

Dec. 27, 1966

C. C. BROWN

3,294,172

WELL TOOLS, SUCH AS WELL PACKERS

Filed Aug. 5, 1963

5 Sheets-Sheet 1

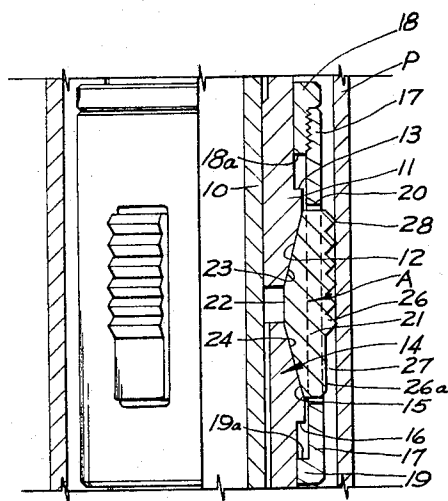


Fig. 1

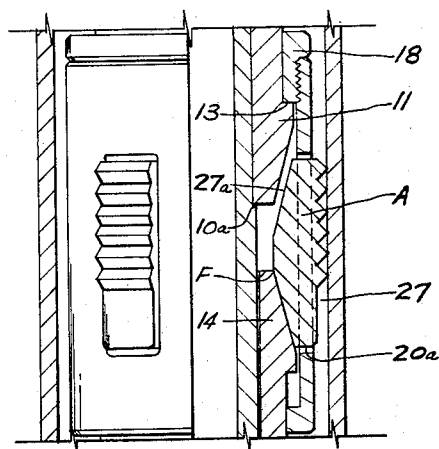


Fig. 2

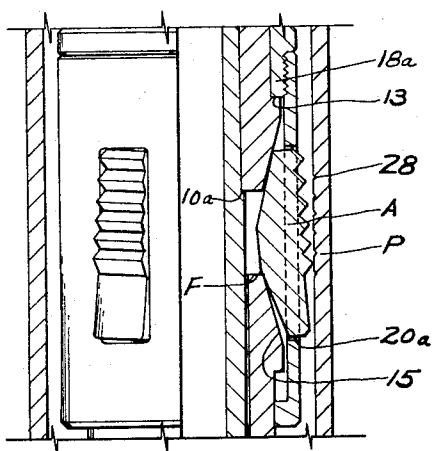


Fig. 3

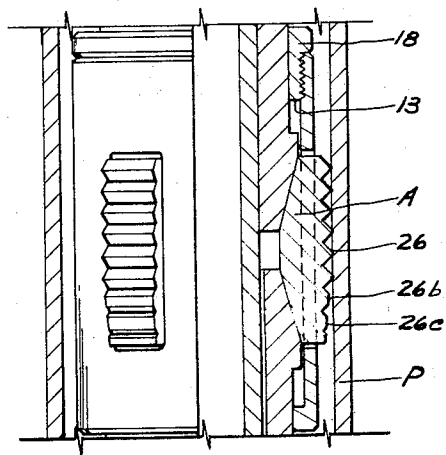


Fig. 4

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Fig. 5

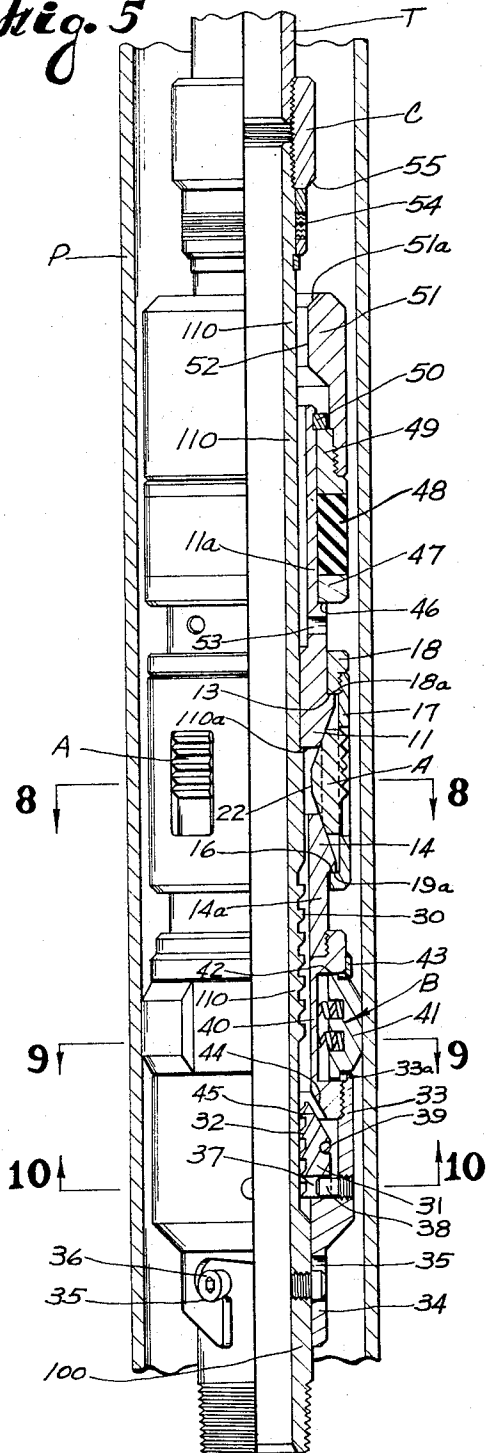
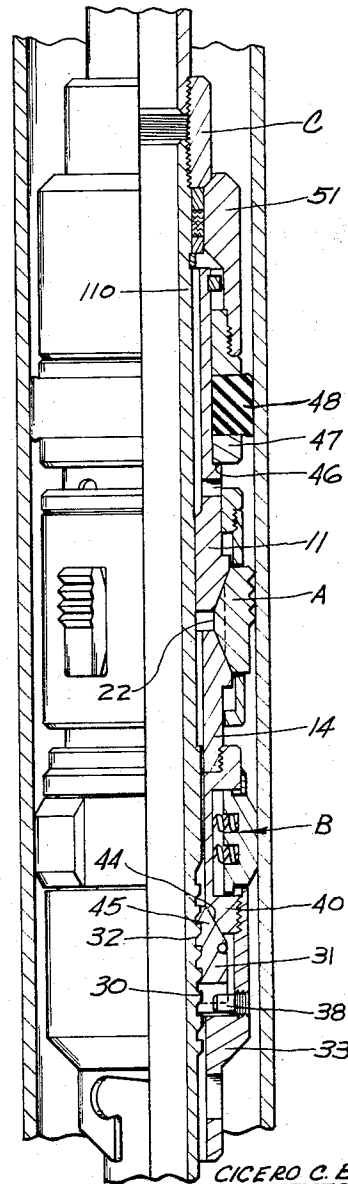


Fig. 6



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5 Sheets-Sheet 3

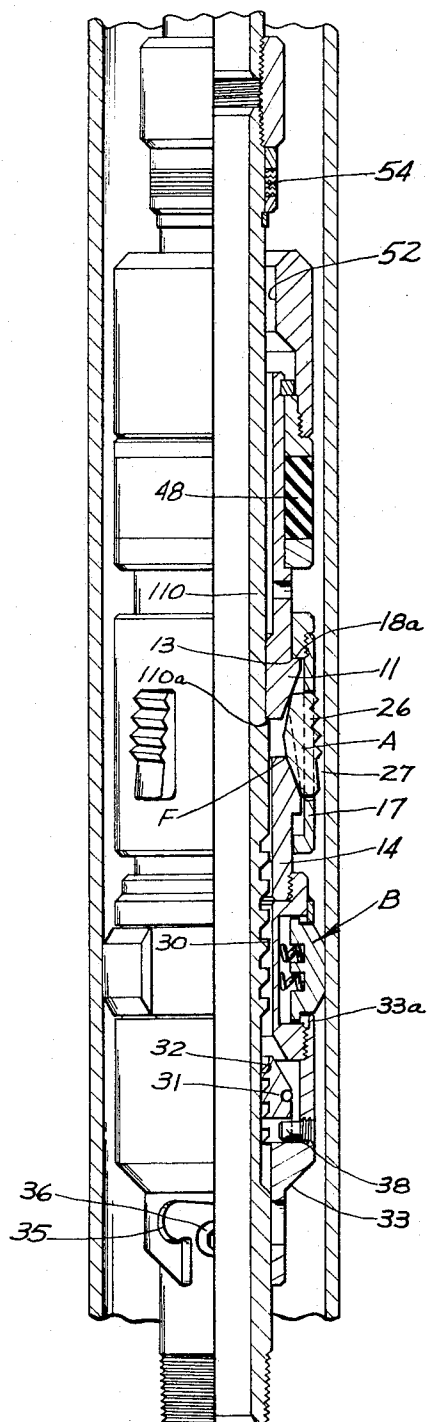


Fig. 7

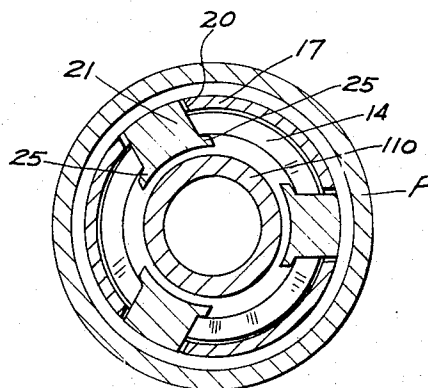


Fig. 8

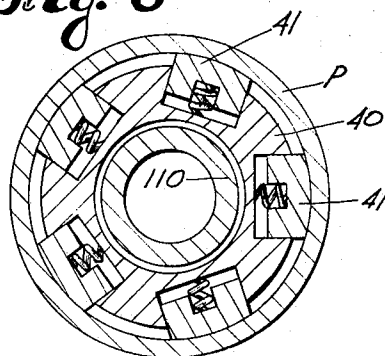


Fig. 9

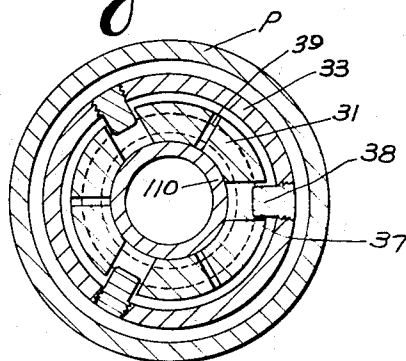


Fig. 10

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5 Sheets-Sheet 4

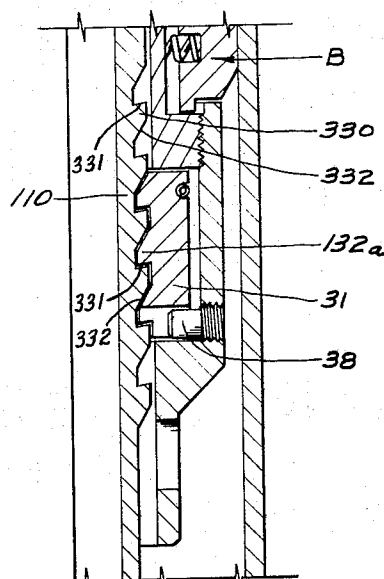
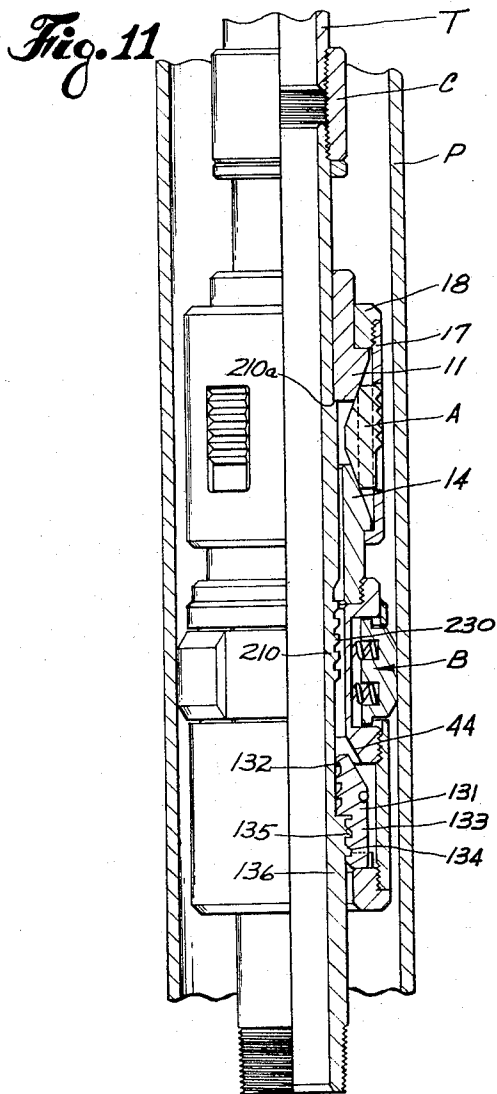
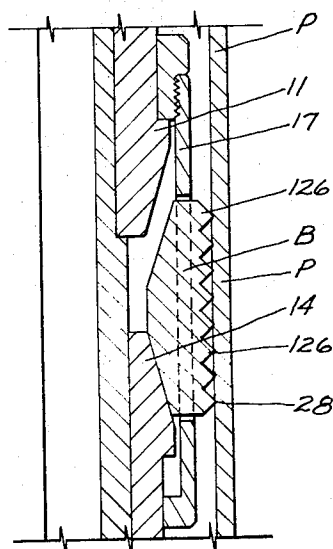


Fig. 12



PRIOR ART

Fig. 13

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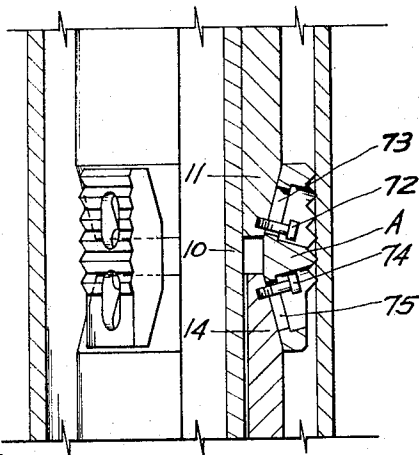


Fig. 15

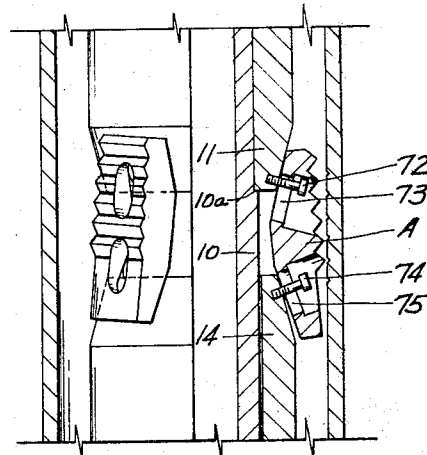


Fig. 16

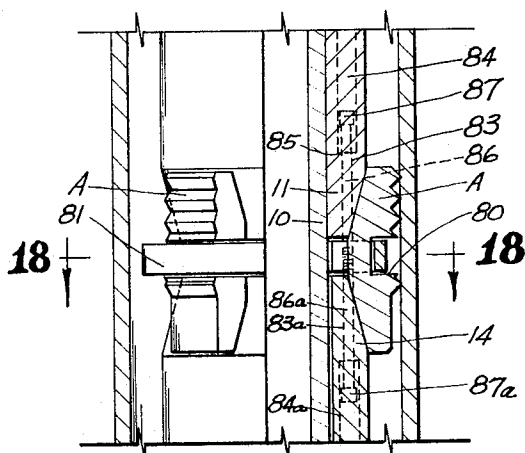


Fig. 17

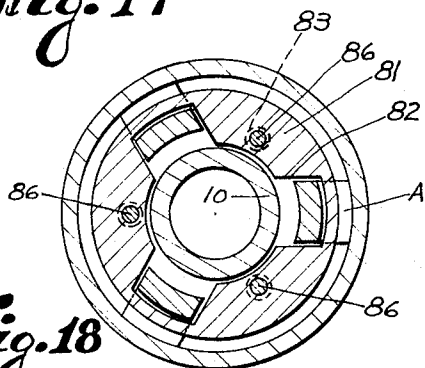


Fig. 18

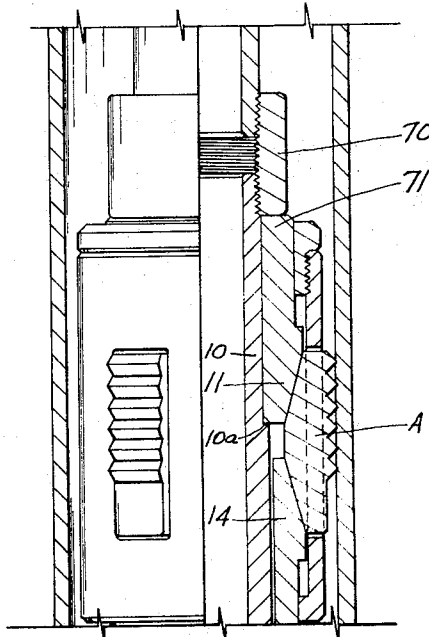


Fig. 14

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WELL TOOLS, SUCH AS WELL PACKERS
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16 Claims. (Cl. 166—139)

This invention relates to new and useful improvements in well tools, such as well packers. The invention includes an anchoring means assembly for use in a well bore and relates particularly to an anchoring means assembly which will effectively hold its position within the bore against longitudinal or axial forces from either direction. The anchoring means assembly is particularly applicable for use in anchoring well devices, such as well packers and the like, or well tubing within a well bore.

The usual anchoring means assembly for holding forces applied from either direction, that is, above or below the assembly, generally involves the use of a gripping element or slip having external teeth for engaging the wall of the casing or well pipe, together with upper and lower expander cones which co-act with the gripping element to control its radial movement. When in a set position, the gripping element has been moved into gripping position by wedging the gripping element between said cones and the well pipe, whereby the teeth of said gripping element bite into the wall of the well pipe bore; actually, the teeth form small grooves or indentations in said wall which assures firm anchoring of the assembly to the particular well pipe with which said teeth are engaged. Since upper and lower cones are provided, any force from above the assembly will move the upper cone further downwardly with respect to the gripping element to increase its gripping action; similarly, any force from below the assembly moves the lower cone upwardly relative to the gripping element to also urge the element into tighter gripping position. It is by reason of the upper and lower cones which co-act with the gripping element, that said element will effectively hold its anchored position against excessive forces exerted either in an upward or a downward direction against the assembly.

The expander cones are movable longitudinally or in a direction which is parallel to the axis of the well bore while the gripping element is movable in a radial path with respect to the bore. Obviously, as the upper and lower cones move toward each other and move the gripping element in a radial direction outwardly into its gripping position, a tight gripping engagement between the element and the pipe is effected. As has been noted, the set position is maintained because the gripping element is wedged between said cones and the pipe wall. Because of this gripping action, release of the anchoring means cannot be readily accomplished by first releasing one cone and then attempting to pull the gripping element from its wedged position between the other cone and the pipe because the element, being backed by said other cone, cannot move radially inwardly toward its released position; if the element has been set tight enough to perform proper anchoring, the gripping element cannot normally be pulled away from the backup cone without shearing off its gripping teeth and in some instances, even shearing is impossible with the result that the pipe or tubing string on which the anchoring assembly is mounted may actually be ruptured or pulled apart. Therefore, in the conventional two-direction or dual-lock anchoring means assembly, release must be accomplished by withdrawing or moving each of the two expander cones from behind the gripping element whereby the gripping element may undergo the necessary inward radial movement to disengage its gripping teeth from the pipe wall.

Because the gripping element is movable in a radial direction, it is not sufficient to move only one of the cones

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from behind said gripping element and thereby effect release since the other cone will retain the element in its wedged position. Thus, in all prior art, two direction or dual-lock anchoring means assemblies, in which the anchoring means is to be releasable, it is necessary to provide means for retracting both expander cones from behind the radially movable gripping element in order to effect disengagement of the teeth of the element from the pipe. This basic requirement leads to the disadvantage of complicating the structure of the actuating means for the cones and to the additional disadvantage of inconsistency in efficient operation. Since both cones must undergo movement with respect to the gripping element, the final retraction or releasing operation may not be positive in its actuation with the result that full release may not be accomplished.

It is, therefore, a primary object of this invention to provide a two-direction or dual-lock anchoring means assembly where in a gripping element is maintained in gripping position by upper and lower expander elements and which is so constructed that positive release of the gripping element may be accomplished by a straight upward pull upon the upper expander element, which eliminates the necessity of imparting movement to both expander cones in order to release the assembly.

An important object of the invention is to provide an anchoring means assembly of the character described which is so constructed that a lifting movement imparted to the upper cone will provide sufficient clearance for the gripping element to move through a rocking or swinging motion sufficient to permit the gripping element to disengage the pipe wall to thereby permit it to be pulled off of the lower cone.

Another object is to provide an anchoring means assembly of the character described wherein upward movement of the upper cone, together with the particular construction of the gripping element and particularly of its toothed surface, is such that clearance spaces are provided which will allow the gripping element to undergo a rocking or swinging motion sufficient to release its toothed surface from the pipe wall, whereby subsequent lifting permits the gripping element to be pulled upwardly with respect to the lower cone.

Another object of the invention is to provide a two direction dual-lock anchoring means assembly which is particularly applicable for use in combination with well packers or other well devices or as an anchoring means for well tubing; the assembly being adaptable to be employed with mechanical, hydraulic or other conventional setting means and being releasable by a straight upward pull upon the assembly.

A particular object of the invention is to provide an anchoring means assembly which, when combined with a mechanical setting means, requires only slight left-hand rotation with no significant torque to set it and which is released by a right-hand rotation and upward pull on the tubing string.

Still another object is to provide an anchoring means assembly, of the character described, which may be combined with and form a part of a releasable mechanically-set packer and which will maintain its anchored position against longitudinal forces from either direction; the device involving only slight left-hand rotation with no significant torque and setting down of tubing weight in order to set the packer and being releasable by right-hand rotation and upward pull on the tubing string.

A further object of the invention is to provide an improved well packer having a supporting mandrel which is releasably connected to an anchoring means to maintain said anchoring means in an unset position during lowering into the well; said releasable connection being releasable by manipulation of the mandrel to permit the

mandrel to be moved downwardly relative to the anchoring means to thereby set said means. The packer also includes means for latching the mandrel to the anchoring means when in set position to lock the packer in set position within the well bore, with said latching means being unlatched by right-hand rotation of the mandrel with respect to the anchoring means, after which an upward movement of the mandrel relative to said anchoring means effects unsetting of the anchoring means and permits withdrawal of the packer from the well.

The construction designed to carry out the invention will be hereinafter described, together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

FIGURE 1 is a vertical sectional view of an anchoring means assembly constructed in accordance with the present invention and showing the gripping element thereof in gripping position;

FIGURE 2 is a similar view illustrating the position of the parts after the upper expander cone has been moved upwardly to begin release of the gripping element;

FIGURE 3 is a similar view illustrating the rocking or swinging movement which the gripping element undergoes to effect release of its gripping engagement with the well pipe upon continued upward movement of the upper cone and the parts connected therewith;

FIGURE 4 is a partial sectional view showing a slightly modified construction of a gripping element;

FIGURE 5 is a view partly in section and partly in elevation of a well packer device to which the improved anchoring means assembly has been applied, said well packer device having a mechanical setting means and the parts being shown in the position as said device is lowered toward its final position in a well pipe;

FIGURE 6 is a view similar to FIGURE 5 illustrating the well packer device and the anchoring means assembly in their set position;

FIGURE 7 is a view similar to FIGURES 5 and 6 illustrating the packer as it is moved to a released position whereby it may be removed from the well bore;

FIGURE 8 is a horizontal cross-sectional view taken on the line 8—8 of FIGURE 5;

FIGURE 9 is a horizontal cross-sectional view taken on the line 9—9 of FIGURE 5;

FIGURE 10 is a horizontal cross-sectional view looking upwardly and taken along the line 10—10 of FIGURE 5;

FIGURE 11 is a view partly in section and partly in elevation illustrating the improved anchoring means assembly of this invention utilized as a pipe anchor;

FIGURE 12 is an enlarged partial sectional view of a modification of the locking means for maintaining a device such as a well packer of FIGURE 5 or the anchor of FIGURE 11 in its set position;

FIGURE 13 is a view similar to FIGURE 2 but showing a conventional gripping element and illustrating the necessity for imparting movement to both expander cones in order to effect a release of the gripping engagement;

FIGURE 14 is a modified form of anchoring assembly in which the upper expander cone is connected with the mandrel;

FIGURE 15 is a modified form of the anchoring assembly wherein the slip carrying cage is omitted and in lieu thereof, connecting pins between each gripping element and the expander cones are provided, this figure illustrating the gripping elements in gripping position;

FIGURE 16 is a view similar to FIGURE 15 showing the manner in which the gripping element is released;

FIGURE 17 is a view partly in section and partly in elevation illustrating still another modification of a dif-

ferent type of means for mounting the gripping elements with respect to the expander cones; and

FIGURE 18 is a horizontal cross-sectional view taken on the line 18—18 of FIGURE 17.

In the drawings, the preferred form of the improved anchoring means assembly comprising the invention is illustrated in FIGURES 1 through 3 and said assembly includes a central tubular mandrel or support 10. As will be hereinafter explained, this mandrel or support may form part of any suitable well device which it is desired to anchor within a well bore. An upper expander cone 11 having an outer inclined expander surface 12 surrounds the mandrel and may be supported thereon in any suitable manner for limited sliding movement. An external upwardly facing shoulder 13 is formed on the expander cone.

A lower expander cone 14 having an external inclined expander surface 15 also surrounds the mandrel 10 and is supported thereon for limited sliding movement in any suitable manner. The lower cone is provided with an external downwardly facing shoulder 16. Surrounding the expander cones 11 and 14 is a tubular cage or carrier sleeve 17 and the upper end of said sleeve is closed by a threaded collar 18. The lower surface 18a of said collar is adapted to be engaged by the upwardly facing shoulder 13 of the upper cone, as will be explained. The lower end of the sleeve or cage 17 has an inwardly extending projection 19 and the upper surface 19a thereof is adapted to engage the downwardly facing shoulder 16 of the lower cone.

The tubular cage or carrier sleeve 17 has a plurality of windows or openings 20 formed therein and movable radially within each window is a gripping element or slip A. Any desired number of gripping elements may be provided in circumferentially spaced positions around the cage and, as illustrated, three of such gripping elements are preferable. As will be explained, the gripping elements A are adapted to move radially outwardly when the expander cones 11 and 14 are moved into a position behind the gripping elements; similarly, when the upper cone is retracted or moved upwardly relative to each gripping element, the gripping element is adapted to be moved to a released position.

Each gripping element comprises a main body portion 21 which has its rear surface formed with a central area 22 which is curved in cross-section (FIGURE 8) and which lies in a plane parallel to the axis of the mandrel. Above the area 22, each gripping slip has an inclined surface 23 which is complementary to and is adapted to co-act with the inclined expander surface 12 of the upper cone. Similarly, below the central area 22, the inner surface of each gripping element has an inclined surface 24 which is complementary to and adapted to co-act with the expander surface 15 of the lower cone. The cross-sectional shape of each gripping element or slip is shown in FIGURE 8, each slip having longitudinal ribs or projections 25 which extend vertically of the slip at its inner surface. The body portion 21 of the slip is movable through the window or opening 20 in the cage or sleeve 17 and the projections 25 will prevent each gripping element from being displaced radially outwardly through said window.

On its outer surface, the body 21 of each gripping element is formed with a gripping area comprising gripping teeth 26. The teeth preferably extend from the upper portion of said outer surface to a point either at or slightly below midheight of the body. Below the teeth, the exterior surface is formed with a non-gripping area 26a which is substantially smooth; this non-gripping area is of a smaller diameter than the diameter of the plane in which the apex of each tooth lies, whereby when the teeth engage the pipe, a clearance space 27 is provided between the exterior of the lower portion of each gripping element and the well pipe P within which the assembly is to be anchored. The exact extent of the grip-

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ping area is variable but preferably the lowermost tooth of the gripping area is substantially opposite the upper end of the lower cone 14 when the assembly is in set position, as shown in FIGURE 1; however the extent of the gripping area could extend slightly below the upper end of cone 14 and so long as there is a sufficient space 27 at the lower portion to allow swinging or rocking movement of the body 21, as will be explained, the purpose of the invention will be accomplished.

Instead of the smooth surface 26a, the lower external portion of the slip or gripping element A may be formed with teeth 26b (FIGURE 4) in which the apex of each tooth has been flattened as shown at 26c whereby the flattened teeth 26b provide the non-gripping area and the clearance space 27. This form has been found applicable where it is desired to convert a slip which has been previously formed with sharp teeth throughout its outer surface into a slip which is applicable for use in the present assembly.

In the operation of the anchoring means assembly, the upper cone 11 is moved downwardly with respect to the gripping element A while the lower cone 14 is moved upwardly relative thereto; this may occur simultaneously or one of the cones may move into position behind the slips first, after which the other cone moves into place. As the cones move toward each other longitudinally or in a direction parallel to the axis of the mandrel, their respective inclined expander surfaces co-act with the inclined inner surfaces of each gripping element to effect an outward radial movement of the gripping element, whereby the teeth 26 of the said gripping element are forced into gripping engagement with the inner wall of the pipe P. As the gripping teeth engage the wall of the pipe, the sharpened apex of each tooth forms a slight indentation or groove 28 in the pipe wall. The gripping position of the parts is illustrated in FIGURE 1 and in such position the assembly is anchored to the pipe P.

Any force which is acting downwardly on the assembly will act against the upper cone 11 and will tend to urge said upper cone downwardly with respect to the gripping element A to thereby force the element into tighter gripping position. At the same time, any force from below the assembly will act against the lower cone 14 to also urge the gripping elements into tighter gripping engagement. Thus, the assembly will be firmly anchored against forces from either direction and will maintain its position in the pipe. It is evident from FIGURE 1 that the gripping element is actually wedged between the upper and lower cones and the inner wall of the pipe P; actually, the upper cone maintains the gripping teeth in engagement with the pipe and so long as said cone is positioned as shown in FIGURE 1, each gripping element is held in position and the assembly is firmly anchored within said pipe.

When it is desired to release the assembly, it is only necessary to apply an upward pull upon the upper cone 11. This pull may be effected in any desired manner but is normally effected by an external shoulder 10a on the mandrel engaging beneath the upper cone; the mandrel is connected with the usual well tubing string (not shown in FIGURES 1 to 3) which extends to the surface. As the upper cone is pulled upwardly from behind the gripping element A, it releases the outward radial force which the upper cone has been applying to the gripping element; however, at this time, the lower cone is still in position behind the lower portion of the slip and because the slip is movable in a radial path, said slip is maintained in gripping engagement even though the upper cone has been lifted to the position shown in FIGURE 2.

As the upper cone is lifted to the point where its upwardly facing shoulder 13 strikes the lower end 18a of the collar 18, which is connected to the slip-carrier sleeve 17, the upward pull is transmitted through the cone to said carrier sleeve. As has been described, the gripping elements are mounted in the carrier sleeve 17, projecting out-

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wardly through the windows thereof. Following engagement of shoulder 13 with the collar 18, continued upward pull applies an upward force to the carrier sleeve 17 and the edge 20a which defines the lower end of each window engages the bottom of each gripping element A to transmit such force to the latter. At this point in the release, the clearance space 27 between the lower portion of the gripping element A is present; at the same time, a clearance space 27a has been created between the upper cone 11 and the rear upper portion of the gripping element A so that the upper portion of said gripping element is free to swing inwardly away from the wall pipe.

As continued force is applied to the gripping element A, said element undergoes a swinging or rocking movement about the fulcrum point F which is formed at the point of contact between each gripping element and the upper end of the lower cone 14. This swinging action results because the back-up of the upper cone 11 has been removed and since the clearance spaces 27 and 27a are present, the upward force applied to the gripping element causes the upper portion of the element to move inwardly of the pipe. As swinging of each gripping element occurs, as shown in FIGURE 3, its gripping teeth 26 are disengaged from the wall of the pipe P. Obviously, as soon as the gripping teeth are moved from their engaged position, the continued upward movement of cage 17 will pull the gripping element or slip off of the inclined surface 15 of the lower cone. It is, therefore, possible to merely apply a straight upward pull which first removes the upper cone 11 from behind the upper portion of the gripping element or slip A and then transmits a force to the lower end of the slip which causes the same to rock about the fulcrum F and thereby disengage the pipe. The entire assembly may thus be released by a straight upward pull on the upper cone, followed by an upward pull on the cage 17.

In order to illustrate the advantages of the rocking or swinging action which allows release of the gripping element A from the pipe by the single upward pull and without the necessity of ever retracting the lower cone, reference is made to FIGURE 13 wherein a conventional type of gripping element B is illustrated. In this instance, the gripping element has gripping teeth 126 extending throughout its entire outer surface. When the upper and lower cones 11 and 14 are in set position, the teeth 126 have been moved into gripping engagement with the pipe P. In FIGURE 13, the upper cone 18 has been shown retracted by having moved upwardly relative to the slip B. However, in this instance and because the gripping teeth 126 extend completely to the lower end of the gripping element, there is no clearance space between the outer surface of the gripping element and the pipe P which would be comparable to the space 27. Therefore, any continued upward pull upon the cage 17 which carries the gripping element B cannot be effective to permit the slip to undergo a rocking or swinging action because the teeth of the slip are wedged into the grooves 28. Instead, the lower half of the conventional slip B remains wedged between the lower cone 14 and the pipe P and it is impossible by merely pulling upwardly on the cage to cause a release of the gripping element B without shearing off the teeth of the slip to disengage them from the grooves or indentations 28. It is for this reason that the prior art assemblies have required that the lower cone 14 also be retracted or moved downwardly relative to the slip B before said slip can be released from its gripping position.

From the foregoing it will be seen that by providing a clearance between the lower portion of a non-gripping area on each gripping element and the pipe wall, it is possible to effect a full release of the assembly by applying a straight upward pull which first releases the upper cone and thereafter applies a force to the gripping element A in a direction to rock the slip and disengage the gripping teeth from the pipe.

The anchoring assembly of this invention is applicable for use on well packers, tubing anchors or other well devices which employ any conventional type of setting means, whether it be a hydraulic means or a mechanical means. However, it has been found to be of particular advantage when used with the mechanically set devices, such as weight-set packers wherein a manipulation of the tubing string on which said device is mounted is necessary to accomplish setting and releasing of the anchoring assembly.

In FIGURES 5 through 10, the invention is shown incorporated in a well packer which is arranged to be set within a well pipe P and which will hold a high differential pressure from either side of said packer. As has been explained, where the upper and lower expander cones co-act with the gripping elements or slips, the anchoring assembly holds its position regardless of high differential pressures across the assembly. Referring specifically to FIGURE 5, the upper and lower expanders 11 and 14, together with the cage or carrier sleeve 17 and the gripping elements A, are mounted about a mandrel 110. The mandrel 110 constitutes the main support of the well packer device and is comparable to the mandrel 10 shown in FIGURES 1 through 3. The upper end of the well packer mandrel is coupled by means of the usual coupling C to a well tubing T whereby the well packer may be lowered downwardly to the proper position within the well pipe P. The mandrel 110 is formed with an external shoulder 110a, comparable to the shoulder 10a in FIGURES 2 and 3 and, as will be explained, the shoulder 110a not only supports the upper expander member 11 during lowering, but also provides means for applying an upward force to the upper expander member.

Spaced downwardly from the shoulder 110a, the mandrel or support 110 is formed with a series of external threads 30 which are left-hand, buttress-type threads. The upper surface of each thread is substantially flat, lying in a plane which is normal to the axis of the mandrel, while the lower surface of each thread is beveled in an upward and outward direction. As will be explained, these threads are adapted to interconnect with a plurality of locking dogs or segments 31 having complementary buttress-type left-hand threads 32 formed on their inner surfaces.

The locking dogs or segments 31 are mounted within the upper portion of a tubular housing 33, which housing has a reduced downwardly projecting extension 34 surrounding the exterior of the mandrel 110. The extension 34 is provided with J-slots 35 which are adapted to be engaged by outwardly projecting pins 36 secured in the mandrel 110. In the position shown in FIGURE 5, the pins 36 are engaged within the respective J-slots 35 and couple the mandrel 110 to the housing 33 in which the locking dogs or segments 31 are mounted, said stack.

Each locking dog is non-rotatable with respect to its housing 33 and rotation thereof is prevented by the inter-engagement of a notch 37 formed in the lower end of each segment with an inwardly projecting pin 38 secured in the housing 33, whereby rotation of the segments with respect to the housing is prevented and yet said segments may move a limited distance longitudinally within the housing. To maintain the segments with their inner surfaces in substantial contact with the external surface of the mandrel 110, a garter spring 39 encircles all of the segments and resiliently holds them in position against the mandrel. It is evident that when the J-slot connection is released and the mandrel 110 is moved downwardly with respect to the locking segment 31, the buttress-type threads 30 on the exterior of the mandrel may slide downwardly and ratchet into the complementary threads 32 of said segments in the manner shown in FIGURE 6. By reason of the shape of the threads, engagement is effected by a mere longitudinal movement downwardly with respect to the segments.

As noted, the lower expander 14 of the anchoring

means assembly is located in surrounding relationship to the mandrel 110 and this lower expander member has connection with a friction block unit which is generally indicated at B. The unit B includes a housing 40 having radially movable friction blocks 41 disposed within recesses in exterior thereof and suitable springs urge the friction blocks outwardly into frictional engagement with the wall of the pipe. Outward movement of each block is limited by upper and lower projections 42 on each block. The upper projection engages an upper stop ring 43 welded to the exterior of the body 40 adjacent the upper end of the recess in which the block is movable while the lower projection engages a stop extension 33a formed on the upper end of the housing 33.

The friction block unit B is connected to a downward extension 14a depending from the lower expander member 14 and is also connected with the tubular housing 33 which carries the locking segments 31. The lower end of the bore of the friction block housing 40 is inclined or tapered as shown at 44 and this surface is adapted to co-act with a complementary inclined surface 45 formed on the upper external surface of each locking segment 31. The co-action between the surfaces occurs, as will be explained, when the packer is in set position and functions to prevent outward movement of the locking segments to prevent disengagement of the segments from the buttress threads on the mandrel.

The upper expander 11 is provided with an upwardly projecting tubular extension or support sleeve 11a which surrounds the mandrel 110 in spaced relationship. The support sleeve is formed with an external shoulder 46 upon which a base ring 47 is supported. Above said ring is an elastic sealing or packing element 48 which encircles the support sleeve 11a. An upper confining ring 49 surrounds the upper portion of the sleeve 11a and engages the upper end of the sealing element 48. The sleeve 11a projects above the upper end of the confining ring 49 and a snap ring 50 on the sleeve overlies said upper end; coupled to said ring and extending upwardly therefrom is an annular seal cap 51 having a bore 52, said cap forming an upper abutment at the upper end of the elastic sealing element assembly. When the cap 51 and ring 49 are moved downwardly with respect to the support sleeve 11a, and endwise force is applied to the elastic packing or sealing element 48 to deform the same into sealing engagement with the well pipe P.

When the packer device is in an unset position (FIGURE 5), the space between the support sleeve 11a and the mandrel 110 is open and fluid may flow through ports 53 formed in the lower portion of the sleeve 11a below shoulder 46 and then upwardly above the packer; when the packer is in set position (FIGURE 6), a packing 54 which is mounted on the upper end of mandrel 110 below the coupling C closes the flow.

In the operation of the well packer, the parts are assembled as shown in FIGURE 5 and in such position the radial connecting pins 36 on the lower end of the mandrel 110 are engaged in the J-slots 35 of the lower housing 33. Since this lower housing is attached through the friction block unit 3 to the lower expander 14, said lower expander is effectively latched to the mandrel 110. At the same time, the upper expander 11 is supported upon the external shoulder 110a of the mandrel, which shoulder limits the downward movement of the upper expander on the mandrel and assures that the expanders 11 and 14 are maintained sufficiently far apart to prevent any radial outward movement of gripping elements A during the lowering operation. As the packer is lowered, the friction blocks 41 drag on the wall of the pipe P and the packing element 48 is in its non-sealing or retracted position; also, the seal 54 on the upper end of mandrel 110 is spaced above the seal housing 51 whereby a bypass of fluid through ports 53 and upwardly around the mandrel 110 to the area above the packer may occur.

In setting the packer, the tubing string T is rotated slightly to the left which rotates mandrel 110 to move

the radial pins 36 out of the J-slots 35 and thereafter a downward movement of the mandrel with respect to the rest of the assembly may occur. As the mandrel 110 moves downwardly, the friction block unit B is maintaining the lower expander stationary and is also supporting the slip carrier 17, upper mandrel and elastic packing element. When the mandrel has moved downwardly a sufficient distance, the seal 54 enters the bore 52 of the seal housing to close the bypass around the sealing element 48 and the beveled lower end 55 of coupling C engages a seat 51a provided at the upper end of the annular seal cap 51. Thereafter, the downward weight of the tubing string may be applied through the seal cap and upper confining collar to the upper expander member or cone 11 to move the same downwardly. Through the co-action of the engaged surfaces of the expanders 11 and 14 and the slips A, the slips are moved radially outwardly into gripping engagement with the pipe. Following the anchoring of the gripping elements to the wall of the pipe P, further imposition of tubing weight upon the upper end of the sealing or packing element 48 will deform the same outwardly into sealing position as shown in FIGURE 6.

At the same time that the mandrel 110 has been moved downwardly to effect a setting of the gripping elements or slips A and the deformation of the sealing or packing element 48, the buttress-type threads on the mandrel have ratcheted downwardly into the locking segments 31. After the threads are engaged and in order to assure that the packer will remain in its set position, the tubing T is rotated slightly to the left, possibly about one-half turn, and this causes the segments 31 to be moved upwardly on the mandrel 110 to the position shown in FIGURE 6 where the upper inclined surfaces 45 thereof are engaged with and confined by the inclined surface 44 of the friction block housing 40. Thereafter, the segments cannot expand radially outwardly which assures that the threads thereof will remain in engagement with the threads 30 of the mandrel and at this time the packer is fully locked in its set position. The slight left-hand rotation of the tubing which moves the segments into locked position is not sufficient to uncouple any connection in the tubing string.

Any pressure above the packer which would tend to displace the packer from its anchored position, acts downwardly against the seal cap through the packing element 48 and directly against the upper cone through the shoulder 46, thereby driving the upper cone further behind the gripping slips and urging them into tighter gripping engagement. Similarly, any pressure from below the assembly which would tend to move the assembly upwardly, will act upwardly against the seal 48 and seal cap 51, which force is transmitted through collar C and mandrel 110 to pull upwardly on the locking dogs 31, housing 40 and lower cone 14, tending to urge the cone further upwardly and increase the gripping action of the elements or slips A. The packer is thus capable of holding its anchored position against a high differential pressure across the packer and it makes no difference whether the higher pressure is above or below said packer.

Because the gripping slips are capable of holding the anchored position in both directions, no auxiliary hold-down unit, which is normally used to prevent upward displacement of a packer, is required. By eliminating the necessity of an auxiliary hold-down unit which is usually located above the sealing element of the packer, the entire anchoring means may be located below the sealing element 48 of the packer. With such location, when the sealing element is in set position, it protects the gripping slips from the accumulation of sediment or extraneous matter on said slips, which accumulation may interfere with subsequent release of said gripping slips.

The packer is released by rotating the tubing T and mandrel 110 to the right and at the same time picking up the weight of the tubing. The locking segments or dogs

31 are held against rotation through the pins 38, lower housing 33 and the friction block unit B, the friction blocks maintaining tight frictional contact with the wall of the pipe; non-rotation of the dogs is assisted during the initial rotation of the mandrel by the set slips which are maintained in wedged position by the lower cone so that said lower cone and dogs 31 are held against any rotative movement. As the mandrel 110 is rotated to the right, which is in a direction which will not uncouple any of the collars in the tubing string, the left-hand threads 30 are actuated to cause the mandrel to move upwardly relative to the locking dogs or segments 31. As soon as the threads become disconnected, a straight upward pull on the tubing string and mandrel 110 will move the shoulder 110a on the mandrel beneath the upper expander and will lift said expander upwardly with respect to the gripping elements A. As the mandrel was initially moved upwardly, the downward force on the sealing element 48 was relieved and said packing element moves to its retracted or non-sealing position; at the same time, the upper seal 54 on the mandrel moves out of the bore 52 of the seal housing whereby pressures across the sealing element 48 are equalized.

Continued upward pull on the mandrel after its shoulder 110a has engaged the upper expander 11 moves the expander from behind the gripping elements A as shown in FIGURE 2 and, as has been explained previously, the shoulder 13 at the upper end of the expander 11 engages the collar 18 and applies an upward force to the slip carrier or cage 17. The lower edge 20a defining each slot engages the lower end of each gripping element and accomplishes a rocking or swinging motion of each gripping element in the manner shown in FIGURE 3. Such rocking motion is permitted because there is a space 27 between the lower portion of each gripping element and the wall of the pipe, as well as a space 27a between the upper expander 11 and the upper portion of the gripping element. As heretofore described, the gripping element or slip will fulcrum or swing about the point F which moves the gripping teeth 26 out of engagement with the pipe wall, after which continued upward pull on the slip carrier will pull the gripping elements off of the lower expander 14 to release the gripping action. Thereafter, the J-pins 36 may be re-engaged with the J-slots 35 to reconnect the parts in the manner shown in FIGURE 5, after which the entire packer may be removed from the well pipe or reset at a different elevation in said pipe.

In FIGURE 11, the anchoring means assembly of this invention is illustrated as incorporated into a tubing anchor device which will anchor the lower portion of the tubing within the well pipe P. This structure is substantially similar to the structure of the well packer illustrated in FIGURES 5 to 10 except that the packing or sealing element 28 and its associated parts are omitted. Also, in this form of the invention the J-pins 36 and slots 35 are omitted and in place thereof a modified type of locking dogs or segments is shown.

Each locking segment 131 has internal threads 132 which are similar to the left-hand threads 32 of the form shown in FIGURE 5. Additionally, each segment is formed with an extension 133 having right-hand buttress-type threads 134 within its bore. The bore of the extension is larger in diameter and co-acts with right-hand threads 135 formed on a lower enlarged diameter portion 136 of the mandrel 210.

The right-hand threads 134, 135 take the place of the J-pins 36 and slots 35 and releasably connect the mandrel 210a to the remainder of the assembly during lowering in the well bore. When setting the anchor shown in FIGURE 11, the tubing T is rotated to the right to disconnect said threads without affecting any of the couplings C in the tubing string. As soon as threads 134, 135 are disconnected, the mandrel 210 is lowered in the manner heretofore described so that the weight of the tubing string

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may be imposed upon the upper expander 11; during such downward movement, as was the case in the well packer device, the friction block unit B maintains the lower expander stationary and the slips may be moved to a gripping position. At the same time that the mandrel 210 is moving downwardly to set the gripping elements or slips A, left-hand threads 230, which are formed on the exterior of the mandrel and which are comparable to the left-hand threads 30 on mandrel 110, move downwardly to interengage with the threads 132 of locking segments 131. Thereafter, a slight left-hand rotation will move the locking segments upwardly into contact with the inclined confining surface 44 of the friction block unit and the gripping elements will be maintained in their gripping position.

Release of this form of the invention is accomplished in the same manner as that heretofore described in which a right-hand rotation will permit an upward movement of the mandrel 210 with respect to the assembly, so that the external shoulder 210a on the mandrel will engage the upper expander and move the same upwardly from behind the gripping elements A; thereafter, continued upward movement applies an upward force to the slip carrier or cage 17 whereby the gripping elements may undergo a rocking or swinging movement which disengages the same from the pipe wall P and allows the gripping elements to be pulled upwardly off of the lower expander 14.

In the form of the locking dog or segment 31 shown in FIGURES 5 and 11, it is necessary that after the left-hand threads 30 of mandrel 110 engage the left-hand threads 32 of each locking segment, a slight left-hand rotation be effected to move the locking segment into contact with the confining inclined surface 44 of the friction unit B. In FIGURE 12, a modification is shown which would eliminate this requirement. In this instance, the shape of the left-hand buttress threads on the mandrel 110 and the threads within each locking segment is changed. Referring to FIGURE 12, buttress-type threads 330 are formed with an upper surface 331 which is at a different angle with respect to the axis of the mandrel than the lower surface 332. Threads 132a on the segment 31 are complementary to the threads 330 whereby when the threads are engaged, any upward force on the mandrel will produce a resultant force which urges the segments 31 inwardly toward the axis of the mandrel, thereby assuring that said segments will remain in engagement with the teeth of the mandrel to lock the device in set position. Where the particular configuration of threads shown in FIGURE 12 is employed, the co-acting inclined surfaces 45 on the segments and the inclined surface 44 on the friction block unit B, as well as the requirement of slight left-hand rotation, are eliminated. It is, of course, obvious that the arrangement of FIGURE 12 may be employed in the well packer device of FIGURE 5 or it could be employed in the well anchor device of FIGURE 11. Also, the particular segments 131 shown in the anchor device of FIGURE 11 could be employed with the form of packer device shown in FIGURE 5.

In FIGURE 14 a modification of the anchoring assembly is illustrated. This form is substantially the same as the form of the invention illustrated in FIGURES 1 to 3 except that the upper expander cone 11 does not have limited sliding movement with respect to the mandrel 10. Instead, the shoulder 10a abuts the lower end of the cone 11 and said cone is maintained in contact with said shoulder by a collar 70 which is threaded onto the mandrel and which engages the upper end of an extension 71 formed on said upper cone. In this form the lower cone has a limited sliding movement on the mandrel 10 in the same manner as its mounting is previously described.

In the operation of this form, the gripping elements are moved into gripping position by a downward move-

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ment of the mandrel 10 and upper cone 11 with respect to the gripping elements A and the lower cone 14 so that the elements are set. To effect a release, the mandrel and upper cone are moved upwardly simultaneously with respect to both the lower cone and the slips so that the upper cone is moved from behind the upper portion of said slips. The shoulder 13 on the upper expander then applies upward force to the cage 17 and gripping elements so that the release is effected in the same manner as has been described with respect to FIGURES 1 to 3.

In FIGURES 15 and 16, a modification of the invention is illustrated in which the cage 17 is omitted. In place of the cage, connecting pins 72 in the upper cone and a co-acting slot 73 in each gripping element are provided; each pin and slot provide for a connection between the upper cone and the gripping elements which permits limited longitudinal movement relative to each other. Similarly, co-acting pins 74 and slots 75, one slot in each gripping element, connect the lower expander 14 and the lower portion of each gripping element so that these parts may undergo limited movement relative to each other. The connecting pins and slots perform the function of the cage 17 of the form of the invention shown in FIGURES 1 to 3 in that the slips are carried by the assembly with limited movement with respect to the expander cones.

In operation, the slips are set by moving the two cones 11 and 14 inwardly with respect to each other to thereby move the gripping elements outwardly into gripping position (FIGURE 15). As is obvious, the connecting pins and slots permit this movement.

To effect release, the upper cone 11 is pulled upwardly from behind the slip and after reaching a position which will allow the slip to swing inwardly, the pin 72 and slot 73 co-act to apply upward force on the slip. As has been described with respect to the other forms, this upward force results in an inward rocking or swinging movement of the slip to disengage the gripping teeth. After release of the gripping slips from the pipe, continued upward pull on the slips allows the slip to move upwardly off of the lower cone 14 and thereafter the connecting pin 74 and its co-acting slot 75 permit the assembly to be removed from the well pipe.

In FIGURES 17 and 18 still another manner of mounting the gripping elements A with respect to the expander cones is illustrated. In this form, each gripping slip is formed with an external groove 80 within which an annular retaining member 81 is disposed. The retaining member is clearly illustrated in FIGURE 18 and is suitably recessed at 82 so that each gripping element A is movable in a radial direction. It is evident that the retaining member 81 prevents complete outward displacement of the gripping elements from the assembly. For connecting the retaining element 81 and therefore the gripping slips which are interconnected therewith, to the upper expander cone 11, the expander cone is formed with a longitudinal bore 83; the bore is counterbored at 84 to provide a shoulder 85. A connecting rod 86 is threaded into the upper end of the annular retaining member 81 and has an enlarged head 87 movable within the counterbore. With this arrangement, the upper expander 11 is connected with the retaining member 81 which mounts the gripping elements and may undergo limited longitudinal movement relative thereto.

The lower expander 14 is similarly connected to the member 81, said lower expander having an opening 83a, counterbore 84a and connecting rod 86a having the enlarged head 87a. The rod 86a is threaded into the underside of the retaining member and connects the lower expander thereto with limited movement.

It is evident that this form operates in the same manner as the other forms, the retaining member 81 being in fact an equivalent and substitute for the cage 17.

The foregoing disclosure and description of the inven-

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tion is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What I claim is:

1. An anchoring means assembly for use in a well bore including,
 - a support,
 - an upper expander member mounted on the support and a lower expander member mounted for limited sliding movement on said support,
 - a gripping element disposed exteriorly of the expander members and coacting with said members so that relative vertical movement of the expander members with respect to the element effects a radial movement of the gripping element with respect to the axis of the support,
 - means engageable with the gripping element and the expander members and mounting said gripping element for limited movement vertically with respect to the expander members,
 - the upper portion of the outer surface of said gripping element having a gripping area for gripping the wall of the well bore and the lower portion of said outer surface having a non-gripping area,
 - and means on the inner surface of said gripping element coacting with the upper and lower expander members when the latter are moved toward each other to thereby move the gripping element radially outwardly whereby its gripping area is engaged with the well bore wall and its non-gripping area is spaced from the well bore wall.
2. An anchoring means assembly as set forth in claim 1, wherein
 - the means mounting the gripping element for movement relative to the expander members includes a part which is not engaged with the upper expander when the gripping element is in set position, an initial upward movement of said upper expander member relative to the mounting means and gripping element moving said upper expander into engagement with said part of the mounting means and thereafter moving the upper expander relative to the gripping element to release said gripping element from the holding action of said upper expander member,
 - continued upward movement of said upper expander member applying an upward force through said mounting means to the gripping element to release the gripping element from the holding action of the lower expander member, whereby the assembly may be removed from the well bore.
3. An anchoring means assembly as set forth in claim 1, wherein
 - a plurality of gripping elements are mounted in circumferentially spaced relationship around the expander members, and also wherein the upper and lower expander members are annular and co-act simultaneously with all gripping elements.
4. An anchoring means assembly as set forth in claim 1, wherein
 - a plurality of gripping elements are mounted in circumferentially spaced relationship around said expander members, and also wherein the upper and lower expander members are annular and co-act simultaneously with all gripping elements,
 - the means mounting the gripping elements for movement relative to the upper expander member including a part which is not engaged with the upper expander when the gripping elements are in set position, an initial upward movement of said upper expander member relative to the mounting means and gripping elements moving said upper expander into engagement with said part of the mounting means and thereafter moving the upper expander relative

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- to the gripping elements to release said gripping elements from the holding action of said upper expander member,
- continued upward movement of said upper expander member applying an upward force through said mounting means to the gripping elements to release said elements from the holding action of said lower expander member, whereby the assembly may be removed from the well bore.
5. An anchoring means assembly as set forth in claim 1, wherein
 - the gripping area on the upper portion of the outer surface of the gripping element comprises teeth and the non-gripping area on the lower portion of said surface is a substantially smooth surface.
6. An anchoring means assembly as set forth in claim 1, wherein
 - the gripping area on the gripping element comprises a plurality of gripping teeth, each of which has a sharp gripping edge, and
 - the non-gripping area on said element comprises a plurality of teeth each of which has had its apex removed whereby the teeth are incapable of any gripping action, whereby a space is formed between the non-gripping area and the well bore wall when the gripping element has been moved into gripping position.
7. An anchoring means assembly for use in a well bore including,
 - a support,
 - upper and lower expander members mounted for sliding movement on said support,
 - a gripping element carrier connected with said expander members and mounted for limited axial movement relative thereto,
 - and a gripping element mounted on said carrier for radial movement relative to the axis of the support,
 - the upper portion of the outer surface of said gripping element having a gripping area for gripping the wall of the well bore while the lower portion of said outer surface is formed with a non-gripping area,
 - and means on the inner surface of said gripping element co-acting with the upper and lower expander members when the latter are slidably moved toward each other to thereby move the gripping element radially outwardly whereby its gripping area is engaged with the well bore wall and its non-gripping area is spaced from the well bore wall.
8. An anchoring means assembly as set forth in claim 7, wherein
 - the connection between the carrier and the upper expander member is such as to permit an initial upward movement of said upper expander member relative to the carrier and the gripping element to release said gripping element from the holding action of said upper expander member, said element being maintained in gripping position by the holding action of the lower expander member,
 - continued upward movement of said upper expander member applying an upward force to the carrier and to the gripping element to release the gripping element from the holding action of the lower expander member, whereby the assembly may be removed from the well bore.
9. In an anchoring means assembly which comprises,
 - a support with movable upper and lower expander cones and a gripping element carrier, the improvement residing in
 - a gripping slip mounted for radial movement in said carrier,
 - said gripping slip comprising a body having its inner surface formed with inclined areas for co-action with the upper and lower expander cones,
 - the upper portion of the outer surface of the body having gripping teeth formed thereon and the lower por-

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tion of said outer surface being smooth and lying in a longitudinal plane inwardly of the longitudinal plane in which the apex of each gripping tooth is disposed.

10. An anchoring means assembly for use in a well bore including,
 a tubular mandrel,
 an upper expander cone slidable on the mandrel, a lower expander cone below the upper cone and also slidable on the mandrel,
 a slip carrier encircling the expander cones and having limited longitudinal movement relative to said expanders,
 a plurality of gripping slips mounted in said carrier for radial movement with respect thereto,
 internal surfaces on each gripping slip adapted to co-act with said expander cones, whereby movement of the cones toward each other moves the gripping slip outwardly into gripping position with the well bore, said slip being wedged between the bore wall and said expander cones,
 each gripping slip having the upper portion of its outer surface formed with gripping teeth and having the lower portion of said outer surface void of gripping teeth, whereby said lower portion is spaced from the wall of the bore,
 upward movement of the upper expander cone relative to the slips and lower expander withdrawing said upper cone from contact with the inner surface of each slip to create a space between said upper cone and each slip, whereby a subsequent upward applied force upon each slip results in a rocking of the upper portion of each slip and disengagement of its gripping teeth from gripping position to permit said slip to be withdrawn from contact with the lower expander cone.

11. An anchoring means assembly for use in a well bore including,
 a support,
 an upper expander member mounted on the support for limited longitudinal movement thereon,
 a lower expander member mounted on the support for limited longitudinal movement thereon,
 an annular carrier surrounding the upper and lower expander members and having limited longitudinal movement relative to said members,
 a gripping element mounted in said carrier and movable in a radial direction with respect to the support,
 co-acting means on said expander members and on said gripping element for moving the gripping element in a radially outward direction to move said element into gripping position with a well bore when the expander members are moved longitudinally toward each other,
 said gripping element having a well bore gripping area formed on the outer surface of its upper portion with the lower portion of said outer surface being spaced from the wall of the bore when the gripping area is engaged with the bore wall,
 upward movement of the upper expander member creating a clearance between said upper expander member and the upper portion of the inner surface of the gripping element, whereby a subsequent upward force applied to the gripping element will result in an inward rocking movement of the upper end of said element to disengage its gripping area from the wall of the bore and allow said gripping member to be moved upwardly relative to the lower expander member.

12. The combination with a well packer device having a central mandrel connected with a tubing string and having a deformable sealing element mounted on the upper portion of the mandrel and a friction means unit on its lower portion, of an anchoring means assembly mounted on said mandrel between the sealing element and said friction means unit, said assembly including,

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an upper expander cone slideable on the mandrel and having connection with the sealing element,
 a lower expander cone slideable on the mandrel and having connection with the friction means unit,
 a slip carrier encircling said expander cones and having limited longitudinal movement relative thereto, and
 a plurality of gripping slips mounted on said carrier for radial movement,
 each gripping slip comprising a body having its inner surface formed with inclined areas for co-action with the upper and lower expander cones,
 the upper portion of the outer surface of the body having gripping teeth formed thereon and the lower portion of said outer surface having a non-gripping area.

13. A well packer device comprising,
 a tubular mandrel having connection with a tubing string,
 a plurality of external threads formed on the mandrel,
 a friction block unit surrounding the lower portion of the mandrel and having friction blocks for engaging a well pipe within which the device is lowered, means for releasably connecting the mandrel to the friction block assembly,
 an anchoring means assembly having connection with said friction block unit, said assembly including an upper expander cone, a lower expander cone, a slip carrier surrounding said cones and a plurality of gripping slips mounted in said carrier for radial movement,
 each gripping slip having the upper portion of its outer surface formed with a gripping area while the lower portion of its outer surface is formed with a non-gripping area,
 a packing element having its lower portion supported upon the upper expander cone of the anchoring means assembly,
 a confining abutment above the packing element and adapted to be engaged by an external projection on the mandrel when the mandrel is moved downwardly with respect to the packing element, and friction block unit, whereby a downward movement of the upper expander cone first effects a setting of the slips and then deforms the packing element into sealing position,
 and a plurality of locking segments mounted below the lower cone and engageable by the threads on the mandrel as the mandrel moves downwardly to set the anchoring means assembly and the sealing element, the engagement of such threads with the locking segments locking the packer in its set position, said threads being left-hand threads whereby a subsequent rotation of the tubing string and mandrel in a right-hand direction will disengage said threads from the locking segments to permit upward movement of the mandrel to effect an unsetting of the packing element and a release of the gripping slips of the anchoring means assembly.

14. The combination with a well tubing anchor having a central mandrel connected with a tubing string and having a friction means unit releasably connected to its lower portion, and an anchoring means assembly mounted on said mandrel above said unit, said assembly including,
 an upper expander cone mounted on the mandrel,
 a lower expander cone slideable on the mandrel and having connection with the friction means unit, a slip carrier encircling said expander cones and having limited longitudinal movement relative thereto, and
 a plurality of gripping slips mounted on said carrier for radial movement,
 each gripping slip comprising a body having its inner surface formed with inclined areas for co-action with the upper and lower expander cones,
 the upper portion of the outer surface of the body

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having gripping teeth formed thereon and the lower portion of said outer surface having a non-gripping area.

15. The combination set forth in claim 14 wherein the gripping teeth extend from the upper end of the body to a point at least half way of the height of the body and also wherein the lower non-gripping area on the slip body is a smooth surface. 5

16. A well packer device comprising, a tubular mandrel having connection with a tubing string, 10

a plurality of external threads formed on the mandrel, a friction unit surrounding the lower portion of the mandrel and having friction means for engaging a well pipe within which the device is lowered, 15

means comprising a pin and J-slot connection between the mandrel and friction unit for releasably connecting the mandrel to the friction unit,

an anchoring means assembly having connection with said friction unit, said assembly including an upper expander cone, a lower expander cone, a slip carrier surrounding said cones and a plurality of gripping slips mounted in said carrier for radial movement, 20

each gripping slip having its outer surface formed with a gripping area, 25

a packing element having its lower portion supported upon the upper expander cone of the anchoring means assembly,

a confining abutment above the packing element and adapted to be engaged by an external projection on the mandrel when the pin and J-slot is disconnected and the mandrel is moved downwardly with respect 30

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to the packing element and friction unit, whereby a downward movement of the upper expander cone first effects a setting of the slips and then deforms the packing element into sealing position,

and a plurality of locking segments mounted below the lower cone and engageable by the threads on the mandrel as the mandrel moves downwardly to set the anchoring means assembly and the sealing element, the engagement of such threads with the locking segments locking the packer in its set position,

said threads being left-hand threads whereby a subsequent rotation of the tubing string and mandrel in a right-hand direction will disengage said threads from the locking segments to permit upward movement of the mandrel to effect an unsetting of the packing element and a release of the gripping slips of the anchoring means assembly.

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