Nov. 26, 1968 J. E. STACHOWIAK 3,412,803

WELL TOOL ANCHORS

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Fig. 1

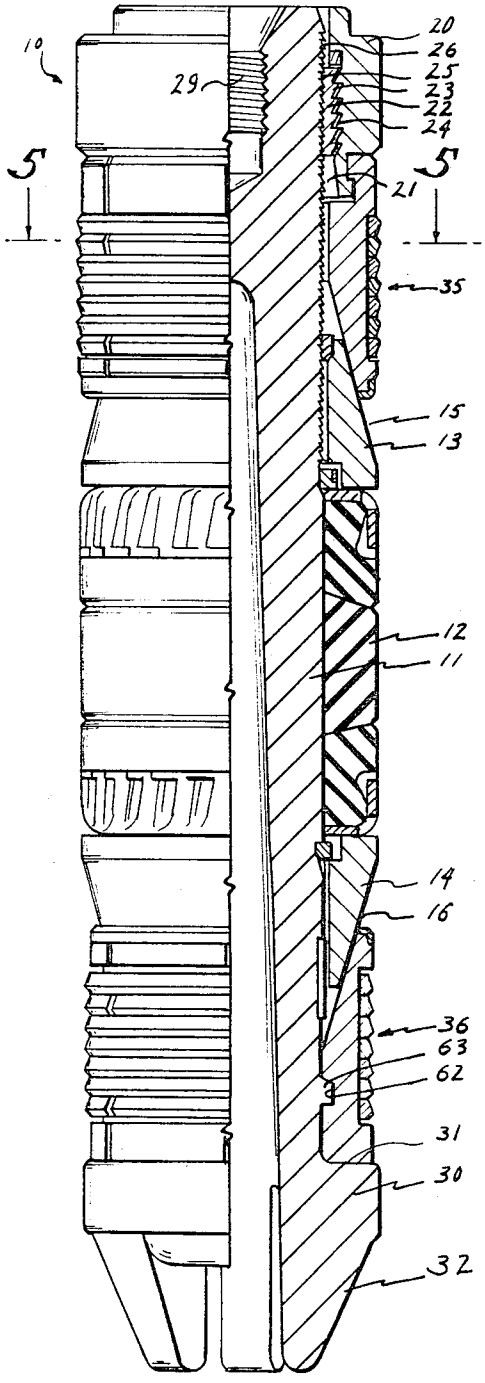

Fig. 5

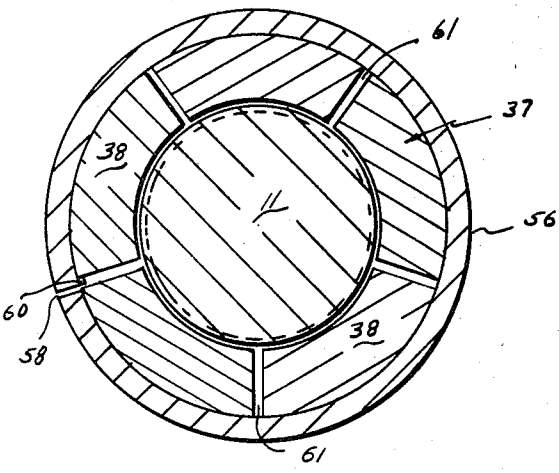

Fig. 6

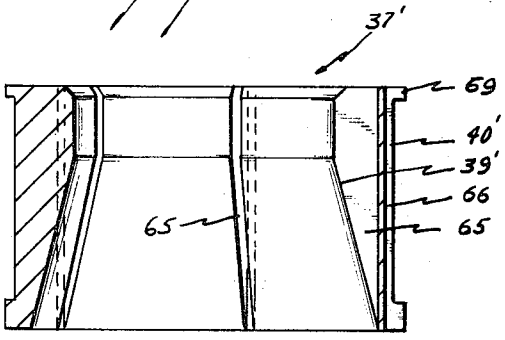

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Fig. 2

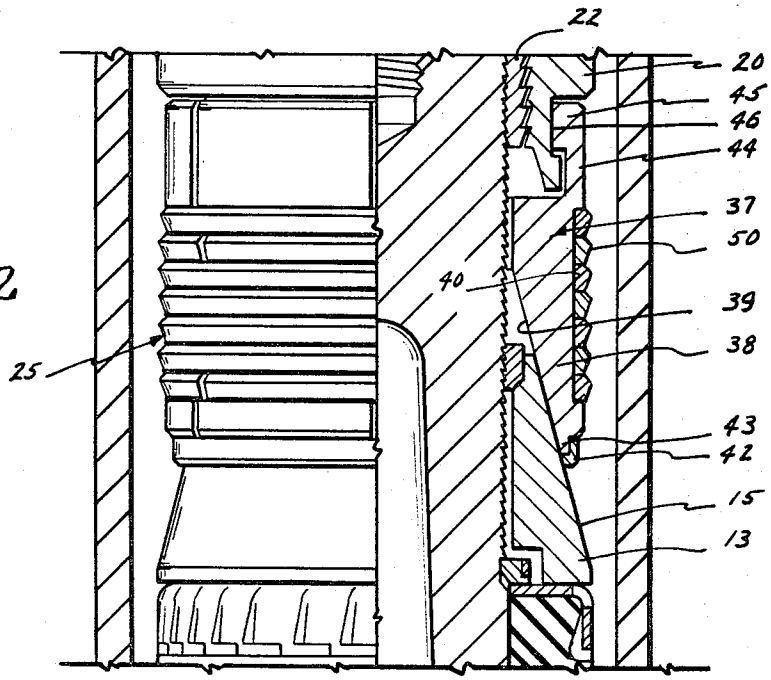


Fig. 3

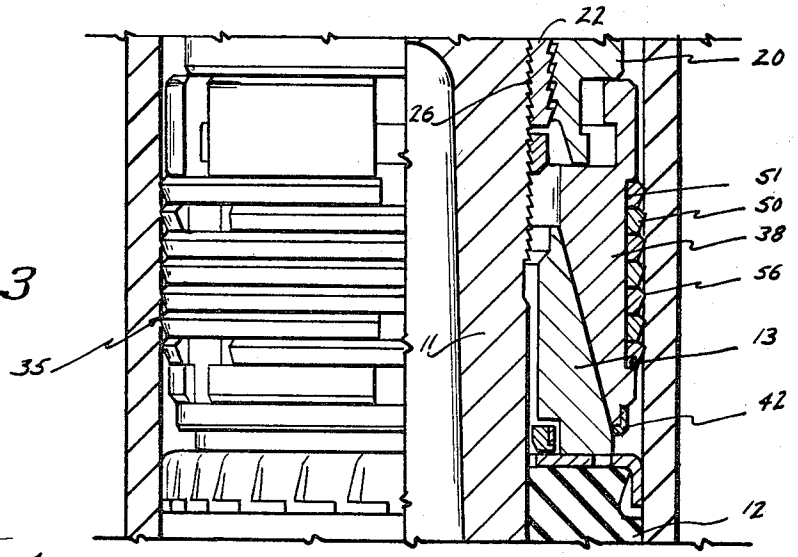
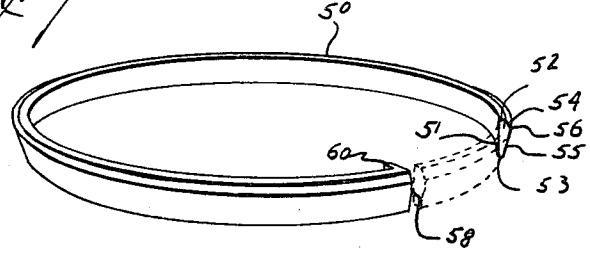


Fig. 4



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WELL TOOL ANCHORS

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ABSTRACT OF THE DISCLOSURE

Apparatus for anchoring a well tool in a well bore, including a body member and an expander cone on said body member, a segmental or breakable support member which can be shifted outwardly of said body member by said expander cone, and a plurality of expansible slip bands encircling and engaging said support member whereby outward shifting of said support member by said expander cone can expand said slip bands into gripping engagement with a well bore wall.

This invention relates generally to well tools and more specifically to a new and improved anchor means for well tools.

Numerous well tools require that a body member be anchored in a well conduit against movement therein, either in one or both directions. Examples of such well tools are packers, bridge plugs and cement retainers. In the prior art, anchoring devices have generally taken the form of wedge-shaped slips having external wickers or teeth thereon adapted to grip the well conduit wall when shifted outwardly by an expander. Although these devices have for a number of years attained a degree of commercial success, they have, in some instances, been costly to manufacture and unreliable in operation.

An object of the present invention is to provide a new and improved anchoring device for a well tool which is effective to anchor a body member in a well conduit.

Another object of the present invention is to provide a new and improved anchoring device which is inexpensive to manufacture and reliable in operation.

These and other objects are attained in accordance with the present invention by providing an expansible support means on a body member and a means for expanding the support means outwardly of the body member. An expansible anchor means is provided which encircles and engages the support means. The anchor means is adapted, when expanded by the support means, to engage the wall of a surrounding well conduit and anchor the body member against movement therein.

An expansible anchor means in accordance with the present invention can take the form of a resilient ring member having a flat inner surface and upper and lower surfaces extending at right angles to the inner surface. The ring member further has outer surfaces converging to form a relatively sharp edge around the outermost periphery thereof. The ring member is split at a point around the circumference whereby the ring member can be radially expanded responsive to outward pressure on its inner surface.

The novel features of the present invention are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may be best understood by way of illustration and example of various embodiments thereof when taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a longitudinal partial sectional view of a well tool embodying the principles of the present invention;

FIGURE 2 is an enlarged, fragmentary sectional view

of one embodiment of the present invention with the anchor means in retracted position;

FIGURE 3 is a view similar to FIGURE 2 with the anchor means expanded to anchor in the well conduit;

FIGURE 4 is an isometric view of an anchor member in accordance with the present invention;

FIGURE 5 is an enlarged cross-section on line 5—5 of FIGURE 1; and

FIGURE 6 is a sectional view of the support means in another embodiment of the present invention.

Referring to FIGURE 1, a well tool **10**, commonly called a bridge plug, is shown with parts in retracted or "running-in" positions. Although a bridge plug is shown, it will be appreciated that this particular type of well tool is shown for convenience of illustration and that the well tool **10** could be any other conventional tool used in the well arts which is to be anchored in a well conduit.

The well tool **10** has a central tubular body member **11** around which an elastomeric packing element **12** can be mounted. Upper and lower expander cones **13**, **14** are slidably carried about the body member **11** and engage opposite ends of the packing element. The expander cones are identically shaped but oppositely disposed, the upper cone **13** having outer inclined surfaces **15** converging upwardly and inwardly toward the body member **11** and the lower cone **14** having outer inclined surfaces **16** converging downwardly and inwardly toward the body member **11**.

A generally tubular setting head **20** is movably mounted on the body member **11** at an upper end portion thereof. The setting head **20** can have an internal recess **21** therein which contains a split ratchet slip **22** having cam teeth **23** on its outer periphery which engage companion cam teeth **24** on the outer wall of the recess **21**. The ratchet slip also has teeth **25** on its inner surface which engage complimentary teeth **26** on the upper portion of the body member **11**. It will be appreciatetd that the ratchet slip **22** functions as a unidirectional clutch in a conventional manner to permit downward movement of the setting head **20** relative to the body member **11** and to prevent converse relative movement.

A blind bore **29** in the upper end of the body member **11** is threaded to receive a tension stud (not shown) or other conventional release device which is connected to the tension member of a typical setting tool (not shown). A compression member of the setting tool engages the upper end of the setting head **20** and it will be appreciated that upwardly directed setting forces can be exerted on the body member **11** through the tension member while downwardly directed setting forces can be exerted on the setting head **20** through the compression member. An annular flange **30** at the lower end of the body member **11** provides an upwardly facing shoulder or abutment **31** and downwardly extending guide members **32** can serve to guide the well tool **10** during its descent in a well conduit.

Upper and lower anchor assemblies **35**, **36**, in accordance with the present invention, are mounted around the body member **11** between the upper expander cone **13** and the setting head **20** and between the lower expander cone **14** and the upwardly facing abutment **31** on the body member **11**, respectively. Inasmuch as the anchor assemblies are substantially identical but oppositely disposed, only the upper anchor assembly **35** will be described in detail.

Referring to FIGURES 2 and 5, an anchor assembly includes an expansible support means **37** comprised of a plurality of segments **38**, for example five, radially spaced about the body member **11**. Each segment has an inner inclined surface **39** which diverges downward and outwardly of the body member **11** and which is complementary to

the outer inclined surface 15 on the expander cone 13 in a manner whereby relative movement between the segments 38 and the expander cone 13 will cause outward shifting or expansion of the segments. A longitudinally extending recess 40 is formed in the periphery of each segment 38 so that when the segments are placed side-by-side as shown, a continuous external recess is formed which extends around the entire periphery of the support means 37.

An expansible restraining band 42 can be positioned in a groove 43 around the lower end of the support means 37 to restrain expansion thereof. The band 42 can be made of a ductile and stretchable material such as brass which will yield and stretch as the support means is expanded outwardly to cause controlled and uniform expansion thereof. Each segment 38 can further be provided with an upwardly extending connecting portion 44 having an inwardly extending shoulder 45 which engages in an annular groove 46 in the setting head 20. This provides a strong connection between the anchor assembly 35 and the setting head 20 as long as the anchor assembly is in its retracted position to prevent premature operation. Of course, as the support means 37 is expanded, the shoulders 45 are moved outwardly and are released from the groove 46.

The anchor assembly 35 further includes a plurality of expansible ring members 50 which encircle the support means 37 and engage in the annular recess 40. Seven ring members 50 are illustrated although other numbers could be used. As shown in detail in FIGURE 4, each ring member has a flat inner surface 51 and upper and lower surfaces 52, 53 extending at right angles to the inner surface 51. Outer surfaces 54, 55 converge to form sharp edge 56 of an upwardly facing tooth 57, the sharp edge extending around the outermost periphery of each ring member 50. Although other configurations will be suggested to those skilled in the art, it is preferable that the upper outer surface 54 diverge outwardly at an angle in the range of 23° to 30° from the plane of the upper surface 52 of the ring member 50 and that the angle of upward divergence of the lower outer surface 55 be such that the two surfaces 54, 55 come together at a right angle to form the sharp edge 56. Each ring member 50 has a radially cut split 58, so that the ring members will be radially expansible in response to outward pressure on their inner surfaces 51.

The ring members 50 are preferably made of suitable metal which has inherent resilience such that the ring members can be expanded to the inside diameter of the well conduit without being permanently deformed. Thus it will be appreciated that the ring members can function as restraining members for the support segments 38 as long as they are in retracted positions as shown in FIGURE 2 as well as functioning to permit controlled and uniform expansion of the support means 37 as a unit when it is moved into an anchoring position as shown in FIG. URE 3. It has been found that shaped steel wire is suitable for making the ring members 50 although other means such as rings machined from a length of metal tubing can be used. In the latter case, more than one tooth can be formed by each ring. Additionally, each of the ring members 50 can be made to have interlocking upper and lower surfaces with adjacent ones of the ring members with the uppermost ring member as shown in FIGURE 2 interlocked with the upper portion of the recess 40.

It is desirable that the splits 58 in each ring member be circumferentially staggered so that they do not line up, one with another, and for this purpose each ring member 50 can have an inwardly extending projection 60 formed thereon as shown in FIGURES 4 and 5. The projection 60 on each ring member 50 can fit when the parts are assembled into the spaces 61 between adjacent support segments 38 in a manner whereby the splits 58 are circumferentially staggered about the support means 37. Also it may be desirable to provide a small, shearable screw connection (not shown) between each ring member and the support means 37 to insure that the ring members will remain properly positioned on the support means prior to outward expansion thereof.

As previously mentioned, the lower anchor assembly 36 is substantially identical to the above-described assembly in structure and operation. However, as shown in FIGURE 1, the connecting portions 44 of the upper assembly are omitted and an internal annular groove 62 is formed in each segment and receives an annular flange 63 on the body member 11 so that the segments are immovable longitudinally relative to the body member but can be shifted outwardly thereof by downward movement of the lower expander cone 14.

An alternative embodiment of a support means is shown in FIGURE 6. In this embodiment, the support means 37' is integrally formed to be circumferentially contiguous but has longitudinally extending slots 65 around its inner periphery. The slots 65 extend through the inclined surfaces 39' and are sufficiently deep that only thin web portions 66 connect between segments. Also, outer slots 69 can be cut above, below and within the outer recess 40' along the same radial lines as the inner slots 65 to further weaken the web portions 66. With this arrangement, outward pressure exerted by an expander cone on the inner inclined surfaces 39' of the support means 37' will cause it to fracture or break at the web portions 66 into a plurality of segments which can then be shifted outwardly to engage the ring members 50 with the well conduit wall. The projections 61 on the ring members 50 can engage in the outer slots 69 to circumferentially stagger the rings in the same manner as shown in FIGURES 1 and 2. Inasmuch as the support means 37' is initially circumferentially continuous, a restraining band as shown in FIGURE 2 need not be used. Moreover, the support means 37' can have sufficient strength that connecting portions to the setting head can be omitted.

Operation

The parts can be assembled as shown in the drawings and lowered into a well conduit to a selected setting depth. At this point, a suitable mechanism (not shown) of a type commonly used in the art can be operated to apply upwardly directed setting forces to the body member 11 and to apply downwardly directed setting forces to the setting head 20. Such forces will cause the setting head 20 and the lower abutment 31 to be moved relatively toward one another. Depending upon the relative strengths of the restraining bands 42, one anchor assembly can be operated before the other, if desired. Assuming that the upper band is the weaker, the support segments 38 which make up the upper support means 37 will be driven downwardly over the upper expanded cone 13 and shifted outwardly thereby. As the setting head 20 moves downwardly, the ratchet slip 22 expands and contracts as it ratchets down over the body teeth 26. Outward expansion of the support means 37 exerts outward pressure on the inner surfaces 51 of the ring members 50 to expand them toward the surrounding conduit wall. When the wall is reached as shown in FIGURE 3, the sharp edges 56 of the ring members 50 bite into and grip the wall to prevent further downward movement of the support means. At this point, the body member 11 will begin to move upwardly relative to the upper anchor assembly 35 and the lower abutment 31 will transmit setting forces to the lower anchor assembly 36 to operate it. The packing element 12 is compressed between the expander cones 13, 14 and expanded outwardly of the body member 11 into sealing engagement with the well conduit wall.

When a predetermined magnitude of setting force is reached, the tension stud (not shown) will fracture in a conventional manner to release the setting mechanism for retrieval from the well bore. The upper anchor assembly 35 prevents upward movement of the bridge plug 10; the lower anchor assembly 36 prevents downward movement; the ratchet slip 22 locks the compression energy in the packing element 12; the packing element 12 packs off

the annulus between the body member **11** and the surrounding well conduit wall.

The operation of an anchor assembly in accordance with the present invention using the alternative support means **37'** shown in FIGURE 6 will be substantially the same as above described except that as an expanded cone is forced into the support means, it will fracture or break into several segments along lines defined by the longitudinal slots **65, 69**. Thereafter the segments are shifted outwardly to expand the ring members **50** into engagement with the well conduit wall in the same manner as described above.

A new and improved anchor means has been disclosed which is effective to anchor a body in the well conduit, simple in operation and inexpensive to manufacture. Since certain modifications or changes may be made in the disclosed embodiments without departing from the inventive concepts involved, it is intended that all matter contained in the foregoing description are shown in the attached drawings shall be interpreted as illustrative and not in the limiting sense.

I claim:

1. A well tool comprising: a body; expanded means movably disposed on said body and having outer inclined surfaces converging inwardly toward said body; support means having inner inclined surfaces complementary to said surfaces on said expanded means, said support means being formed of a plurality of segments whereby said support means can be shifted outwardly of said body by movement of said expander means relative to said support means; and expansible slip means encircling and engaging said support means, said slip means being expanded outwardly into gripping engagement with the wall of the well conduit upon outward shifting of said support means.

2. The well tool of claim **1** further including means to restrain outward shifting of said support means.

3. The well tool of claim **2** further including head means movably mounted on said body adjacent said support means; and latch means for releasably locking said support means to said head means.

4. The well tool of claim **3** further including unidirectional clutch means to permit movement of said head means relative to said body in one direction along said body and to prevent movement of said head means relative to said body in the opposite direction.

5. A well tool comprising: a body; annular expander means movably disposed on said body and having outer inclined surfaces converging inwardly toward said body; annular support means having inner inclined surfaces complementary to said surfaces on said expander means, said support means being circumferentially continuous, said support means being provided with a plurality of spaced generally longitudinal grooves therein so that outward pressure exerted by said expander means on said inner inclined surfaces will cause said support means to be separated into at least two segments which can be expanded outwardly by said expander means; and expansible anchor means encircling and engaging said support means, said anchor means being adapted to be expanded outwardly by said at least two segments.

6. A well packer for use in a well comprising: a body; an elastomeric packing means mounted about said body for sealing against the wall of a surrounding well conduit; segmented support means adapted for expansion outwardly of said body; expander means on said body adjacent said packing means and slidably engaging said support means for expanding said support means outwardly of said body; and a plurality of expansible anchor bands constituting gripping teeth and mounted on the outer periphery of said support means and adapted, when expanded outwardly of said body by said support means, to anchor said body and packing means in a well conduit.

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