

[54] **ANCHORING MECHANISM FOR A WELL TOOL**

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[58] Field of Search. **166/138-140,**
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267, 269, 291, 289

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[57] **ABSTRACT**

An anchoring mechanism for a well tool includes a slip element coupled for both tilting and lateral movement to an associated housing and held in normally retraction position by a conical coil spring capable of deflection to a substantially flat condition, said slip element when contacted by an expander tilting in one direction until a slip tooth engages the casing, whereupon continued movement of the expander behind the slip head causes tilting in the opposite direction for full engagement of all slip teeth with the casing. Such tilting and outward movement is enabled by the coil spring's ability to assume a substantially flat condition so that the parts occupy a minimum of space.

9 Claims, 5 Drawing Figures

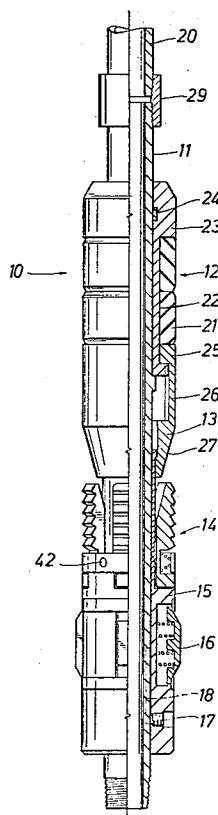


FIG. 1

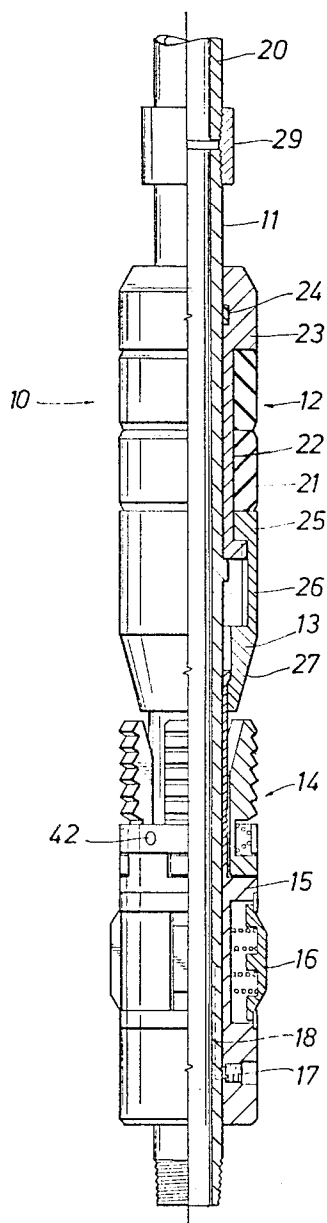


FIG. 2

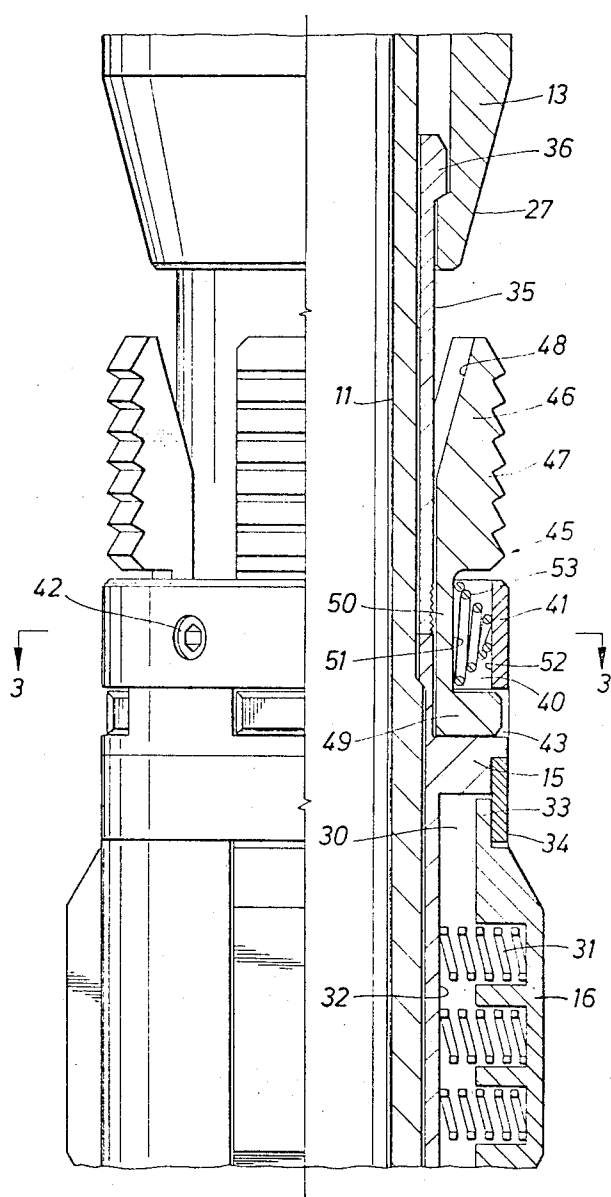


FIG. 3

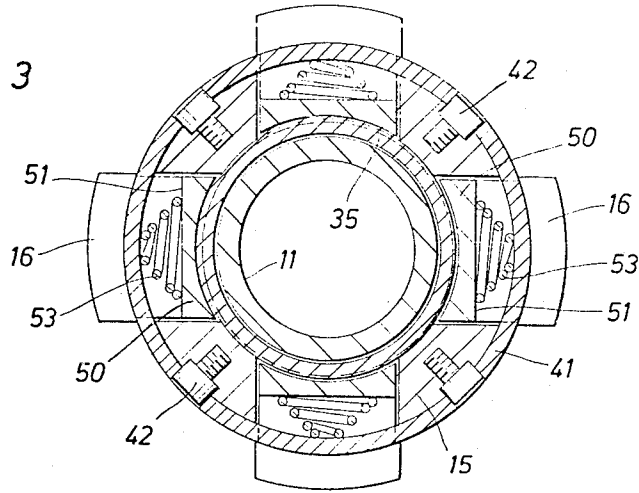
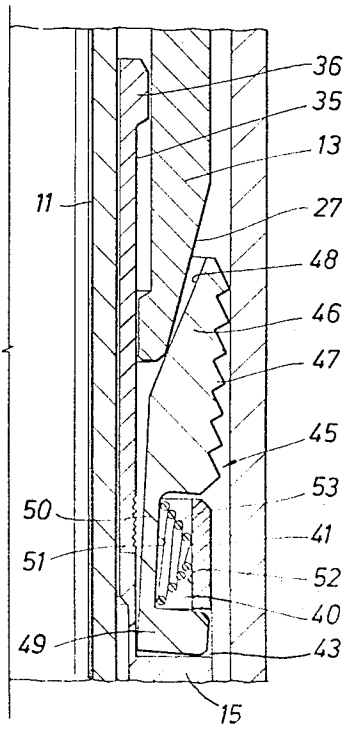


FIG. 4

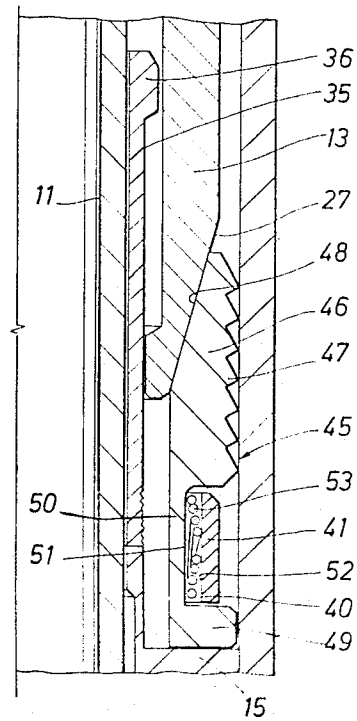


FIG. 5

ANCHORING MECHANISM FOR A WELL TOOL

This invention relates generally to well packers and more specifically to a new and improved anchoring mechanism for preventing movement of a well packer or similar tool in a well casing.

It is quite common to anchor a well tool against movement in a well casing through use of an expansible device commonly called a "slip" which is movable between a normally retracted or running-in position and an expanded or set position where the slip is wedged by an expander in gripping contact with the inner wall of a well casing. Quite a wide variety of slip configurations have been used, however, almost all of them have certain shortcomings. For example one type of slip has a pivot region of reduced cross-section which is quite fragile and easily broken when an obstruction is encountered in a well bore. Another type of slip has a pivot pin connection with the drag block housing and is somewhat complex in constructional arrangement. Yet another type of slip is caged within an annular housing for projection through windows therein, and is subject to not being fully retracted during running, so that the slip teeth may drag against the casing in an undesirable manner. Still another type of slip is arranged for a tilting action, however, this slip is spring loaded in such a manner as to require a substantial amount of lateral dimension in the tool to mount the slip in a operable manner.

The general object of this invention is to provide a new and improved well tool anchoring mechanism which does not have fragile pivots, is inexpensive to manufacture and simple in operation, and occupies a fully retracted position until set against the well casing.

This and other objects are attained in accordance with the concepts of the present invention through the provision of a well tool anchor including a slip member having a wedge shaped head that is integrally attached to a dog portion by a connecting wall section. The slip member is mounted in a recess in an adjacent housing member in such a manner that the wall section and the dog portion are within the recess while the head extends externally of the housing member. The recess is opened to the outside of the housing member at a point adjacent the dog so that the dog extends into the opening to mechanically interconnect the slip member with the housing member. A portion of the housing member overlies the wall section of the slip member, and a yieldable spring is positioned therebetween and functions to hold the slip head in a normally retracted position. The spring is in the form of a conical coil spring or the like so as to be capable of deflection to a substantially flat condition upon expansion of the slip head by an associated expander. The dog portion is somewhat loosely fitted within the opening to allow for the tilting action that occurs as the slip is expanded.

The present invention has other objects and advantages which will become more clearly apparent in connection with the following detailed description of a preferred embodiment, taken in conjunction with the attached drawings in which:

FIG. 1 is a somewhat schematic view of a well packer utilizing a slip mechanism according to the present invention;

FIG. 2 is an enlarged side sectional view to illustrate the detail of the slip mechanism in retracted position;

FIG. 3 is a cross-section taken on line 3—3 of FIG. 2;

FIG. 4 is a view similar to FIG. 2 except showing the slip in an initial condition during setting; and

FIG. 5 is a view showing the slip fully set against the casing.

Referring initially to FIG. 1, a well packer 10 of fairly typical general overall constructional arrangement is shown as including an elongated mandrel 11 carrying a settable packing structure 12 above an expander 13 that is movable downwardly to expand a normally retracting anchor assembly 14. The anchor assembly 14 is located adjacent the upper end of a control housing or cage 15 having a plurality of drag blocks 16 that frictionally engage the casing. The housing 15 also carries a lug 17 which engages in various positions within a jaw slot 18 on the lower end portion of the mandrel 11 to prevent or enable the setting of the packing structure 12 and the anchor assembly 14.

The upper end of the mandrel 11 is connected by a collar 19 to the lower end of a running-in string or tubing or drill pipe 20. The packing structure 12 may be constituted by one or more elastomeric packing elements 21 mounted around a compression sleeve 22 having an upper abutment 23 fixed to its upper end. The setting sleeve 22 is sealed with respect to the mandrel 11 by a suitable seal ring 24. The lower packing element rests upon a slidable lower abutment 25 that is connected by an intervening sleeve 26 to the expander 13. Thus it will be readily apparent that movement of the abutments 23 and 25 relatively toward one another will compress and expand the packing elements 21 into sealing contact with a well casing. The expander 13 has downwardly and inwardly inclined outer surfaces 27 to provide a wedging action that results in expansion of the anchor assembly 14 upon downward movement of the expander 13 relative thereto.

It will be appreciated that the foregoing tool structure is described primarily for the purpose of illustrating one of the numerous well tools to which the present invention has application. Other examples would be cup-type packers, bridge plugs, packers used for well pressuring operations such as squeeze cementing, fracturing, acidizing and testing, and tubing anchors. Still other uses will become readily apparent to those skilled in the art. In any event, reference may be had to FIG. 2 for an illustration of specific details of the anchoring assembly 14 in accordance with this invention.

As shown in FIG. 2, the control housing 15 through which the mandrel 11 extends has a plurality of circumferentially spaced, radially directed recesses 30, each of which receives a drag block 16. The drag blocks 16 are urged outwardly into frictional contact with a well casing wall by coil springs 31 that engage between the blocks and the back wall surfaces 32 of the recesses 30. Outward movement is limited by coengageable shoulders 33 and 34 at each end of the drag block 16.

The upper end portion of the housing 15 may be coupled by threads to a tie sleeve 35 which extends upwardly within the lower portion of the expander 13 and has an enlarged head 36 which limits downward movement of the housing 15 with respect to the expander 13. Furthermore, the upper end portion of the housing 15 is provided with a plurality of longitudinally extending recesses 40, as shown in FIGS. 2 and 3, opening at the top of the housing. An encircling band 41 is fixed to the housing 15 by screws 42 or the like and has a lesser ver-

tical dimension than the recesses 40 so as to leave a lateral opening 43 at the lower end of each recess.

A slip member 45 is coupled in each recess 40 and includes a head portion 46 with external wickers or teeth 47 and an internal surface 48 that inclines upwardly and outwardly. The head portion 46 is joined to an outwardly projecting dog portion 49 by an intermediate wall section 50 having its outer surface 51 spaced laterally inwardly from the inner wall surface 52 of the band 41. Pressing between the two surfaces 51 and 52 is a conical coil compression spring 53 having the coil formed on a helix of diminishing diameter from the base end to the outer end so as to have the capability for deflection into a substantially planar configuration where the coil is compressed into a spiral. The outwardly projecting dog portion 49 of the slip member 45 is somewhat loosely fitted into the opening 43 so that the entire slip member can be tilted about the dog portion as the slip head 46 is shifted outwardly by the expander 13. Once the upper tooth of the slip head 46 grips the casing, the expander 13 then forces the wall section 50 and the dog portion 49 to tilt outwardly until all the teeth 47 are engaged with the casing as the slip member moves into a generally parallel alignment with the well casing wall. During such movement, the spring 53 is compressed to a substantially flat condition, which condition is possible due to the conical configuration thereof. Yet another embodiment of a spring structure which will also enable the outward movement of the slip element to occur as described above would be a spring in the form of a bowed leaf having a vertical end-to-end length when unstressed such as to have the capability for assuming a substantially flat condition as the slip element 45 is moved outwardly by the expander 13.

In operation, the parts are assembled as shown in the drawing and the tool is coupled to the lower end of the pipe string 20 for running into a well casing. During running, the packing and slip elements 21 and 45 are in retracted positions and the drag blocks 16 slide along in frictional engagement with the wall of the well casing. The index lug 17 is in the closed portion of the jay slot 18 to retain the parts in retracted positions. At setting depth the tool is halted, and the pipe string 20 is elevated slightly while turning a partial turn to the right to position the lug 17 in the elongated vertical portion of the jay slot 18. Then the pipe string is lowered to effect setting of the packer.

Inasmuch as the drag blocks 16 resist downward movement of the housing 15 and thus the slip elements 45, as the pipe string is lowered the expander 13 advances toward the slip heads 46 and comes into contact therewith, whereupon the inclined surfaces 27 and 48 cause the heads to be shifted outwardly. As previously mentioned, in actuality the slip elements 47 first tilt until the uppermost slip tooth bites into the casing as shown in FIG. 4. Then as the expander 13 continues to move underneath the heads 46, each slip element tilts about the engaged tooth until all of the slip teeth are engaged with the casing as shown in FIG. 5. At this point, each slip element 45 has the same vertical orientation as when it was in its retracted position, however the spring 53 is compressed to a substantially flat condition as shown in FIG. 5.

Once the slip elements 45 are engaged with the casing 60, the lower abutment 25 cannot move any further downwardly, and the application of the weight of the

pipe string to the mandrel 11 will cause the upper abutment 23 to advance toward the lower abutment to compress and expand the packing elements 21 into sealing engagement between the compression sleeve 22 and the surrounding wall of the well casing. A predetermined weight of the pipe string is maintained on the packer to retain the packed off condition.

To retrieve the tool, the pipe string 20 is lifted. The compression loading on the elements 21 is relieved so that they can and will inherently retract to their normally relaxed positions. As the expander 13 is withdrawn from behind the slip head 46, the springs 53 push the slip elements back to their normally retracted positions. Once the lug 17 has been rejailed in the closed portion of the jay slot 18, the packer is conditioned for vertical movement in the well casing.

Since certain changes or modifications may be made in the disclosed embodiments without departure from the inventive concepts involved, it is the aim of the appended claims to cover all such changes or modifications falling within the true spirit and scope of the present invention.

I claim:

1. An anchor assembly for use in anchoring a well tool in a well bore, comprising: a slip member having a head portion joined by a wall section to a dog portion; housing means having a recess for receiving said wall section and said dog portion and including means for coupling said slip member against longitudinal relative movement, said slip member being free to move laterally inwardly and outwardly within limits and to tilt in either direction within said recess; and spring means engaged between said wall section and a surrounding portion of said housing means for continuously urging said slip member laterally inwardly, said spring means being capable of deflection to a substantially flat condition upon outward movement of said slip member.

2. The anchor assembly of claim 1 wherein said spring means is in the form of a conical coil.

3. The anchor assembly of claim 2 wherein said wall section is formed to the rear of said head portion and said dog portion so as to define a pocket for receiving the large end of said conical coil.

4. The anchor assembly of claim 3 wherein said surrounding portion is provided by a band that is fixed to said housing member, said band having a lesser vertical dimension than said recess to provide an opening to the side of said housing member, said dog portion being loosely received in said opening.

5. An anchor assembly for use in anchoring a well tool in a well bore, comprising: annular member having a recess in one end; a slip element having a head portion with outer toothed surfaces and joined by a wall section to a dog portion, said wall section and dog portion being coupled within said recess and adapted for tilting as well as lateral inward and outward movement; and spring means engaging between said wall section and a surrounding portion of said annular member for continuously urging said slip element to move laterally inwardly, said spring means being constructed and arranged to assume upon deflection a substantially flat condition, said head portion when engaged by an expander tilting first about said dog portion until a slip tooth engages a well casing wall and then said dog portion tilting about said head portion until all of said toothed surfaces are engaging the casing wall, said spring means deflecting to a substantially flat condition

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upon complete outward movement of said slip element.

6. The anchor assembly of claim 5 wherein said spring means is a conical coil compression spring having the coil formed on a helix of diminishing diameter so as to provide a spiral coil when completely flat.

7. The anchor assembly of claim 6 wherein said wall section is formed rearwardly of the outer surfaces of said head portion and said dog portion to provide a pocket that receives the large end of said spring.

8. The anchor assembly of claim 7 wherein said annular member includes a coupling band overlying said wall section and having a lesser vertical dimension than said recess so that said recess opens to the side of said annular member, said dog portion being loosely received in said opening.

9. An anchor assembly for use in anchoring a well tool in a well bore, comprising: a housing member having a plurality of circumferentially spaced recesses opening at one end thereof; a plurality of circumferentially spaced slip elements, each slip element adapted to be coupled in a respective one of said recesses, each

slip element having a head portion with inner inclined surfaces and outer toothed surfaces and joined by a rearwardly disposed intermediate wall section to an outwardly projecting dog portion, the wall section and dog portion being coupled within a respective recess and adapted for lateral inward and outward movement therein, each recess opening to the side of said housing member at a location spaced from the end surface thereof, the dog portion of each slip element being loosely fitted within a respective opening; means between said openings and said end surface overlying the wall section of each slip element; and a conical coil spring received in each recess and bearing between the wall section of each slip element and said overlying means so as to continuously urge a respective slip element laterally inwardly, each coil spring being arranged and adapted to assume a substantially flat condition upon outward shifting of the slip elements by an associated expander.

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