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J. H. CURRENT

3,374,840

WELL TOOL

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Fig. 1

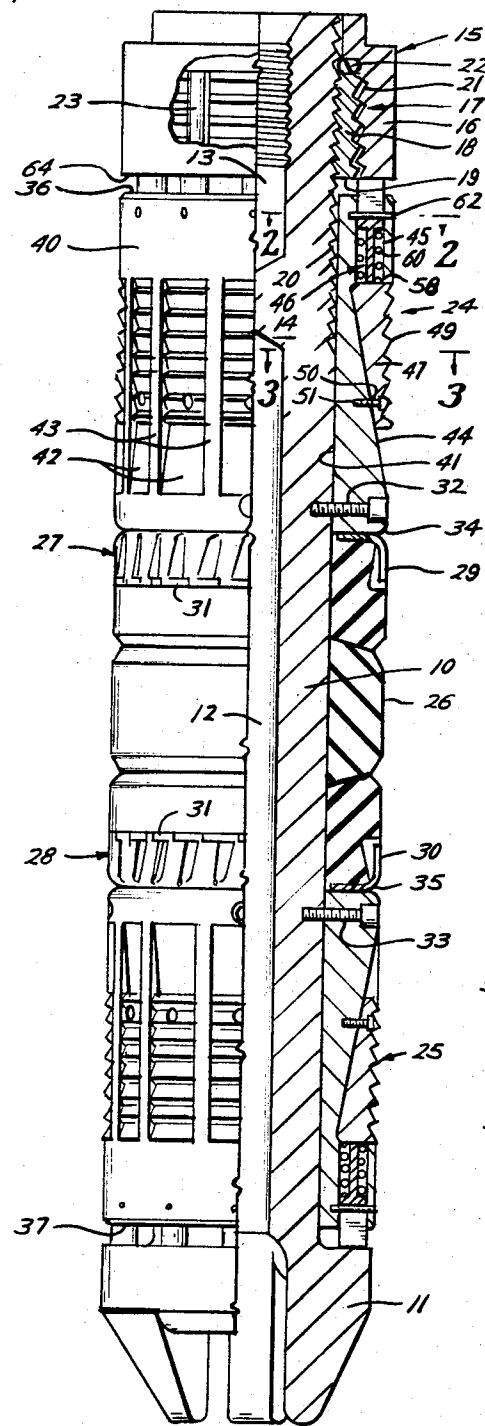


Fig. 2

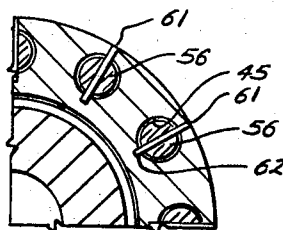


Fig. 3

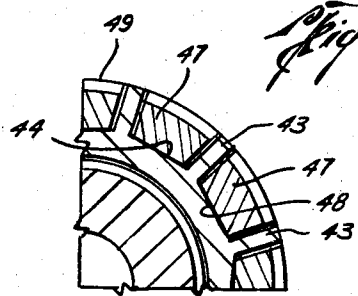


Fig. 5

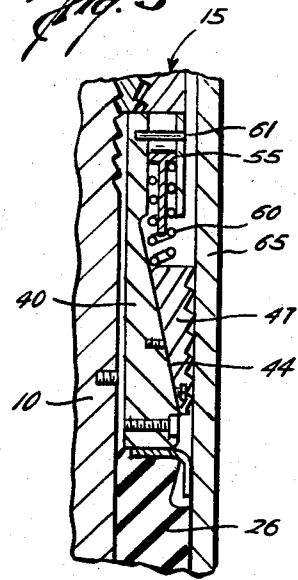
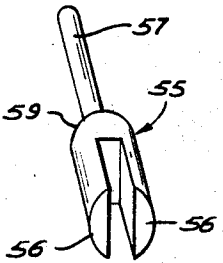


Fig. 4



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1

3,374,840

WELL TOOL

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6 Claims. (Cl. 166—134)

ABSTRACT OF THE DISCLOSURE

A well packer apparatus including a body member having a packing element mounted thereon, expander sleeves adjacent the end of the packing element, abutments engageable with the expander sleeves and movable relatively toward each other in order to advance the expander sleeves toward each other and thereby compress and expand the packing element, slip means movable on the expander sleeves to set positions, and means for moving the slip means to set positions independently of movement of the abutments relatively toward each other.

This invention relates generally to subsurface well tools and, more particularly, to a well packer or plug for packing off in a well conduit.

An object of the present invention is to provide a new and improved well packer or plug for isolating sections of a well bore.

A further object of the present invention is to provide a new and improved packer or plug which includes anchor assemblies permitting the use of larger packer or plug body diameters, yet which will withstand crushing under the most severe loads.

A further object of the present invention is to provide a new and improved packer or plug having a plurality of independently operated anchors so that each anchor will engage the wall of a well conduit which is not perfectly round and will support a load substantially equal to the other anchors so that the conduit will not be distorted.

A further object of the present invention is to provide a new and improved packer or plug wherein the travel required for setting is approximately equal to the travel required to set the packing elements so that the work required to set the packer or plug is considerably less than the work required to set known tools.

Another object of the invention is to provide a new and improved packer or plug which includes anchor assemblies so constructed that the chances of premature setting while running in and out of the well conduit are virtually eliminated.

With these and other objects in mind, the invention comprises an elongated, tubular body which carries normally retracted packing between abutments which are movable toward each other for expanding the packing. One of the abutments is integral with the body and the other abutment is slidable over the body. Interposed between the packing and each abutment is a slip and expander means including a tubular sleeve which has a plurality of pockets formed therein. Each pocket receives a slip segment and the backs of each pocket form inclined surfaces over which the slip segments are movable for shifting them outwardly from the body and into engagement with the well conduit. A plurality of initially restrained energy storing springs, each of which abuts a slip segment, provide a means for shifting the slip segments longitudinally over the inclined expander surfaces and outwardly from the body. Means are provided which are operable upon movement of the abutments toward each other for releasing the energy stored in the springs so that

2

the springs will act to move the slips outwardly, independently of the movement of the abutments.

The novel features of the present invention are set forth with particularity in the appended claims. The present invention, both as to its structural organization and utility together with further objects and advantages thereof, may best be understood by way of illustration and example of one embodiment when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is an elevational view of a bridge plug which embodies the present invention, parts thereof being shown in section for purposes of clarity;

FIG. 2 is an enlarged section on line 2—2 in FIG. 1;

FIG. 3 is an enlarged section on line 3—3 in FIG. 1;

FIG. 4 is an enlarged isometric view of a part included in the present invention; and

FIG. 5 is an enlarged fragmentary sectional view showing the various parts of the invention after the bridge plug has been set in a well conduit.

Turning now to FIG. 1, a bridge plug is shown which embodies the principles of the present invention. However, it will be understood that a bridge plug is shown for purposes of illustration only and the inventive concept encompasses other well tools such as production packers and cement retainers. The bridge plug has an elongated, tubular body 10 with an integral lower guide and abutment 11 formed at its lower end. Centrally in the body is a lower blind bore 12 and an upper threaded bore 13. Between the two bores is a solid plug 14 integral with the body, for preventing fluid flow through the body. The threaded bore 13 provides a means for attaching the body to a conventional setting tool in a well known manner.

Movably disposed on the upper portion of body 10 is an upper abutment 15. The upper abutment is in the form of an annular setting head 16 which is sized for reception on the tubular body. Cooperating between the abutment and the body is a locking device 17 unidirectionally permitting longitudinal relative movement between the abutment and body. The locking device comprises a split ratchet nut 18 which is received within an annular recess 19 in the movable abutment 15 and is cooperable with downwardly facing ratchet teeth 20 on body 10 and with tapered surfaces 21 around the periphery of the annular recess to permit the abutment 15 to move downwardly relative to body 10 but prevent downward movement of the body relative to the abutment. An annular resilient member 22 within recess 19 maintains a biasing force on the split nut to force it downwardly around the mandrel and prevent backlashing as the nut ratchets down on the mandrel during setting. A pin 23 can be placed between segments of the split nut 18 to engage slots (not shown) in both the body 10 and abutment 15 to prevent relative rotation between the abutment, body and split nut.

Carried by body 10 above lower abutment 11 and below movable abutment 15 are oppositely disposed upper and lower slip and expander means 24, 25 which will be more fully described hereafter. Positioned around the body 10 between the upper and lower slip and expander means 24, 25 is an elastomeric packing sleeve 26, each end of the sleeve being bonded to and confined within expansible, anti-extrusion rings 27, 28. The anti-extrusion rings include skirt portions 29, 30 having a series of imbricated fingers 31 with each finger being in overlapping relationship with an adjacent finger. This particular design allows the fingers to flex radially outwardly as packing element 26 in foreshortened and expanded and thereby adapt themselves to the configuration of the well conduit. When the packing is expanded, the overlapping relationship between the fingers is maintained so that skirt portions 29, 30 can be expanded without passages being formed there-

in through which the elastomeric packing elements can cold flow under pressure.

The slip and expander means 24, 25 are slidably disposed on the tubular body 10 but are initially held against sliding movement along the body by shear pins 32, 33. When shear pinned to the body, the lower and upper ends 34, 35 of the means 24, 25 respectively abut the upper and lower anti-extrusion rings 27, 28 on packing element 26. It will be noted, however, that the upper end 36 of upper means 24 and the lower end 37 of lower means 25 are positioned a distance away from the upper and lower abutments 15, 11 for purposes which will be described below.

Turning now to the upper and lower slip and expander means 24, 25 constructed in accordance with principles of the present invention, attention is directed to the fact that both upper and lower arrangement of parts are identical but are oppositely disposed in all respects. For purposes of simplification, only the upper means 24 will be described and it will be appreciated that the reference characters used denote like but oppositely disposed parts in lower means 25. With attention being directed to FIG. 1, the upper slip and expander means includes a tubular sleeve 40 having a longitudinal bore 41 therethrough which is sized for reception on body 10. Around a lower circumferential portion of sleeve 40 are a plurality of slip pockets 42 separated by rib or web portions 43 which are integrally formed with the sleeve. As shown in FIGS. 1 and 3, the back of each pocket is upwardly and inwardly inclined and forms a flat expander surface 44 which extends from a point near the lower end of sleeve 40 to a point intermediate the ends thereof. Extending longitudinally through the sleeve from its upper end 36 into each slip pocket 42 are a plurality of bores 45, each of which receives an initially restrained means for shifting a slip segment over a cam surface and outwardly of the packer body to engage the well conduit. These shifting means, indicated generally by the numeral 46, will be more fully described hereinafter.

Received in each pocket 42 is a slip segment 47. As shown in FIGS. 1 and 3, each slip segment is generally wedge-shaped and has an inclined, flat back surface 48 which mateably cooperates with an inclined surface 44 in a slip pocket 42 when the parts are assembled. The outer periphery of each slip segment may have a curvature which is the same as the curvature of the inner wall of the well conduit in which the packer or plug is to be set and has upwardly facing wickers or teeth 49 formed thereon. Near the lower edge of the slip segment is a pin hole 50 which receives the shear pin 51 for releasably securing the slip segment within a pocket 42.

Each slip shifting means 46 includes a fork 55 (FIG. 4) having upwardly extending bifurcated legs 56 and a downwardly extending shank 57. Coiled around the shank 57 and abutting between the upper face 58 of a slip element 47 and a shoulder 59 on fork 55 is a helical coil spring 60. The spring is compressed when the parts are assembled and each spring is retained in a compressed condition by a spring retaining pin 61 which extends between leg portions 56 and into pin holes 62 formed in the walls of the bores 45 as shown in FIG. 2. The lower end of each fork 55 abuts the top face of a slip element 63 and the upper ends of the legs 56 extend upwardly across the clearance space between the upper end of sleeve 40 and the movable abutment 15 and abuts a downwardly facing shoulder 64 on the movable abutment.

In operation, the parts are assembled as shown in FIGS. 1-3 and attached to a wire line or other setting tool which is capable of exerting an upward pull on body 10 and a downward push on movable abutment 15. Such setting tools are well known and need not be described here. The apparatus is then lowered into the well conduit to a predetermined setting point. The setting tool is actuated and an upwardly directed setting force is applied to body 10

and a downwardly directed setting force is applied to movable abutment 15, causing the upper and lower abutments to approach each other. The setting forces are initially transmitted through forks 55 to slip elements 47 to cause the shear pins 51 to shear and thus release the slip segments for longitudinal and outward movement. The compressed springs 60 then act to move the slip segments longitudinally over the inclined surfaces 44 and outwardly of body 10 until the slips wedge against the casing wall as shown in FIG. 5.

As abutments 15, 11 further approach one another, the lower face of movable abutment 15 and the upper face of lower abutment 11 abut the ends of the sleeves 40. Thereafter, the setting forces act to shear pins 32, 33, and release the sleeves for sliding movement over body 10. As the sleeves approach one another, the annular packing element 26 is foreshortened and expanded into packed off condition between the conduit wall and the body 10. During the approach of the sleeves to each other, the compression springs 60 act to continuously wedge the slip segments against the wall of the well conduit 65. It should be noted, however, that the wickers or teeth on the slip segments will not be dulled or ground away by engagement with the well conduit during setting because the setting forces required to expand the packing element are applied to the sleeves 40 independently of the slip segments.

When the setting force is built up to a predetermined point, the setting tool releases from the bridge plug automatically and the locking device 17 between the movable abutment 15 and the body 10 prevents upward relative movement of the body with respect to abutment and maintains the packing 26 in an expanded condition to seal off the annulus between the well conduit and the body as shown in FIG. 5.

Forces acting from either above or below the plug will not act to move it up or down the well conduit. An upwardly acting force is transmitted via packing element 26 and upper sleeve 40 directly to the inclined surfaces 44 which are underneath the slip segments 47 which must hold this force, the surfaces acting to wedge the slip segments outwardly and causing the slip teeth to bite into the walls of the conduit. Conversely, a downwardly acting force is transmitted via the packing element and the lower sleeve and directly to the inclined surfaces under the slip elements which must hold this force.

Advantages of the present invention are numerous. For example, the total travel required to set the bridge plug is approximately equal to the travel required to set its packing element. Therefore, less work is required to set the plug than is required for known tools. Also, each slip segment is moved longitudinally and radially out to the conduit wall independently of the other slip segments, allowing each segment to engage a conduit which is not perfectly circular and further allowing each segment to carry an equal load. The wickers or teeth on the slip segments are not dulled or ground away by engagement with the well conduit as the packing element is being expanded. Furthermore, since the slip segments are initially shear pinned within the recessed slip pockets, the chances of premature setting while running in or out of the well are virtually eliminated. Also, the longitudinal webs between slip pockets form integral parts of the sleeves and give the sleeves strength to withstand tremendous loads without collapsing or crushing. The added strength due to these webs allows the sleeves to have thinner cross sections which will allow greater packer or plug body diameters.

Since certain changes may be made in the above-disclosed apparatus without departing from the scope of the inventive concept involved, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

5

What is claimed is:

1. Apparatus for anchoring a body in a well conduit comprising: a sleeve movably mounted on said body, said sleeve having a plurality of pockets therein; a plurality of slip segments received in said pockets; means for releasably securing said slip segments in said pockets; spring means abutting each of said slip segments capable of moving said slip segments longitudinally of said pockets and outwardly of said body; and means abutting said slips for releasing said securing means whereby said spring means can act to move said slip segments independently of movement of said sleeve.

2. A well tool comprising: a body member having a packing element mounted therearound; expander means adjacent the ends of said packing element adapted for advancement toward each other to apply compressive force to said packing element; abutment means on said body member arranged for engagement with said expander means and for movement relatively toward each other in order to advance said expanders toward each other; slip means movable between retracted and expanded positions on said expander means; and means for moving said slip means from retracted to expanded positions independently of movement of said abutment means relatively toward each other.

3. The well tool of claim 2 further including releasable means for securing said slip means in retracted positions; and means responsive to movement of said abutment means relatively toward each other for releasing said securing means.

6

4. The well tool of claim 3 wherein said releasing means includes force transmitting members extending between said slip means and said abutment means.

5. A well tool comprising: a body member; expander means slidable along said body member; slip means movable between retracted and expanded positions on said expander means; releasable means for securing said slip means in retracted positions; abutment means on said body member movable into engagement with said expander means for sliding said expander means along said body member; and means responsive to movement of said abutment means toward engagement with said expander means for effecting release of said securing means so that said slip means can move to said expanded positions.

6. The well tool of claim 5 further including means operable upon release of said securing means for moving said slip means from retracted to expanded positions.

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30 JAMES A. LEPPINK, *Primary Examiner*.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,374,840

March 26, 1968

James H. Current

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

In the heading to the printed specification, lines 3 and 4, "Schlumberger Well Surveying Corporation" should read -- Schlumberger Technology Corporation --. Column 2, line 67, "in" should read -- is --. Column 5, line 21, "retraced" should read -- retracted --.

Signed and sealed this 19th day of August 1969.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.

Commissioner of Patents