seal with the casing. Therefore, increased weight applied to the mandrel is utilized in effecting a tighter seal, rather than weakening the seal, as would be the case if the shoulder 73 was not present.

Of course the packer could be used simply as a closure of the casing to confine fluid and pressure below the packer, as shown in Figure VII.

The slips 42 and 75, the heads 49 and 72, the base ring 55 and junk pusher 60, are preferably made of drillable material such as cast iron, and the mandrel 53, all screws employed, and the flapper valve 65 are preferably made of drillable material such as brass. The packer sleeve 90 is preferably made of canvas reinforced neoprene, which is also drillable. Therefore, all components of the packer assembly, which is anchored in the casing, are made of material which can be readily drilled up by the drill bit when it is desired to remove the packer.

It will thus be seen that there have been provided improvements in a well packer which insures against premature setting of the packer while it is being run, which provides means for applying all setting force directly to the packer sleeve, which assures sufficient expansion of the packer to form a positive seal with less force, which has increased sealing effect upon application of weight from above after setting, which provides a positive and simple means of disengaging the running tool from the

packer assembly after it is set, and other advantages hereinbefore mentioned.

It will be understood that only a preferred embodiment of the invention has been disclosed herein and that other and further forms and embodiments may be made and still remain within the spirit and scope of the appended claims.

We claim:

1. In a well packer, a mandrel; a base member carried by the mandrel; a plurality of lower slips abutting against the base member; a lower expander head; frangible means connecting the lower expander head to the lower slips and to the mandrel, the lower slips and expander head having contacting tapered surfaces thereon arranged to slidably co-act to move the slips into engagement with a well casing; a resilient packer sleeve disposed about the mandrel above the lower expander head; an upper expander head; frangible means connecting the upper expander head to the mandrel above the packer sleeve; a plurality of upper slips; the upper slips and upper expander head having contacting tapered surfaces thereon arranged to co-act to move the slips into engagement with a well casing; a running tool extending through the mandrel and being threadedly engaged therewith; an anchor cage threadedly engaged to the upper end of the running tool and being disengageably interlocked with the upper slips; the said upper slips being movable radially out of engagement with the anchor cage by co-action with the upper expander head upon unthreading the running tool from the anchor cage and moving same upwardly therethrough; an elongated vertical key channel in the outer wall of the mandrel; and a key attached to the upper expander head and slidably disposed in the channel to hold the mandrel against rotation with respect to the expander head.

2. In a well packer, a mandrel; a base member carried by the mandrel; a plurality of lower slips abutting against the base member; a lower expander head; frangible means connecting the lower expander head to the lower slips and to the mandrel, the lower slips and expander head having contacting tapered surfaces thereon arranged to slidably co-act to move the slips into engagement with a well casing; a resilient packer sleeve disposed about the mandrel above the lower expander head; and external, downwardly facing, annular shoulder on the mandrel initially positioned against the lower expander head but arranged to move upwardly in the packer sleeve to provide an annular recess between the expander head and the shoulder in which the resilient material of the packer sleeve may flow when the mandrel is moved upwardly to expand the resilient packer sleeve; the said mandrel being free to move downwardly with relation to the lower expander head after the packer sleeve is expanded; an upper expander head; frangible means connecting the upper expander head to the mandrel above the packer sleeve; a plurality of upper slips; the upper slips and upper expander head having contacting tapered surfaces thereon arranged to co-act to move the slips into engagement with a well casing.

3. In a well packer, a mandrel; a base member carried by the mandrel; a plurality of spring urged members carried by the base, and being normally urged upwardly thereof; a plurality of lower slips abutting against the base member and holding the spring urged members in retracted position; a lower expander head; frangible means connecting the lower expander head to the lower slips and to the mandrel, the lower slips and expander head having contacting tapered surfaces thereon arranged to slidably co-act to move the slips into engagement with a well casing; a packer sleeve made of resilient material disposed about the mandrel above the lower expander head; an external annular shoulder on the mandrel initially positioned against the lower expander head but arranged to move upwardly in the packer sleeve to provide an annular recess between the expander head and the shoulder in which the resilient material of the packer

11

sleeve may flow when the mandrel is moved upwardly to expand the packer sleeve; said mandrel being free to move downwardly with relation to the lower expander head after after the packer sleeve is expanded; an upper expander head; frangible means connecting the upper expander head to the mandrel above the packer sleeve; a plurality of upper slips; the upper slips and upper expander head having contacting tapered surfaces thereon arranged to co-act to move the slips into engagement with a well casing; the said spring urged members being arranged to move the lower slips upwardly into engagement with the casing entirely above the lower end of the lower expander head when the lower slips are freed of attachment to the lower expander head; the said lower expander head being in contact with the base member after the lower slips are moved into engagement with the casing.

5

10

15

12

References Cited in the file of this patent

UNITED STATES PATENTS

2,117,535	Baker et al. -----	May 17, 1938
2,187,487	Burt -----	Jan. 16, 1940
2,228,503	Boyd et al. -----	Jan. 14, 1941
2,551,240	Bonner -----	May 1, 1951
2,589,337	Burns -----	Mar. 18, 1952
2,589,506	Morrisett -----	Mar. 18, 1952
2,598,340	Baker et al. -----	May 27, 1952
2,600,468	Breaux -----	June 17, 1952
2,681,112	Lee -----	June 15, 1954
2,695,064	Ragan et al. -----	Nov. 23, 1954
2,751,018	Baker -----	June 19, 1956
2,756,827	Farrar -----	July 31, 1956