Jan. 12, 1954 R. C. BAKER 2,665,765

SEGMENTAL SLIP SUBSURFACE WELL TOOL

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Fig. 1.

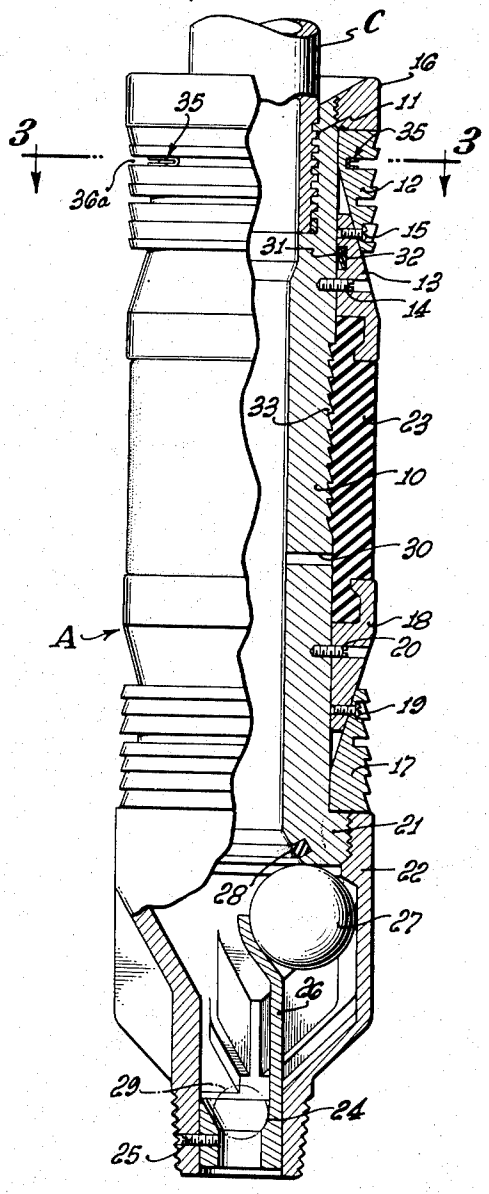
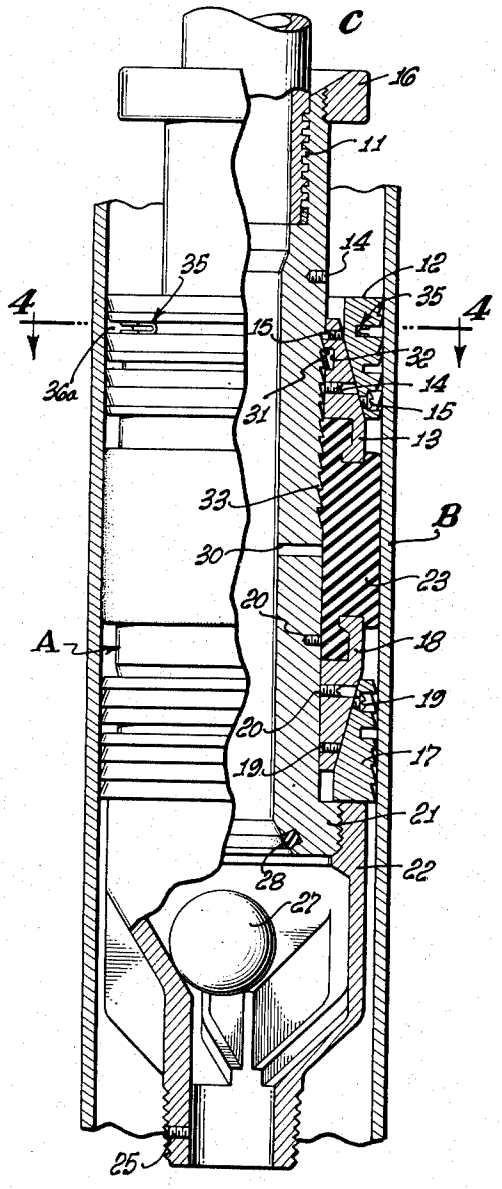


Fig. 2.



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Fig. 3.

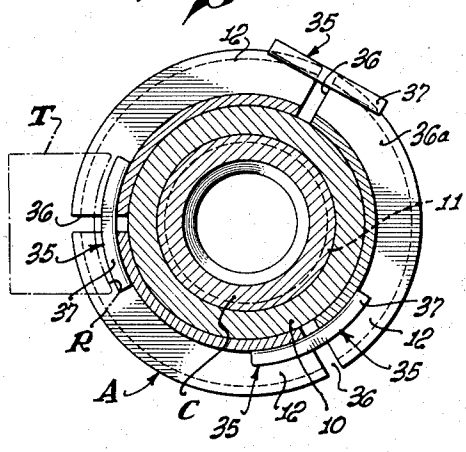


Fig. 4.

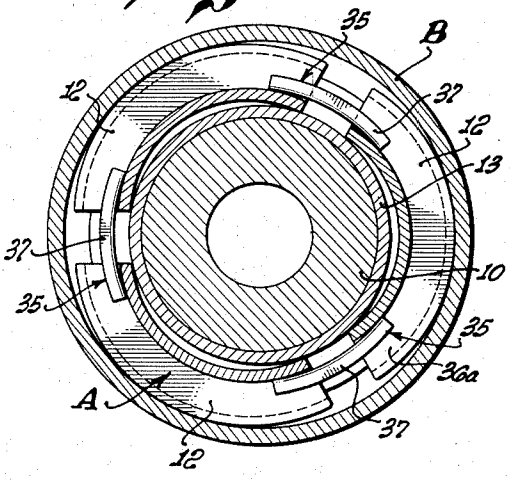


Fig. 5.

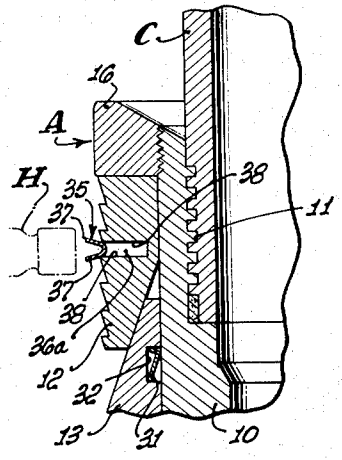


Fig. 6.

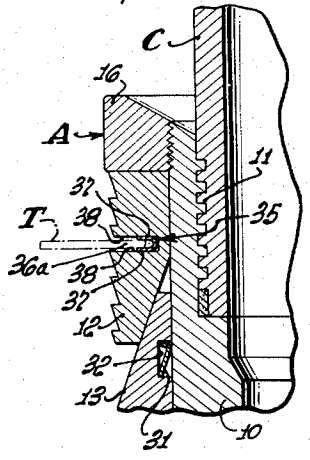
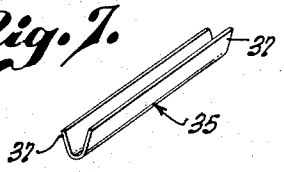


Fig. 7.



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Patented Jan. 12, 1954

2,665,765

UNITED STATES PATENT OFFICE

2,665,765

SEGMENTAL SLIP SUBSURFACE WELL TOOL

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Application April 3, 1950, Serial No. 153,540

7 Claims. (Cl. 166—12)

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The present invention relates to subsurface well tools, and more particularly to well tools embodying segmental slips that are expandible outwardly against well casing, or similar conduits, disposed in well bores.

Subsurface well tools are used that include slips for anchoring them in well casing and the like. The slips are originally retained in retracted position and are later expanded outwardly into engagement with the well casing. The slips may not move outwardly in transverse alignment with each other, or they may not remain in transverse alignment after engaging the casing, which will place, or tend to place, the well tool off center within the casing, and result in its inability to perform properly its intended function or functions. Devices are known for maintaining the slips in transverse alignment, but they tend to urge them to a retracted position after they have been expanded against the casing, and may result in the failure of the slips to retain the well tool anchored to the casing.

Accordingly, an object of the present invention is to provide a subsurface well tool having slips that remain in transverse alignment at all times, and which imposes no retracting forces on the slips once they have been shifted against the well casing, or similar well conduit.

Another object of the invention is to provide subsurface well tools including slip aligners that can be installed easily in the slips, and which are comparatively inexpensive.

A further object of the invention is to provide subsurface well tools having slips and elements for retaining the slips in alignment, and in which the elements are capable of retaining themselves in appropriate position within the slips.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a longitudinal view, partly in section and partly in elevation, of a well packer with its parts in retracted position;

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Fig. 2 is a view similar to Fig. 1, with the well packer anchored in packed-off condition within a well casing;

Fig. 3 is a cross-section, on an enlarged scale, taken along the line 3—3 in Fig. 1, and disclosing the manner of installing the slip aligners in the slips;

Fig. 4 is a cross-section, on an enlarged scale, taken along the line 4—4 in Fig. 2;

Fig. 5 is an enlarged fragmentary section through part of the well tool, illustrating the manner of assembling the slip aligners within the slips;

Fig. 6 is a view similar to Fig. 5, disclosing a slip aligner inserted completely in place;

Fig. 7 is an isometric view of one of the slip aligner elements.

The invention is disclosed in the drawings as applied to a well packer A of the general type disclosed in the United States Patent No. 2,121,051. This well packer is designed to be lowered through a well casing B on the lower end of a tubular string C, with the packer parts in retracted position. The packer includes a main body 10 that can be secured to the lower end of the tubular string C by means of a suitable left-hand threaded connection 11. This body carries a set of upper annular segmental tapered slips 12 adapted to be moved into engagement with the casing by an upper conical expander 13 that is initially secured to the body 10 by one or more shear screws 14. The upper slips 12 are retained initially in retracted or ineffective position by shear screws 15 securing them to the conical expander 13, the upper ends of the slips engaging the upper surface of an abutment member or ring 16 threaded on the main body.

A lower set of annular segmental slips 17 is initially held in retracted position by attaching them to a lower conical expander 18 through the agency of shear screws 19. This lower expander is initially held in ineffective position by shear screws 20 threaded into the body. The lower ends of the lower slips engage an abutment consisting of a flanged portion 21 at the lower end of the body and a valve housing 22 threaded on this flange.

A packing sleeve 23 of synthetic or natural rubber is positioned on the body 10 between and suitably secured to the ends of the expanders 13, 18. This sleeve 23 is retained originally in retracted position free from contact with the casing wall, but is capable of being expanded into engagement therewith.

It is to be noted that the coengaging surfaces on the upper conical expander 13 and upper slips 12 taper in an upward and inward direction, so that relative longitudinal movement of the upper expander within the slips 12 will move the latter outwardly against the casing B. In like manner, the lower expander 18 and lower slips 17 have their coengaging surfaces tapering in a downward and inward direction, in order that relative longitudinal movement of the lower expander within the slips 17 will shift them radially outward into engagement with the casing.

The valve housing 22 contains a tripping ball seat 24 that is initially held therewithin by a shear screw 25. This seat has an upstanding arm 26 for holding a buoyant back pressure valve ball 27 in ineffective position against the interior of the housing, to prevent its upward movement and seating against a valve seat 28 at the lower end of the main packer body 10. Removal of this arm 26 by pumping the tripping ball seat unit 24 out of the housing permits the ball 27 to engage its cooperable seat 28 whenever reverse flow of fluids through the body 10 tends to occur.

The packer A is run in the casing to the desired setting point, after which a tripping ball 29 may be lowered or pumped down through the tubular string C into seating engagement with the tripping ball seat 24. Such engagement prevents any further downward passage of fluid through the well packer A, and allows the pressure of the fluid within the tubing string C and packer body 10 to be increased. This fluid under pressure passes outwardly through ports 30 that open through the body 10 into the interior of the packing 23. Fluid under pressure inflates and elongates the packing sleeve 23, and urges the upper expander 13 upwardly, disrupting the shear screws 14, 15 and shifting the upper expander 13 within the slips 12, sliding the latter radially outward along the abtument ring 16 and into engagement with the wall of the well casing B. The lower shear screws 19, 20 have a substantially greater shear value than the upper screws 14, 15, which insures disruption of the latter under the action of the fluid pressure, as above described.

After the upper slips 12 have been expanded against the casing B, an upward strain may be taken on the tubing string C, which shifts the packer body 10 upwardly within the upper cone 13, and carries the lower expander 18 and slips 17 upwardly with the body 10. This action foreshortens and compresses the packing sleeve 23 and expands it outwardly into sealing engagement with the wall of the well casing. A continuation of the upward strain then disrupts the lower shear screws 19, 20, which allows the lower abutment 21, 22 to shift the lower slips 17 upwardly along the lower expander 18 and radially outward into anchoring engagement with the well casing B. All of the parts are held in the position to which they have been expanded, and are prevented from moving to retracted positions by a suitable lock ring 31, which may be in the form of a split, contactile element contained within a groove 32 in the upper expander 13 and adapted to engage the downwardly facing annular ratchet teeth 33 formed on the exterior of the packer body 10.

After the packer A has been anchored against the well casing B, the pressure can be increased to shear the screw 25 holding the tripping ball seat 24 to the valve housing 22, which enables the seat to be blown out of the valve housing and removes the arm 26 from its holding position against the ball valve element 27, allowing the latter to shift upwardly into engagement with the valve seat 28, in the event that reverse flow through the well packer A tends to occur.

During the upward movement of the upper expander 13, the upper segmental slips 12 may not remain in transverse alignment, so as to insure their engagement with the well casing B in a manner to keep the upper expander 13 and packer body 10 centered or coaxial with respect to the axis of the casing B. One slip segment may drop downwardly along the upper expander a greater distance than another slip segment, which action would tend to place the upper expander 13 and body 10 off center. Were this to occur, the taking of the substantial upward strain on the tubing string C and body 10 necessary to expand the packing 23 and the lower slips 17 against the casing, and to fully and solidly anchor the well packer A against the casing, might impose a bending strain on the packer body 10 (which is usually a casting) and result in its failure.

Even if the slips 12 are moved outwardly along the upper abutment 16 into engagement with the well casing B, while the packing sleeve 23 has been ballooned outward and elongated, as described above, the subsequent relieving of the pressure within the packer body 10 and tubular string C would result in the contraction of the packing sleeve 23 and lowering of the upper expander 13 along the body. When this occurs, the slips 12 may not drop downwardly with the expander uniformly, one slip being lower than the other. Here again, the net result would be the wedging of the upper expander 13 and packer body 10 off center of the well casing, which might result in failure of the tool, or at least in a potential improper packing off of the packing 23 against the casing, when the upward strain is taken on the tubing string C and packer body 10.

The aforenoted difficulties are overcome by providing slip aligners 35 between the adjacent slips 12 of the upper set. These slip aligners consist of relatively wide V-shaped elements made of sheet metal, such as spring brass, that is somewhat malleable. Each slip aligner 35 is relatively short in length and is adapted to be inserted in a circumferential groove 36*a* formed jointly in all of the segmental slips 12, and in transverse alignment with each other, or at right angles to the axis of the packer body 10. The slip aligner extends from one slip 12 across to the adjacent slip, bridging the gap 36 therebetween. Originally, the slip aligner is relatively wide and generally V-shaped in cross-section, the distance across its side flanges or arms 37 being substantially greater than the width of the circumferential groove 36*a*. The slip aligner 35 is forced into the circumferential groove 36*a*, the side walls 38 of the latter moving the side flanges 37 toward each other.

One manner of installing a slip aligner is illustrated somewhat diagrammatically in Figs. 3, 5 and 6. As shown in Fig. 5, a slip aligner 35, which may at first be straight, is placed with its mid-portion across the gap 36 between adjacent segments 12. A hammer H may then be used to tap or start the aligner 35 into the circumferential groove 36*a*, which action moves the arms 37 of the element toward each other under the closing force exerted by the sides 38 of the circumferential groove. After the element has been started in the groove, a setting tool T may be used, in the form of a relatively thin blade having a concave or arcuate end R conforming gen-

erally to the curvature of the base of the circumferential groove 36a. This tool is placed within the slip aligner 35 and its outer end struck with a hammer, forcing the slip aligner well within the groove 36a and also bending it into a generally arcuate shape, such as disclosed in Figs. 3 and 4.

All of the slip aligners 35 may be mounted within the upper slips 12 in the manner described, each aligner extending within the circumferential groove 36a from one slip segment 12, across the clearance gap 36, into the next slip segment 12.

When the upper slips 12 are expanded outwardly against the well casing as a result of upward movement of the upper expander 13 along the packer body 10, the slip aligner elements 35 maintain the slips in transverse alignment with each other, but they do not offer any substantial resistance to radial outward movement of the segments 12. Of course, as the segments are urged outwardly by the conical expander, the gaps 36 between the adjacent segments widen. However, the slip aligners 35 are long enough to each bridge the larger gap after the slips have been fully expanded into anchoring engagement with the well casing. In the event that the conical expander 13 tends to shift downwardly as a result of bleeding off of the pressure within the tool, the slip segments 12 will merely move downwardly along the casing as a unit with the cone 13, the aligning elements 35 maintaining the segments in transverse alignment with one another. As a result, it is evident that one slip cannot drop below another slip, so as to force the well tool off center.

It is also to be noted that the slip aligners 35 are independent of one another, and, accordingly, do not impose any inwardly directed forces tending to shift the segments 12 inwardly toward retracted position, particularly during downward movement of the upper expander 13 along the packer body. The slips 12 will remain outwardly to the extent that they have been moved by the upper expander 13. As a result, when the tubing string C and packer body 10 are moved upwardly, to expand the packing sleeve 23 and the lower slips 17 against the casing B, the upper slips 12 are in engagement with the well casing, and will instantly grip the casing more securely, to enable the aforementioned expanding actions of the other packer parts to take place. If the slips 12 were to retract, even slightly, from the well casing, they could not provide the necessary anchor against which the upward strain is taken, and it would be impossible to set the lower slips 17 and expand the packing sleeve 23 against the casing.

In view of the relative malleability of the aligner elements 35, which may be made of spring-like half-hard brass, for example, they can be made to conform generally to the curvature of the base of the circumferential groove 36a. Despite such curving or bending of the slip aligners, they still possess spring characteristics, in that the forcing of the elements within the circumferential groove 36a will cause the side flanges 37 to tend to spring apart, and grip or dig into the side walls 38 of the circumferential groove, thereby insuring retention of the aligners 35 in their appropriate position within the circumferential groove. The aligners will remain in position during outward expansion of the segments 12 against the casing, the slip segments and aligners merely sliding circumferentially with respect to one another without the aligners 35 tending to move outwardly of the circumferential groove 36a.

The inventor claims:

1. A well tool, including a body adapted to be lowered in a well casing on a running-in string, means for anchoring said body to the well casing comprising a set of segmental slips having a circumferential groove therein, individual elements in said groove separate from each other for maintaining said slips in transverse alignment with respect to each other, each element extending from one segmental slip to an adjacent segmental slip and being at least as wide as the distance between the opposed side walls of the groove so as to be held in position by simultaneously frictionally engaging both of the opposed side walls of said groove.

2. A well tool, including a body adapted to be lowered in a well casing on a running-in string, means for anchoring said body to the well casing comprising a set of segmental slips having a circumferential groove therein, individual elements in said groove separate from each other for maintaining said slips in transverse alignment with respect to each other, each element extending from one segmental slip to an adjacent segmental slip, and each element being generally V-shaped in cross-section and having spring-like side flanges pressing against the side walls of said groove to hold said element in position within said groove.

3. A well tool, including a body adapted to be lowered in a well casing on a running-in string, means for anchoring said body to the well casing comprising a set of segmental slips having a circumferential groove therein, individual elements in said groove separate from each other for maintaining said slips in transverse alignment with respect to each other, each element extending from one segmental slip to an adjacent segmental slip, each element being of spring-like, malleable material and of generally arcuate shape and being at least as wide as the distance between the opposed side walls of the groove so as to simultaneously frictionally engage both of the opposed side walls of said groove to hold said element in position within said groove.

4. A well tool, including a body adapted to be lowered in a well casing on a running-in string, means for anchoring said body to the well casing comprising a set of segmental slips having a circumferential groove therein, individual elements in said groove separate from each other for maintaining said slips in transverse alignment with respect to each other, each element extending from one segmental slip to an adjacent segmental slip, each element being made of spring-like malleable material and being arcuate along its length and generally V-shaped in cross-section to provide side flanges of said element tending to move inherently apart into firm engagement with the side walls of said groove to hold said element in position within said groove.

5. A well tool, including a body adapted to be lowered in a well casing on a running-in string, means for anchoring said body to the well casing comprising a set of segmental slips having a circumferential groove therein, individual elements in said groove separate from each other for maintaining said slips in transverse alignment with each other, each element extending from one segmental slip to an adjacent segmental slip, each element having opposed gripping portions simultaneously engaging both of the opposed side walls

of said groove to retain said element in said groove.

6. A well tool, including a body adapted to be lowered in a well casing on a running-in string, means for anchoring said body to the well casing comprising a set of segmental slips having a circumferential groove therein, individual elements in said groove separate from each other for maintaining said slips in transverse alignment with respect to each other, each element extending from one segmental slip to an adjacent segmental slip, and each element having spring-like side portions simultaneously pressing against the side walls of said groove to hold said element in position within said groove.

7. A well tool, including a body adapted to be lowered in a well casing on a running-in string, means for anchoring said body to the well casing comprising a set of segmental slips having a circumferential groove therein, individual elements

in said groove separate from each other for maintaining said slips in transverse alignment with respect to each other, each element extending from one segmental slip to an adjacent segmental slip, each element being of spring-like, malleable material and of generally arcuate shape, each element having opposed gripping portions simultaneously engaging both of the opposed side walls of said groove to retain said element in position within said groove.

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