Dec. 19, 1961 W. D. MYERS 3,013,611

SPRING SET WELL PIPE ENGAGING APPARATUS

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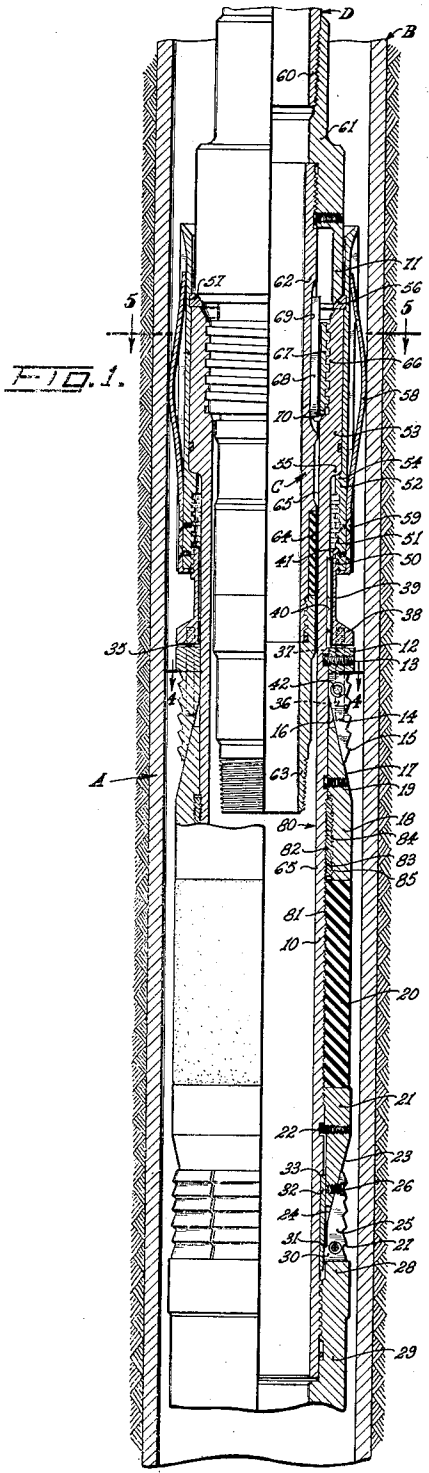


FIG. 1.

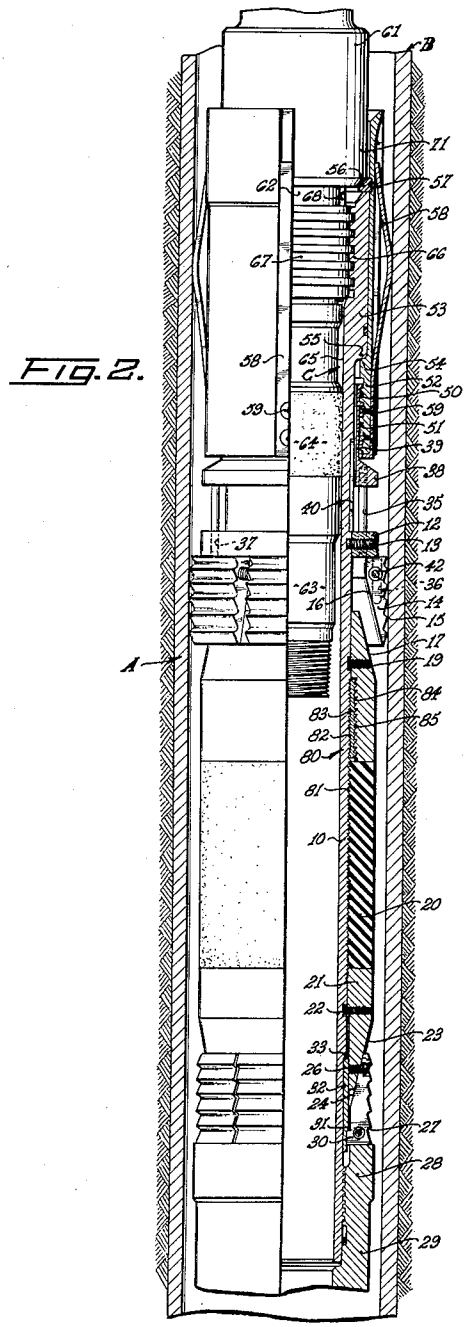


FIG. 2.

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FIG. 3.

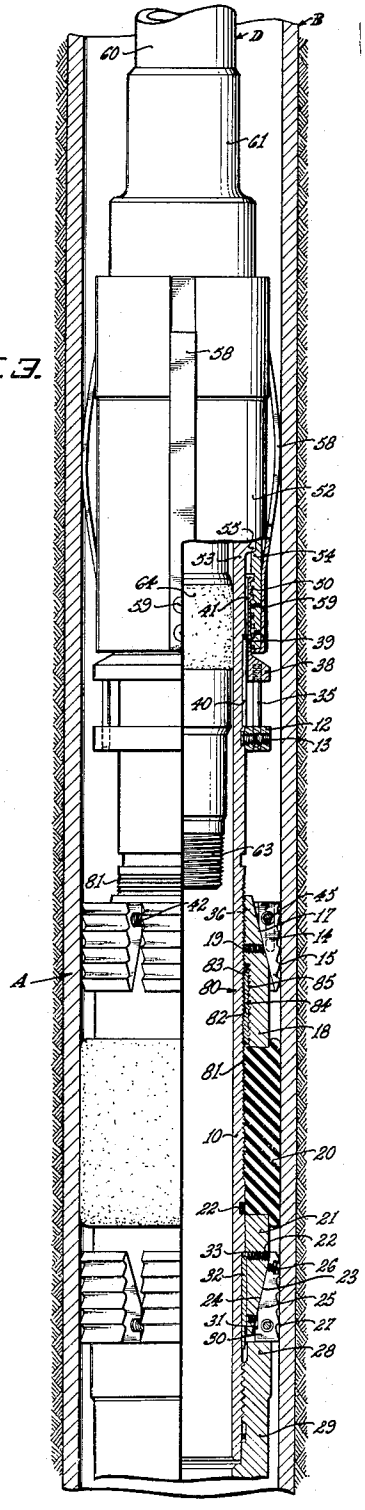


FIG. 4.

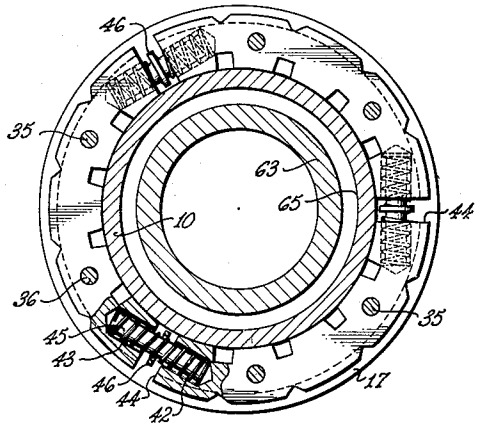
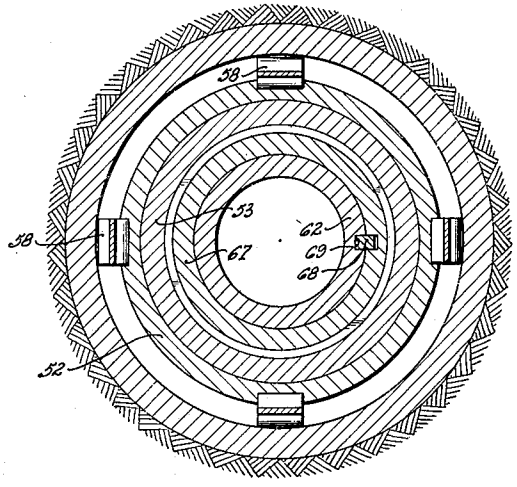


FIG. 5.



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Fig. 6.

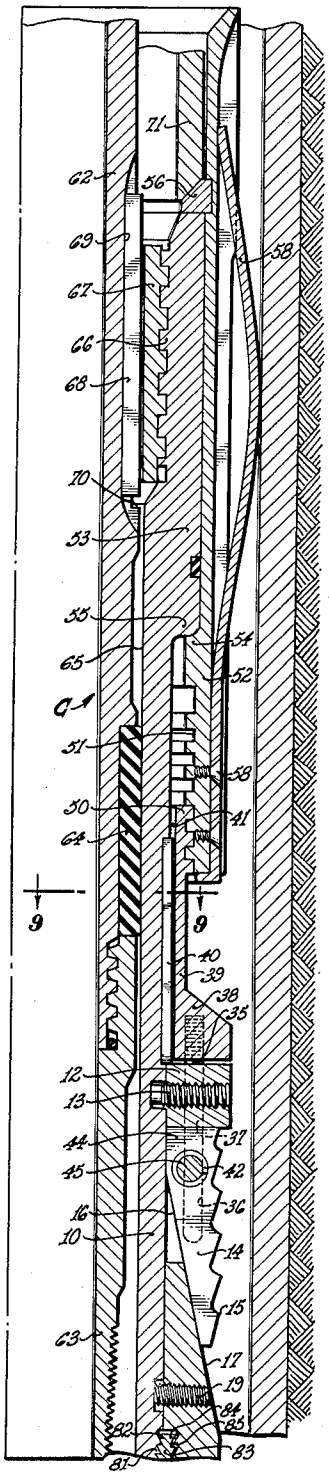


Fig. 8.

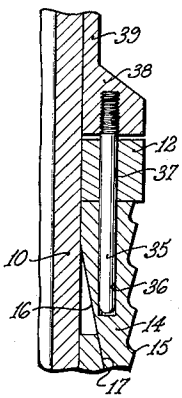


Fig. 9.

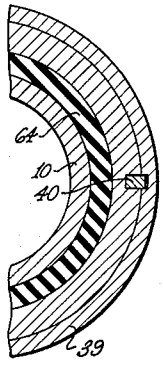
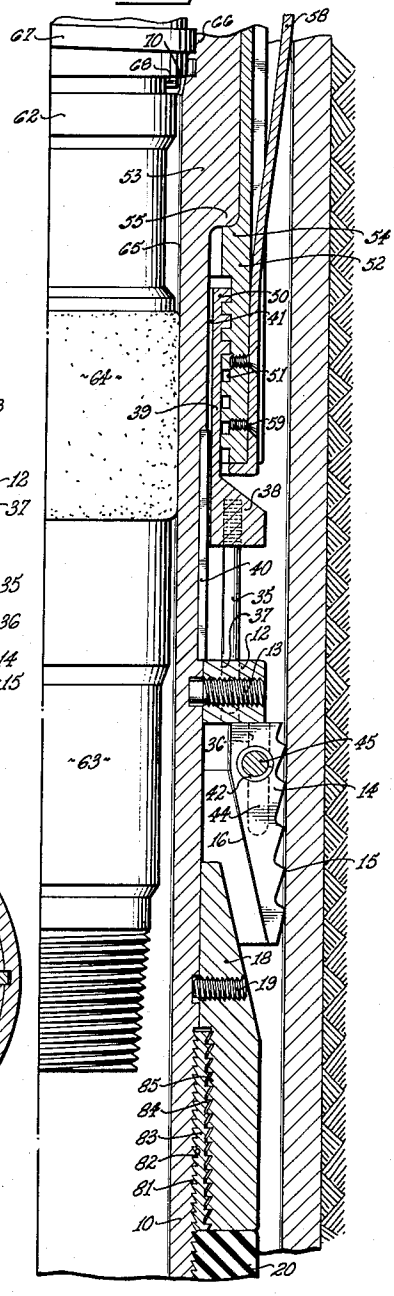


Fig. 7.



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3,013,611

SPRING SET WELL PIPE ENGAGING APPARATUS

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Filed Dec. 29, 1958, Ser. No. 783,530
11 Claims. (Cl. 166—134)

The present invention relates to subsurface well bore equipment, and more particularly to well packers adapted to be anchored in packed-off condition in well bores to perform certain desirable operations therein, such as cementing, acidizing, producing, formation fracturing, testing or bridging.

An object of the invention is to provide a well packer having normally retracted devices, such as normally retracted slips, or a normally retracted packing, or both, which are capable of being expanded mechanically in the well bore, the mechanism for effecting expanding of the devices being self contained in the packer itself.

Another object of the invention is to provide a subsurface well tool having normally retracted slips which are expanded outwardly by devices embodied within the slips themselves.

A further object of the invention is to provide a subsurface well tool having normally retracted segmental slips which are expandible outwardly by devices embodied in the slips themselves, and in which such devices maintain the slip segments in alignment with one another.

An additional object of the invention is to provide an improved well packer capable of being run in a well bore on a tubular string and of being set mechanically in the well bore, the well then being adapted to be completed with the well packer and tubular string used for production purposes, all without requiring removal of the tubular string from the well bore.

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 sectional and side elevational view of an apparatus disposed in the well casing, with certain of its parts in their initial retracted positions;

FIG. 2 is a view similar to FIG. 1 with the upper portion of the apparatus expanded against the surrounding well casing;

FIG. 3 is a view similar to FIG. 1 in which the apparatus has been anchored in packed-off condition in the well casing;

FIG. 4 is an enlarged cross-section taken along the line 4—4 in FIG. 1;

FIG. 5 is a cross-section taken along the line 5—5 on FIG. 1;

FIG. 6 is an enlarged fragmentary longitudinal section through the upper portion of the apparatus illustrated in FIG. 1;

FIG. 7 is an enlarged fragmentary longitudinal section through the upper portion of the apparatus, with the parts in the position disclosed in FIG. 2;

FIG. 8 is a fragmentary longitudinal section through the upper slip portion of the apparatus;

FIG. 9 is a section taken along the line 9—9 on FIG. 6.

The apparatus A disclosed in the drawings is adapted to function as a well packer to be anchored in packed-off condition in a well casing B and is preferably of the type

that can be used for well production purposes. It is run in the well casing, or similar conduit string, on a setting mandrel C, the upper portion of which is attached to the lower end of a tubular running-in string D, such as tubing or drill pipe extending to the top of the hole.

The well packer includes a tubular body 10 having an upper retainer ring 12 secured thereto by means of screws 13, or the like, against which a set of upper segmental slips 14 is initially retained. These segmental slips have upwardly facing wickers or teeth 15 adapted to embed themselves in the wall of the well casing B when the slips are expanded outwardly thereagainst. They also have inner surfaces 16 tapering in an upward and inward direction and engaging a companion externally tapered surface 17 on an upper expander 18 initially releasably secured to the body of the tool by one or more shear screws 19.

Surrounding the body is a packing sleeve 20 of rubber or rubber-like material disposed initially in a retracted position, with its upper end engaging the upper expander 18 and its lower end engaging a lower expander 21 secured initially to the body of the tool by one or more shear screws 22. This lower expander has an external expander surface 23 tapering downwardly and inwardly, engaging companion inner tapered surfaces 24 on a lower set of segmental slips 25 held initially in retracted position by shear screws 26 attaching them to the lower expander. These lower slips have downwardly facing wickers or teeth 27 adapted to engage the wall of the well casing when expanded outwardly thereagainst by the lower expander.

Initially, the lower slips 25 rest upon the upper abutment end 28 of a body extension 29 threadedly secured to the main tubular body 10 of the tool. To preclude inadvertent premature tripping of the lower slips 25, they may be provided with an inwardly directed flange 30 engaging a downwardly facing shoulder 31 of a stop ring 32 surrounding the body with its upper end bearing against a downwardly facing shoulder 33 on the body. In the event that foreign material tends to wedge between the lower slips 25 and the wall of the well casing B, during lowering of the apparatus A in the latter, the force will be transmitted from the lower slips directly to the body 10 of the tool, passing from the slip flange 30 and ring 32 to the body shoulder 33.

The upper set of slips 14 is retained initially in a retracted position by a plurality of longitudinally extending retainer pins 35. As shown, a pair of such retaining pins are slidably disposed in companion longitudinal bores 36 in each slip segment 14, the retaining pins extending through aligned longitudinal holes 37 in the body ring 12. The retaining pins are threadedly secured to the lower head 38 of a release sleeve 39 surrounding the body 10, which is rotationally coupled thereto by virtue of a longitudinally extending key 40, suitably secured to the body, and received within a companion keyway 41 in the release sleeve. When the release sleeve 39 is shifted upwardly along the body 10 of the tool, as hereinafter described, the pins 35 will be pulled upwardly out of the sockets or bores 36 in the slips 14, allowing compression springs 42, extending transversely between adjacent slips 14, to expand and shift the slips outwardly into engagement with the wall of the well casing. As shown, each compression spring 42 bridges the gap between adjacent slips 14 and are disposed in opposed transverse bores 43 extending inwardly from the ends or side faces 44 of each slip. Not only will the compression spring 42 expand the slips 14 outwardly when the retaining pins 35 have been withdrawn from the slip socket 36, but such spring also retains the slip segments in transverse alignment with respect to each other, so that they will lie in substantially

the same plane normal to the axis of the well casing B when engaged with the wall of the well casing.

As further assurance that the slip segments 14 will be maintained in transverse alignment with one another, a rod 45 may be inserted within the helical compression spring 42, extending well within the aligned and opposed bores 43 in the adjacent slip segments. This rod has a diameter conforming to the inside diameter of the helical compression spring, and will bridge the gap between the adjacent segments 14 when the slips have expanded outwardly, insuring their maintenance in transverse alignment.

To insure that the rod 45 will extend into opposed bores 43 to substantially the same extent after expansion of the slips 14 against the well casing B, a central keeper 46 may be secured to the rod. In this manner, the rod 45 is prevented from remaining fully within one bore 43 and moving substantially out of the opposed bore 43 in the opposite slip segment. The coaction of the keeper 46 with the adjacent spring turns results in the rod 45 moving out of each of the aligned bores by substantially equal amounts.

The release sleeve 39 is shifted upwardly to pull the pins 35 from the slip sockets 36 in response to rotation of the body 10. The upper end of the release sleeve is constituted as a threaded head portion 50 threadedly meshing with internal threads 51 in the lower portion of a setting sleeve or drag body 52 encompassing the upper body portion 53 of the well packer. A lower flange 54 on the setting sleeve engages a downwardly facing shoulder 55 on the packer body 10, the setting sleeve being prevented from moving longitudinally of the body by an upper split snap ring 56 engaging the upper end of the body and disposed within an internal groove 57 in the setting sleeve 52. This construction permits the tubular body 10 of the well packer to swivel within the setting sleeve or drag body 52, these parts being movable together longitudinally in the well casing. Rotation of the setting sleeve 52 is resisted by circumferentially spaced longitudinally extending outwardly bowed drag springs 58, the lower ends of which are secured to the setting sleeve by screws 59, and the upper ends of which may bear against the setting sleeve. The intermediate portions of the springs 58 frictionally engage the wall of the well casing B, and resist movement of the setting sleeve 52.

The tubular string D extending to the top of the well casing is secured to the main packer body 10 by being threadedly attached to the upper threaded box 60 of a mandrel sub 61 that is, in turn, threadedly secured to the upper body portion 62 of the mandrel C. This mandrel has a lower section 63 threadedly attached to its upper section, the lower section clamping a packing structure 64 on the mandrel, which is adapted to sealingly engage the inner wall or bore 65 of the tubular packer body. The mandrel C is secured to the upper threaded box 66 of the packer body 10 through the agency of a threaded nut 67 which is rotationally coupled to the mandrel C by a longitudinally extending key 68 suitably secured to the mandrel and received within a longitudinal keyway 69 in the threaded nut. With the nut 67 completely threaded downwardly fully within the body box 67, an upwardly facing shoulder 70 on the mandrel is engageable with the lower end of the nut 67 to transmit upwardly directed forces from the mandrel C through the nut 67 to the body 10 of the tool. With the nut 67 threaded within the tool, a depending skirt 71 on the sub 61 is engageable with the split snap ring 56, which, in turn, engages the upper end of the packer body 10.

The threaded connection 50, 51 between the release sleeve 39 and the setting sleeve 52 is preferably a left-hand one, such that right-hand rotation of the body 10 of the tool and the release sleeve 39 will feed the latter upwardly along the setting sleeve 52, which is prevented from rotating by the frictional engagement of the drag springs 58 against the wall of the well casing. Such upward movement will pull the retaining pins 35 from the slip sockets 36 and permit the springs 42 to expand the upper slips 14 outwardly against the well casing. For the purpose of facilitating disconnection of the mandrel C from the body 10 of the tool when desired, the threaded connection between the nut 67 and the body box 66 is also preferably a left-hand one.

In employing the well packer A in the well casing B, the parts are arranged as disclosed in FIG. 1, with the release sleeve 39 in a downward threaded position with respect to the setting sleeve 52, the retaining pins 35 being disposed in the slip sockets 36 and thereby holding the upper segmental slips 14 in their initial retracted positions. The apparatus is run in the well casing to the location at which the well packer is to be set. When such location is reached, the tubular string D is turned in a right-hand or clockwise direction. Such turning motion is transmitted through the key 68 to the nut 67 and from the latter to the body 10 of the tool, turning all of the packer mechanism with it, with the exception of the setting sleeve 52, rotation of the latter being resisted by the engagement of the drag springs 58 against the wall of the well casing B. The turning of the packer body 10 is transmitted to the release sleeve 39 through the key 40 secured to the body, and which is received in the keyway 41 in the release sleeve. Such rotation produces an upward feeding of the release sleeve 39 along the body 10 of the tool, and also along the setting sleeve 52, because of the left-hand threaded connection 50, 51, which is made up originally in a relatively loose fashion; whereas the nut 67 is made up tightly in the box 66. When the upward feeding has proceeded to the extent at which the retainer pins 35 are removed upwardly completely from the slip sockets 36, the springs 42 are effective to expand and shift the slip segments 14 outwardly into engagement with the wall of the well casing, such as disclosed in FIG. 2.

After the slips 14 have engaged the well casing B, the tubular string D is moved upwardly, shifting the mandrel C upwardly with it. The mandrel shoulder 70 engages the nut 67, to move the nut and the body 10 upwardly with it, all of the packer parts below the upper segmental slips 14 then moving upwardly until the upper expander 18 moves behind these slips. The upper expander cannot move to any further extent, since it is wedged behind the upper slips 14, whereupon the taking of a sufficient upward pull or strain upon the body 10 of the tool will shear the shear screws 19 securing the upper expander 18 to the body of the tool, which shear screws have a lower shear value than the lower shear screws 22, 26, the body of the tool moving upwardly and carrying the lower expander 21 and lower segmental slips 25 upwardly with it toward the upper expander 18. This action foreshortens the rubber or rubber-like packing sleeve 20 and expands it outwardly into sealing engagement with the wall of the well casing. A continuation of the upward force on the tubing string D and the body 10 of the tool will then effect a disruption or shearing of the lower shear screws 22, 26 holding the lower expander 21 to the body 10 and the lower segmental slips 25 to the lower expander, whereupon the body extension 29 shifts the lower segmental slips 25 upwardly along the lower expander 21 and radially outwardly into anchoring engagement with the wall of the well casing, the parts then occupying the positions illustrated in FIG. 3 of the drawings.

A sufficient upward strain is taken on the tubing string D as to insure the embedding of the wickers 15 of the upper slips 14 in the wall of the well casing, the appropriate compression of the packing sleeve 20 into sealing engagement with the wall of the well casing as well as with the body of the well packer itself, and the embedding of the lower slip wickers 27 in the wall of the well casing. The strain on the tubing string D may now be re-

lieved, downward movement of the body 10 of the tool being prevented by a one-way lock device 80, which may assume any suitable form. As shown, the body 10 of the tool has circular ratchet teeth 81 thereon facing in a downward direction adapted to engage companion internal ratchet teeth 82 on a split ratchet sleeve 83 mounted in the upper expander 18. The exterior of the ratchet sleeve 83 is formed as cam teeth 84 adapted to coact with companion cam teeth 85 on the upper expander. Thus, the ratchet teeth 81, 82 permit upward movement of the body 10 relative to the upper expander 18, but preclude downward movement relative thereto since the downward movement will cause the ratchet teeth to coengage and the cam teeth 84, 85, whose cam surfaces taper in a downward and inward direction, will result in the ratchet sleeve 83 being urged inwardly to retain the ratchet teeth in engagement with one another.

After the packer A has been anchored in packed-off condition in the well casing in the manner described, the tubular string D may remain connected to the packer and the well can be completed and placed in production. Well production from below the well packer will flow into the well casing B and thence upwardly through the packer body 10 into the mandrel C, passing upwardly through the mandrel and the tubular string D to the top of the well bore. Leakage around the mandrel is prevented by the sealing engagement of the mandrel packing 64 against the wall 65 of the packer body.

It is, accordingly, apparent that a subsurface well tool, such as a well packer, has been set in the well bore by mechanical means only. The torque necessary to effecting release of the upper segmental slips 14 is transmitted directly from the body 10 of the tool to the release sleeve 39, which is fed upwardly along the body 10 of the tool and the setting sleeve 52, pulling the retaining pins 35 from the slip sockets 36. It is then only necessary to take an upward strain on the tubular string D and the entire packer apparatus to effect a full setting of the well packer in the well casing against movement in both longitudinal directions, and to preclude leakage between the body of the well packer and the surrounding well casing.

The inventor claims:

1. In a well apparatus adapted to be set in a well bore: a body adapted to be lowered in the well bore on a running-in string; normally retracted means on said body; spring means for shifting said normally retracted means laterally outwardly of said body; retainer means secured to said normally retracted means to prevent said spring means from expanding said normally retracted means; and means responsive to rotation of said body to release said retaining means from said normally retracted means, comprising a device connected to said retaining means and means slidably splining said device to said body.

2. In well apparatus adapted to be set in a well bore: a body adapted to be lowered in the well bore on a running-in string; means for anchoring the body in the well bore comprising segmental slips having longitudinally extending bores therein; spring means for shifting said slips laterally outwardly of said body; retaining means including pins disposed in said longitudinally extending bores to prevent said spring means from shifting said slips outwardly; means providing a slidable splined connection between said retaining means and body; and means responsive to rotation of said body and retaining means for moving said retaining means longitudinally to remove said pins from said longitudinally extending bores.

3. In well apparatus adapted to be set in a well bore: a body; normally retracted means on said body; spring means for expanding said normally retracted means laterally outwardly of said body; a friction drag device; retaining means threadedly connected to said drag device and secured to said normally retracted means to prevent said spring means from expanding said normally retracted means; and means providing a slidable splined connection between said body and retaining means, whereby rotation of said body rotates said retaining means relative to said drag device to feed said retaining means longitudinally of said body and drag device to release said retaining means from said normally retracted means.

4. In well apparatus adapted to be set in a well bore: a body; means for anchoring said body in the well bore comprising segmental slips having longitudinally extending bores therein; spring means for shifting said slips laterally outwardly of said body; a friction drag device; retaining means threadedly connected to said drag device and including pins disposed in said longitudinally extending bores to prevent said spring means from shifting said slips outwardly; and means providing a slidable splined connection between said body and retaining means, whereby rotation of said body rotates said retaining means relative to said drag device to feed said retaining means longitudinally of said body and drag device to remove said pins from said longitudinally extending bores.

5. In well apparatus adapted to be set in a well bore: a body; normally retracted means on said body; spring means for expanding said normally retracted means laterally outwardly of said body; a friction drag device mounted on said body to permit said body to rotate within said drag device; retaining means threadedly connected to said drag device and secured to said normally retracted means to prevent said spring means from expanding said normally retracted means; and means providing a slidable splined connection between said body and retaining means, whereby rotation of said body rotates said retaining means relative to said drag device to feed said retaining means longitudinally of said body and drag device to release said retaining means from said normally retracted means.

6. In well apparatus adapted to be set in a well bore: a body having an abutment thereon; an upper expander on said body; upper slips engageable with said expander and having longitudinally extending bores therein; a lower expander on said body; lower slips engaging said lower expander; means for longitudinally moving said lower slips and lower expander relative to each other to expand said lower slips outwardly; spring means engaging said upper slips to expand said upper slips laterally outwardly of said body; a friction drag device above said abutment; retaining means threadedly connected to said drag device and including pins extending through said abutment into said longitudinally extending bores to prevent said spring means from shifting said upper slips outwardly; and means providing a slidable splined connection between said body and retaining means, whereby rotation of said body rotates said retaining means relative to said drag device to elevate said retaining means and remove said pins from said longitudinally extending bores and permit said springs to expand said upper slips outwardly.

7. In well apparatus adapted to be set in a well bore: a body having an abutment thereon; an upper expander on said body; upper slips engageable with said expander and having longitudinally extending bores therein; a lower expander on said body; lower slips engaging said lower expander; means for longitudinally moving said lower slips and lower expander relative to each other to expand said lower slips outwardly; spring means engaging said upper slips to expand said upper slips laterally outwardly of said body; a friction drag device above said abutment; a release sleeve slidably splined to said body and threadedly connected to said drag device; pins secured to said release sleeve and extending through said abutment into said longitudinally extending bores to prevent said spring means from shifting said upper slips outwardly; whereby rotation of said body rotates said release sleeve relative to said drag device to elevate said release sleeve and pins and remove said pins from said longitudinally extending bore.

8. In well apparatus adapted to be set in a well bore: a body adapted to be set in the well bore on a running-in string; means for anchoring said body in the well bore comprising a set of initially retracted slip segments expandible outwardly; means retaining said slips in retracted position; means adapted to release said retaining means; and spring means acting between and engaging adjacent slip segments for expanding said segments laterally outward at an increase in circumferential distance from each other upon release of said retaining means.

9. In well apparatus adapted to be set in a well bore: a body adapted to be set in the well bore on a running-in string; means for anchoring said body in the well bore comprising a set of initially retracted slip segments expandible outwardly; means retaining said slips in retracted position; means adapted to release said retaining means; adjacent slip segments having aligned transverse bores opening through the adjacent ends of said segments; and a compression sprng in each of said aligned bores for expanding said segments at an increase in circumferential distance from each other upon release of said retaining means.

10. In a well apparatus adapted to be set in a well bore: a body adapted to be set in the well bore on a running-in string; means for anchoring said body in the well bore comprising a set of initially retracted slip segments expandible outwardly; means retaining said slips in retracted position; means adapted to release said retaining means; adjacent slip segments having aligned transverse bores opening through the adjacent ends of said segments; compression springs in said bores for expanding said segments (laterally outwardly) at an increase in circumferential distance from each other upon release of said retaining means; and means disposed in each spring and transverse bore for maintaining said segments in alignment with each other.

11. In well apparatus adapted to be set in a well bore: a body adapted to be set in the well bore on a running-in string; means for anchoring said body in the well bore comprising a set of initially retracted slip segments expandible outwardly; means retaining said slips in retracted position; means adapted to release said retaining means; adjacent slip segments having aligned transverse bores opening through the adjacent ends of said segments; compression springs in said bores for expanding said segments (laterally outwardly) at an increase in circumferential distance from each other upon release of said retaining means; and a pin disposed in each spring and extending into aligned transverse bores for maintaining said segments in alignment with each other.

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