

July 29, 1958

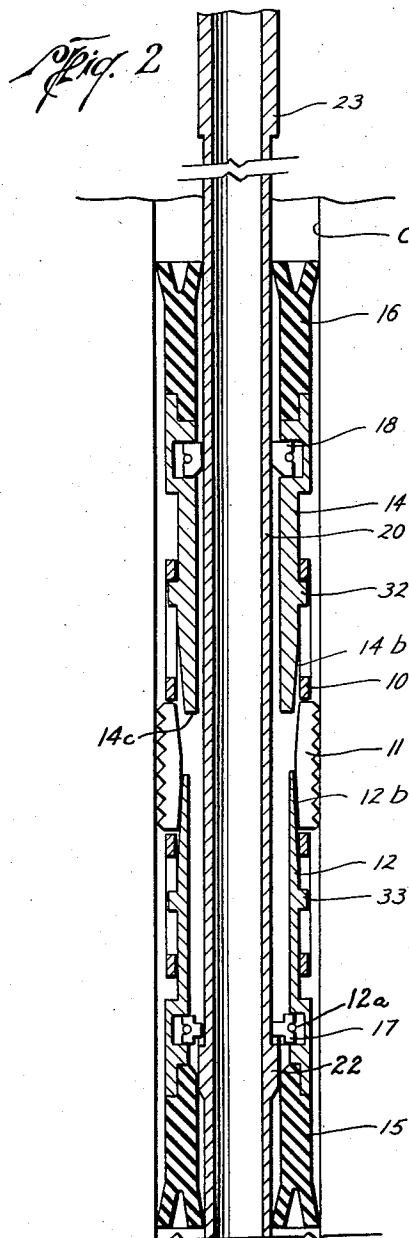
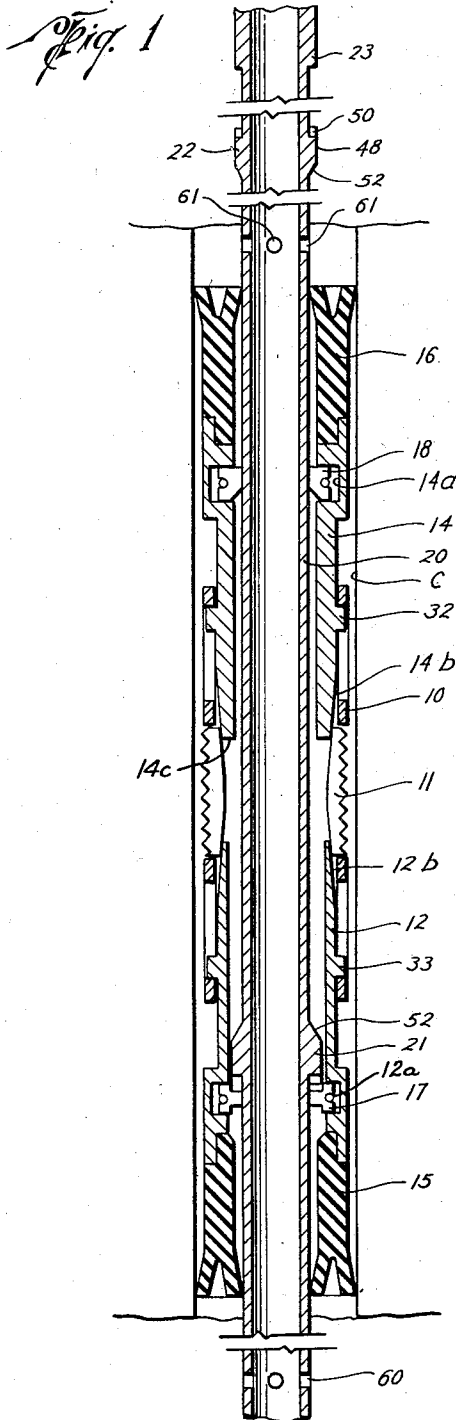
C. C. BROWN

2,845,126

WELL PACKERS

Filed Oct. 3, 1952

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

Fig. 3

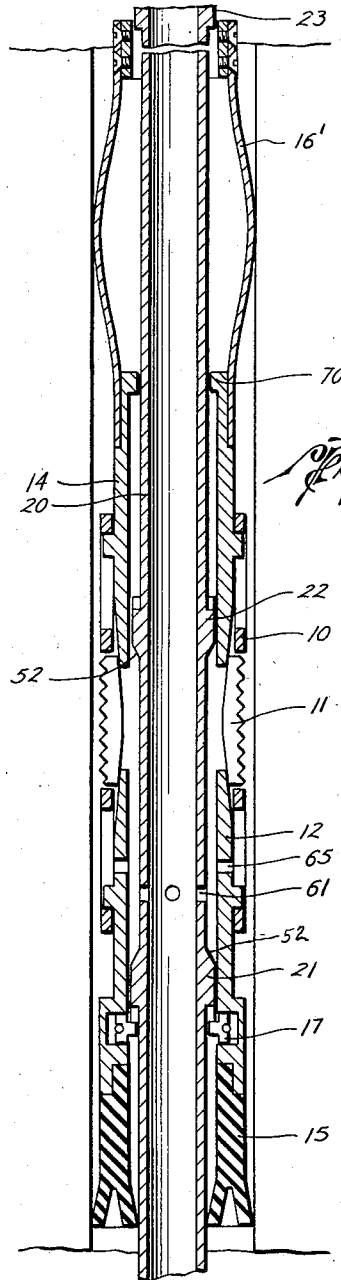
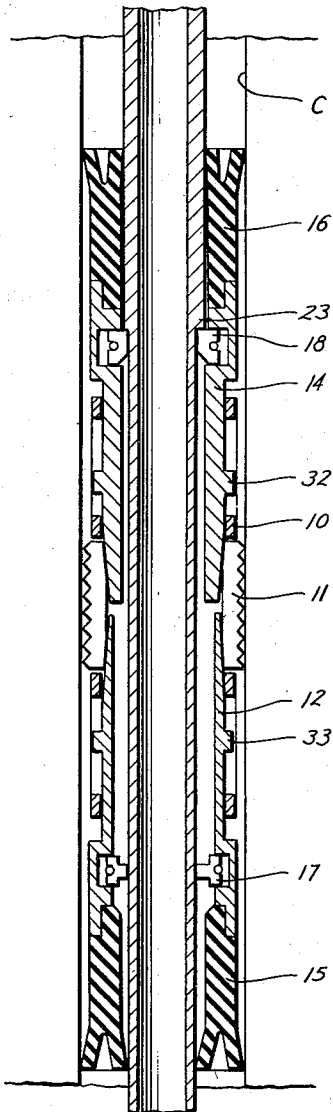


Fig. 8

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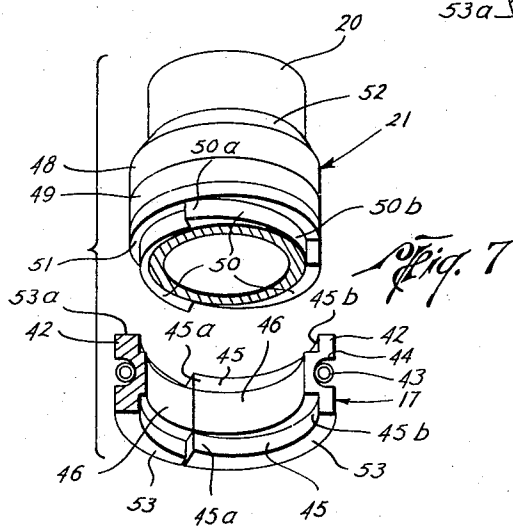
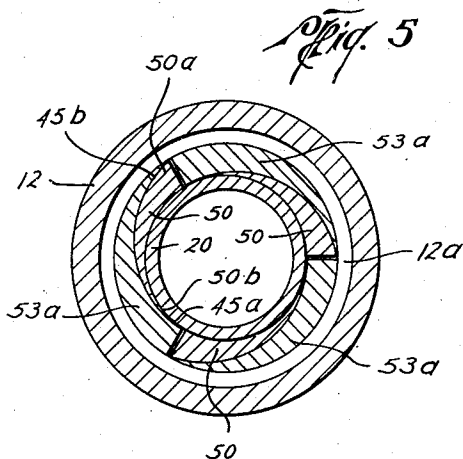
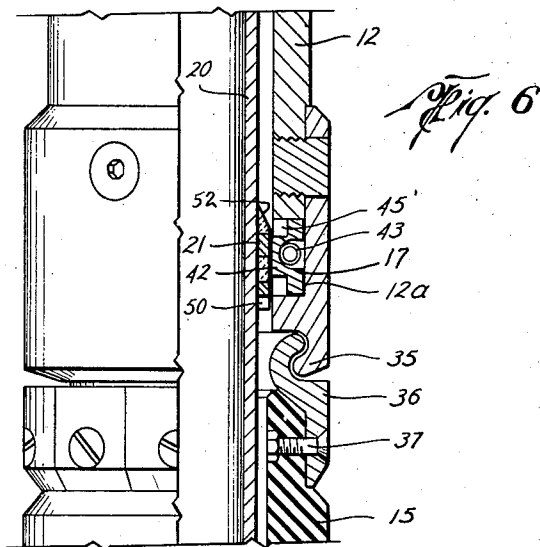
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1

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WELL PACKERS

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Application October 3, 1952, Serial No. 312,938

11 Claims. (Cl. 166—119)

This invention relates to new and useful improvements in well packers for use in oil wells and the like.

It is an object of this invention to provide an improved well packer wherein the slips are set in gripping contact with the well casing by a longitudinal movement of the well tubing extending through the packer, and thereafter the slips are maintained in their set position by the fluid pressure of the well acting on the packing means.

An important object of this invention is to provide a well packer wherein the packer has a cam expansible means co-acting with a cam means on the tubing, whereby the tubing can be moved longitudinally to set the well packer upon a co-action between said cam means and said cam expanded means.

Another object of this invention is to provide a well packer in which the well packer has an expansible abutment means adapted to cooperate with a shoulder means on the well tubing extending through the packer to permit the setting and release of the packer in the well casing, said expansible abutment means being cam-actuatable to permit said tubing to move longitudinally with respect to said packer.

Still another object of this invention is to provide a well packer which can be set in gripping contact with the well casing and jarred loose therefrom by a longitudinal movement of the well tubing through the packer, such setting and jarring being effected by co-action between spaced projections on said well tubing and spaced projections on said well packer.

The construction design 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 longitudinal sectional view of the well packer of this invention, illustrating the relationship of the parts as the packer is lowered into the well pipe or casing.

Figure 2 is a view similar to Figure 1, but illustrates the relationship of the parts for the setting of the slips by the movement upwardly of the lower slip expander.

Figure 3 is a view similar to Figure 1, but illustrates the relationship of parts when the upper slip expander is moved downwardly to set the slips.

Figures 4 and 4A together illustrate the details of the well packer of this invention, with Figure 4 illustrating the upper portion thereof and Figure 4A illustrating the lower portion thereof.

Figure 5 is a horizontal sectional view taken on line 5—5 of Figure 4A, and illustrates the cam construction which enables the expansible projection to be expanded to an open bore position.

Figure 6 is a partial view, partly in section and partly in elevation, illustrating the expansion of the expansible

2

projection to permit the tubing to pass through the bore thereof.

Figure 7 is an exploded view, illustrating cam construction on the tubing and the cam track construction on the lower slip expander which permits the well tubing to pass therethrough.

Figure 8 is a view similar to Figure 1, but illustrates a modification of the device shown in Figure 1, wherein a spring friction means is utilized at the upper end of the upper slip expander instead of a packing element.

In the drawings, the letter C designates a well pipe or casing which is disposed within a well bore, and into which the well packer of this invention is adapted to be lowered and set for various well operations. The improved well packer of this invention includes a slip housing 10 which supports pipe gripping slips 11 for radial movement with respect thereto. In order to move the slips 11 into gripping contact with the well pipe C, a lower slip expander 12 and an upper slip expander 14 are provided. The lower slip expander 12 has a flexible packing element 15 disposed therebelow, while the upper slip expander 14 has a friction member 16 which is adapted to contact the inner surface of the well pipe C. The lower slip expander 12 has an expansible projection 17 disposed within an annular recess 12a in its bore, while the upper slip expander 14 has an expansible projection 18 within an annular recess 14a in its bore. For the lowering of the well packer into the desired position within the well casing C, the well tubing 20 has thereon a shoulder 21 which is adapted to contact the projection 17. Spaced from the shoulder 21 is an upper shoulder 22 and spaced upwardly therefrom is another shoulder or abutment 23. These shoulders 21, 22 and 23 co-act with the radial projections 17 and 18 to effect the setting and the release of the slips 11 from gripping contact with the well pipe or casing C, as will be described in detail hereinafter.

Referring now to Figures 4-7, therein can be seen the details of the well packer of this invention. As shown in these Figures 4-7, the slip housing 10 is in the form of a tubular sleeve which has openings 30 through which the slips 11 are adapted to move and in which such slips 11 are confined against longitudinal movement relative to the housing 10. The inward radial movement of the slips 11 is limited by contact with the conical or tapered surface 14b of the upper slip expander and a similar conical or tapered surface 12b of the lower slip expander. The slip housing 10 also has slots 31 for the reception of pins 32 connected to the slip expander 14 and pins 33 connected to the slip expander 12. The pin 32 thus limits the upward longitudinal movement of the slip expander 14 relative to the slip housing 10 and the slips 11 so that the conical surface 14b cannot disengage from the upper inclined surface 11a of the slips 11. The slots 31 permit the pins 32 to move downwardly and thereby permit the movement of the slip expander 14 downwardly relative to the slip housing 10 so that the conical surface 14b can act against the inclined or conical surface 11a on the rear of the slips 11 to force such slips 11 radially outwardly. The pins 33 on the lower slip expander 12 function in the same manner as the pin 32 on the upper slip expander 14 and their movement in the slots 31 permit the conical surface 12b to move against the conical or inclined surface 11b of the slips 11 to force such slips outwardly.

As was previously pointed out, the lower slip expander 12 has an annular resilient packing element 15 connected at its lower end. This packing element 15 is made of rubber or similar resilient elastic material, and the lower end of the packing element has a groove 15a therein whereby a pair of annular lips 15b and 15c are formed. The well fluid pressure, upon reacting against the inner

3

surfaces of the grooves 15a forces the lips 15b and 15c away from each other so that the lip 15b contacts the well casing C while the inner lip 15c contacts the exterior of the well tubing 20. The packing element 15 may be connected to the slip expander 12 by any suitable means, but preferably a hook-shaped portion is formed on the lower end of the slip expander, such hook-shaped portion being designated by the numeral 35. This hook-shaped portion 35 is engaged by a plurality of hook segments 36 which are connected to the packing element 15 by bolts 37 or any other suitable means. As will be appreciated, when a fluid is forcing upwardly on the packing element 15, it will urge the packing element 15 radially outwardly with the hook segments 36 swinging or pivoting on the hooked portion 35 of the slip expander 12, thereby causing substantially the entire outer surface of the packing element 15 to engage with the inner surface of the well casing C.

As shown in Figure 4, the friction means 16 is substantially identical with the annular packing element 15 and is connected to the upper end of the slip expander 14 by hook segments 38 which engage with a hooked portion 39 on the upper end of the slip expander 14, in a similar manner to the connection of the hook segment 36 with the hooked portion 35. The packing element 16 or friction means 16 also has a pair of lips 16b and 16c with an annular groove 16a therebetween so that fluid pressure forces the lips 16b and 16c away from each other and also tends to force the packing element 16 into substantially complete contact with the well casing C. Thus it can be seen that a differential in the well pressure above and below the packing elements 16 and 15, respectively, will cause such packing elements to urge the slip expanders 14 and 12 toward each other to thereby hold the slips 11 in a pipe gripping position with the well casing C. Therefore, once the slips 11 have been set, the differential in well pressure maintains the slips 11 in their set position.

The setting and release of the slips 11 from gripping contact with the well casing C is effected through a co-action between the projections 17 and 18 on the slip expanders 12 and 14, respectively, and the shoulders 21, 22 and 23 on the well tubing 20.

Considering first the details of the expansible projection 17, which is best shown in Figures 4A, 6 and 7, it can be seen that this projection 17 includes a plurality of arcuate segments 42 which are resiliently urged toward each other to form an annular ring by a resilient ring 43. This resilient ring 43 is preferably a coil spring or rubber or any similar elastic material which is placed in the grooves 44 of each of the arcuate segments 42. Although the resilient ring 43 holds the edges of the segments 42 in contact with each other to form an annular ring, it will be appreciated that such segments 42 can be separated by a radial force exerted from within to urge each of the segments 42 outwardly against the action of the resilient ring 43.

On the upper and lower lateral surfaces of each segment 42, there is provided a cam track 45. These cam tracks 45 leave an inner arcuate surface 46 spaced therebetween. Each cam track 45 has one end thereof 45a which extends radially inwardly as far as the inner arcuate surface 46 while the other end of the cam track 45 is designated by the numeral 45b and is of a greater internal diameter than the internal diameter of the arcuate surface 46.

In the lowering of the well packer of this invention into the well bore, in which the well casing C is mounted, the shoulder 21 contacts the expansible projection 17 and the friction means 16 is in contact with the well casing C, whereby the slip expanders 12 and 14 are held apart during such lowering to prevent the setting of the slips 11 prematurely. As best shown in Figure 7, the shoulder 21 has a uniform outer diameter surface 48 which includes an annular weld portion 49. This outer diameter

4

portion 48 is of a greater diameter than the diameter formed by the inner arcuate surfaces 46 when they are held in their closed position by the resilient member 43, so that the shoulder 21 cannot pass through the projection 17 by a simple downward longitudinal movement. On the lower end of the shoulder 21 are a plurality of cams 50, each of which has a large diameter end 50a and a reduced diameter end 50b with the surfaces of the cams being thereby formed in an arcuate eccentric shape similar to the arcuate eccentric shape of the cam tracks 45 on the projection 17. When the shoulder 21 is lowered into contact with the projection 17, the lower lateral surface 51 on the shoulder 21 abuts with the upper lateral surface 53a on the expansible projection 17, while the cams 50 fit within the cam tracks 45. Initially, the enlarged diameter portion 50a of the cam 50 will fit within the increased internal diameter portion 45b of the cam track 45, for each segment 42 which is utilized. Also, the reduced diameter end 50b of the cam 50 will be in contact with the end 45a of the cam track 45, so that there is no tendency to expand the arcuate segments 42 away from each other initially. However, upon rotation of the well tubing 20, the enlarged diameter end 50a of the cam 50 will move toward the reduced diameter end 45a of the cam track 45 which will force the segments 42 radially outward against the action of the resilient member 43. Since the enlarged diameter end 50a is of the same diameter as the outer diameter surface 48, this expansion is sufficient to permit the entire shoulder 21 to pass through the bore of the expansible projection 17, so that the well tubing 20 can be moved below the expansible projection 17.

It will be observed that the upper surface of the shoulder 21 is conical or inclined and is designated by the numeral 52. Such inclined surface 52 is preferably formed by a weld material, although it may be a pre-formed ring which is integral or has been united with the diameter portion 48. This inclined surface 52 after having passed below the expansible projection 17 permits the subsequent expansion of the projection 17 sufficiently to pass the shoulder 21 upwardly through the bore of the projection 17, the purpose of which will be described hereinafter.

The upper shoulder 22 is not shown in detail in the drawings, because it is identical with the lower shoulder 21 except that the inclined surface 52 is turned downwardly while the cams 50 are turned upwardly. Thus with the shoulder 22, it can pass through the projection 17 by an expansion with the inclined surface 52 and is prevented from upward movement when the lateral surface 51 contacts the lower lateral edge 53 of each of the arcuate segments 42. Similarly to the action of the shoulder 21 in its downward movement, the shoulder 22 in its upward movement may pass through the projection 17 by rotation and co-action between the cam 50 and the cam tracks 45 to expand the arcuate segments 42 outwardly. Also, the inclined surface 52 on the shoulder 22 permits the expansion of the segments 55 of the upper radial projection 18 on the upper slip expander 14. The arcuate segments 55 of the projection 18 are substantially the same as the arcuate segments 42 of the projection 17 except that no cam trackway is provided on the segments 55. However, an inclined or conical surface 56 is provided on the lower inner edge of the arcuate segments 56 to enable the passage of the shoulder 22 upwardly by the expansion of the segments 55 against the action of the resilient ring 57 which is substantially the same as the resilient ring 43 used with the radial expansible projection 17.

Above the shoulder 22, there is provided another shoulder 23 which is of substantially the same outer diameter as the outer diameters of the shoulders 21 and 22. This shoulder 23 does not pass below the projection 18 and is not capable of expanding such expansible projection 18, so that it is confined above the projection 18. This

permits the abutment or shoulder 23 to force the slip expander 14 downwardly when such action is desired and as will be explained in detail hereinafter.

The operation of the device shown in Figures 4-7 is best illustrated by Figures 1-3. In Figure 1, the well packer is illustrated in the position in which the parts are lowered into the well to the predetermined point at which it is desired to set the packer. It will be observed that the shoulder 21 forces against the inwardly extending expandable projection 17 to carry the slip expander 12 downwardly. Since the slip expander 12 is connected to the slip housing 10 through the pins 33, the slip housing 10 and the slips 11 are also carried downwardly. The friction means 16 which in the form of the invention shown in Figures 4-7 is an annular packing element, contacts with the well casing C and offers a resistance to its downward movement and since it is connected to the upper slip expander 14, it offers resistance to the downward movement of such expander 14 also. However, the pins 32 on the slip expander 14 engage with the slip housing 10 so that the entire structure is carried downwardly with the well tubing 20 as it is lowered with the shoulder 21 in contact with the projection 17. It will be observed that the friction means 16 prevents the upper slip expander from actuating the slips 11 into gripping position and the contact of the shoulder 21 with the projection 17 holds the lower slip expander from actuating the slips 11, so that in the lowering operation there is no tendency of the slips 11 to set in a gripping position with the well casing C.

When the well packer of this invention has been lowered to the desired point in the casing C, the well tubing is rotated preferably counter-clockwise as viewed in Figure 5 so that the cams 50 co-act with the cam tracks 45 to expand the arcuate segments 42 outwardly and thereby permit the shoulder 21 to pass through the bore of the arcuate segments 42. This places the shoulder 21 below the expandable projection 17 and enables the lowering of the well tubing 20 until the upper shoulder 22 contacts the expandable projection or cam-actuated means 17. During the lowering of the well tubing 20 the friction means 16 prevents the downward movement of the rest of the well packer structure so that relative movement between the well tubing 20 and the rest of the well packer structure is accomplished.

The inclined or conical surface 52 of the projection 22 expands the segments 42 of the projection 17 to permit the shoulder 22 to pass through the bore of the projection 17 to position it therebelow. This position is shown in Figure 2 and it will be appreciated that upon an upward movement of the tubing 20, the contact of the upper surface of the shoulder 22 with the projection 17 serves to raise the slip expander 12 upwardly with respect to the slips 11, thereby setting the lower portion of the slips into gripping contact with the well casing C. After the lower slip expander 12 has been raised to set the slips 11, the well fluid pressure below the packing element 15 maintains the expander 12 in its raised position to maintain the slips 11 in their set position with the well casing C. Thereafter, it is then possible to lower the well tubing 20 as shown in Figure 3 until the abutment or extreme upper shoulder 23 contacts the upper surface of the inwardly extending expandable projection 18. Continued downward movement of the well tubing 20 then forces the upper slip expander 14 downwardly as shown in Figure 3 to force the upper end of the slips 11 outwardly into contact with the well casing C. Once the slips 11 have been set with the expanders 12 and 14 in the positions shown in Figure 3, the differential in fluid pressure above and below the packing element 16 and 15 serves to retain the slip expanders 14 and 12 in such position, so that the well tubing 20 can then be raised and lowered as desired for carrying out the subsequent well operations. It will be observed in Figure 1 that the well tubing 20 has radial passages 60 and 61 below and above the

well packer, respectively, so that fluids can be passed through the well tubing for oil production or other operations. Also, in such lower or set position, there can be no upward movement of the tubing relative to the packer until the tubing is rotated, since the upper end of shoulder 22 abuts the lower surface of the projection 17 to lock the tubing against longitudinal movement until the tubing is rotated.

When it is desired to release the slips 11 from their set position in gripping contact with the well casing C, the tubing 20 is rotated and moved upwardly so that the shoulders 22 and 21 are moved upwardly through the projection 17 to a position such as shown in Figure 1, except that the slip expanders 12 and 14 would be in the position shown in Figure 3. Thereafter, the continued upward movement of the well tubing 20 causes the inclined surface 52 of the shoulder 21 to engage with the lower end 14c of the upper slip expander, since the upper slip expander is of a lesser internal diameter than the internal diameter of the lower slip expander 12. This provides a jarring action on the upper slip expander 14 and moves it upwardly to release the upper ends of the slips 11. The lower slip expander 12 can then be released by moving the well tubing 20 downwardly to cause the shoulder 21 to engage with the projection 17 and force the slip expander 12 downwardly with respect to the slips 11, if such action is necessary. Then to raise the well packer from the well casing C, the well tubing 20 is again raised until the inclined surface 52 on the shoulder 21 abuts against the lower edge 14c of the upper slip expander 14.

In Figure 8, a different form of the invention is illustrated, and in that form the upper friction means 16' is a friction spring means which includes a plurality of bowed friction springs which are attached to the upper end of the upper slip expander 14. These bowed springs therefore take the place of the upper annular packing element as shown in Figure 4, insofar as offering the frictional resistance to the downward movement of the upper slip expander 14 during the lowering of the well packer into the well casing C.

Also, in the form of the invention shown in Figure 8, there is no expandable projection 18, but instead there is provided a fixed projection 70 at the upper end of the slip expander 14. This provides an upper surface for the contact of the abutment or shoulder 23 to set the slip expander 14 and also provides a surface against which the upper shoulder 22 can abut to jar the upper slip expander 14 from its set position. It will be observed that the openings 61 in the well tubing 20 can be located in any position above the shoulder 21 and suitable openings 65 are provided in the lower slip expander 12 for the passage of fluids which come up through the tubing and pass outwardly through the radial openings 61. Of course, the openings 61 could be disposed above the shoulder 22 so that the opening 65 would not be necessary.

The operation of the form of the invention shown in Figure 8 is substantially identical to that shown in Figure 1 except that the shoulder 22 is normally spaced a lesser distance with respect to the shoulder 21. Also, the shoulder 22 is disposed below the inwardly extending radial projection 70 and does not pass thereabove. Thus in setting the well packer shown in Figure 8, the shoulder 21 passes through the projection 17 by rotation and the co-action of the cams 50 with the cam tracks 45 and then the shoulder 22 passes through the projection 17 by the cam action of the inclined surface 52 thereon. After the shoulder 22 is below the projection 17, an upward movement on the well tubing effects a setting of the lower slip expander 12. The upper slip expander 14 is set by the contact of the abutment 23 with the projection 70. After the slips 11 are fully set by both the upper and the lower slip expanders, the well fluid pressure from below urges the slip expanders 12 and 14 toward each other since the friction spring members

16' offer resistance against upward movement and the well pressure tends to force the lower packing element 15 upwardly.

The foregoing disclosure and description of the invention 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 is claimed is:

1. In a well packer having pipe gripping slips, a slip expander for moving said slips into pipe gripping contact with a well pipe, and a well tubing extending through said slip expander, the improvement residing in a cam expansible means carried by said slip expander for longitudinal movement therewith, a cam means on said tubing adapted to contact said cam expansible means to prevent relative longitudinal movement between said slip expander and said tubing, and a cam on said cam means and a cam surface on said cam expansible means engageable with each other for expanding said cam expansible means radially outwardly upon a rotation of said cam means relative to said cam expansible means to effect a release of the contact of said cam expansible means and said cam means to permit longitudinal movement of said tubing with respect to said expander.

2. The improvement set forth in claim 1, wherein said cam expansible means includes a plurality of arcuate segments forming an annular ring, resilient means urging said segments toward each other, and a cam track on each of said segments, and wherein said cam means on said tubing includes an arcuate cam surface for each cam track, said cam surfaces being engageable with said cam tracks to force said segments radially outwardly upon a rotation of said cam means relative to said cam expansible means.

3. A well packer for use in a well pipe, comprising a well tubing extending longitudinally in the well pipe, pipe gripping slips disposed about said tubing, an upper tubular slip expander surrounding said tubing and adapted to be moved downwardly to expand said slips, a lower tubular slip expander surrounding said tubing and adapted to be moved upwardly to expand said slips, a lower annular packing element connected to said lower slip expander and having surfaces in engagement with said well pipe and said tubing, friction means connected to said upper slip expander to contact the well pipe to normally retain said upper slip expander against downward movement relative to said slips, an expansible projection on said lower slip expander and extending radially inwardly, a first shoulder on said tubing engageable with the projection on said lower expander for normally retaining said lower expander against upward movement during the lowering of said packer on the well tubing, and a second shoulder on said tubing spaced from and above said first shoulder, said first and second shoulders being constructed to expand said projection and to pass therethrough to position said second shoulder below said projection, said second shoulder being adapted to engage said projection upon an upward movement of the tubing to effect a setting of said slips in gripping contact with the well pipe.

4. The packer set forth in claim 3, wherein said expansible projection on said lower slip expander includes a plurality of arcuate segments, resilient means urging said segments together to form a ring, and co-acting means on said segments and said shoulders for effecting radial expansion of said segments by said shoulders whereby said shoulders may pass axially through the segments.

5. The packer set forth in claim 3, wherein said upper slip expander has a smaller diameter bore than the bore of said lower slip expander, and said first shoulder on said tubing is of substantially the same external diameter as the bore of said lower slip expander but is of a larger

external diameter than the bore of said upper slip expander, whereby said first shoulder may be moved longitudinally upwardly through said lower slip expander to contact said upper slip expander to effect an upward jarring thereof.

6. The packer as set forth in claim 3, wherein said friction means is an upper annular packing element having surfaces in engagement with said well pipe and said well tubing, the differential of well pressure above and below said upper and lower packing elements urging said elements and their connected slip expanders toward each other to maintain said slips set in gripping contact with the well pipe.

7. The packer as set forth in claim 3, wherein said friction means is a friction spring connected to the upper end of said upper slip expander and extending into contact with said well pipe.

8. In a well packer, a sleeve having an open bore with an annular recess therein, a segmental ring formed of a plurality of arcuate segments mounted in said recess and extending into said bore, resilient means surrounding said ring and urging said segments into said bore to form the complete ring, a tubing extending through said sleeve and said ring, a shoulder on said tubing, and co-acting means on said ring and said tubing to urge said segmental ring radially into said recess against the action of said resilient means upon rotation of said tubing relative to said ring and without longitudinal movement of said tubing relative to said ring during said rotation, said ring being expanded to provide an opening therethrough sufficiently large for said shoulder to pass freely through the bore of said sleeve.

9. A well packer, comprising gripping slips, a slip expander adapted to move said slips into gripping contact with a well pipe, said expander having a longitudinal bore therethrough, a well tubing extending longitudinally through said opening in said expander, a radial projection carried by said expander normally extending into the bore of said expander, said projection being expansible radially outwardly, a shoulder on said tubing adapted to engage said radial projection when said projection is in its normal position whereby longitudinal movement of said tubing effects a longitudinal movement of said expander to move said slips into gripping contact with said well pipe, coacting means on said shoulder and said projection for expanding said projection radially outwardly to provide a central opening in said projection through which said shoulder is longitudinally movable, whereby after the slips are set said tubing can be moved in the same longitudinal direction as for setting said slips.

10. The packer set forth in claim 9, wherein the bore of said radial projection is normally less than the external diameter of said shoulder, said bore being expanded to a diameter substantially equal to the external diameter of said shoulder upon a coaction of said coacting means on said shoulder and said projection.

11. The packer set forth in claim 9, wherein said radial projection has a cam-track thereon, and said shoulder has a cam thereon which coacts with said radial projection upon a rotation of said shoulder relative to said projection to radially expand said projection to permit said shoulder to move longitudinally past said projection, whereby the tubing can continue to move in the same longitudinal direction as for setting said slips.

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