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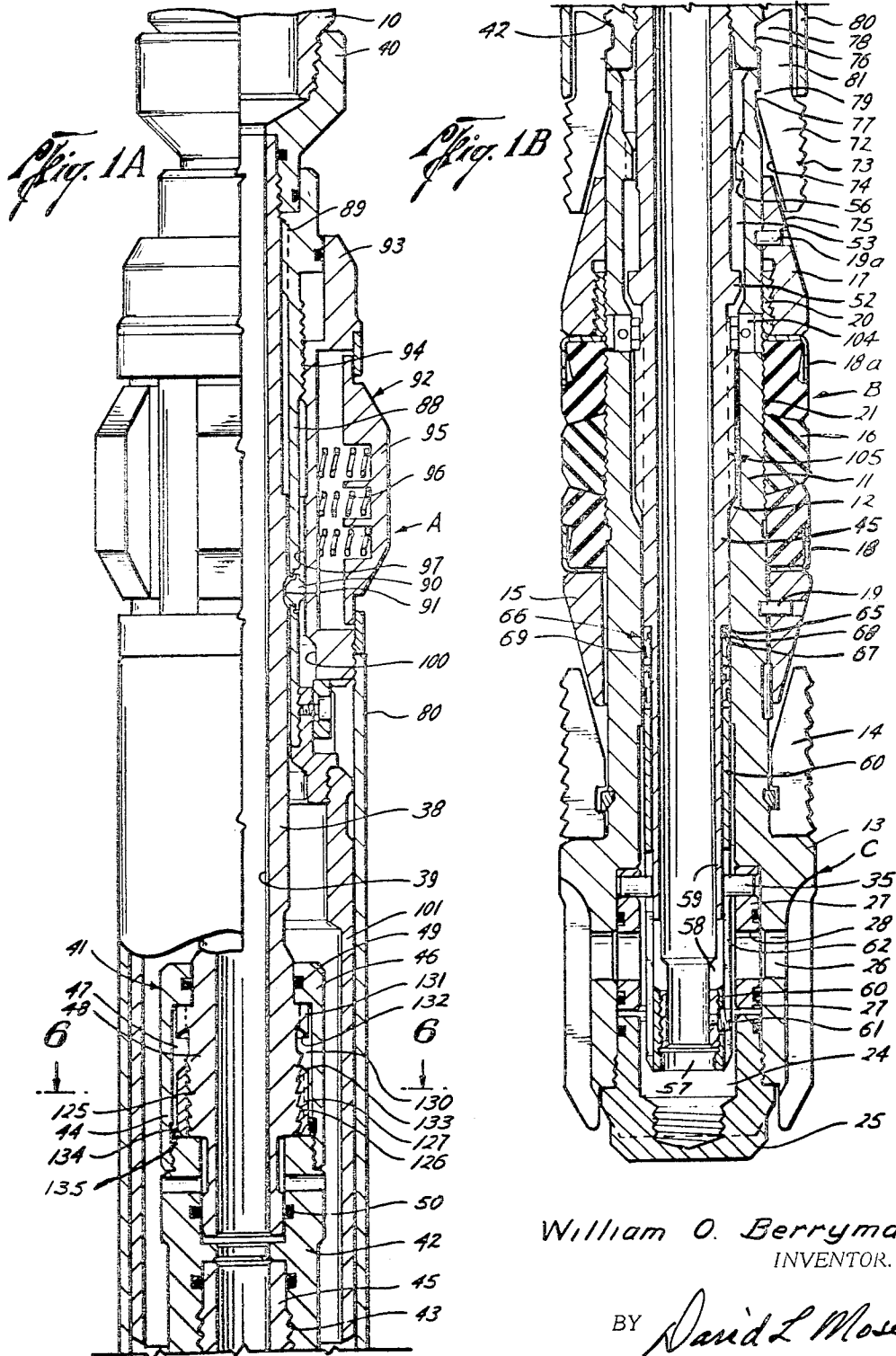
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3,483,921

WELL PACKER HAVING A SELECTIVELY POSITIONABLE VALVE MEANS

Original Filed Oct. 5, 1967

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

Fig. 2

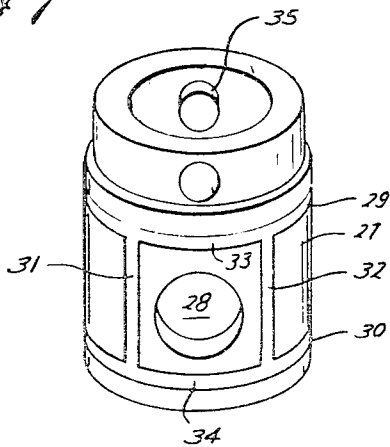


Fig. 3

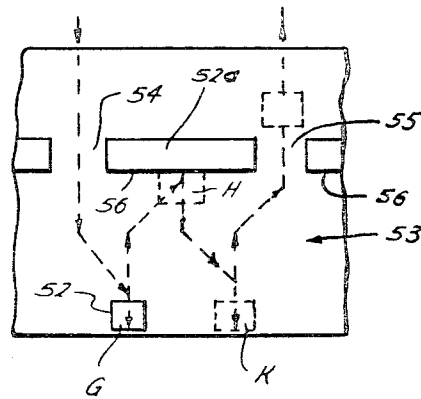


Fig. 4

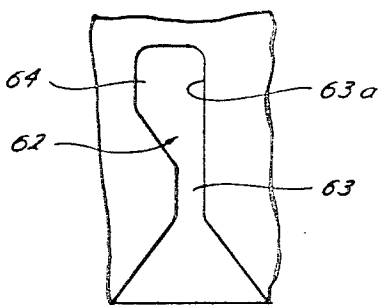


Fig. 5

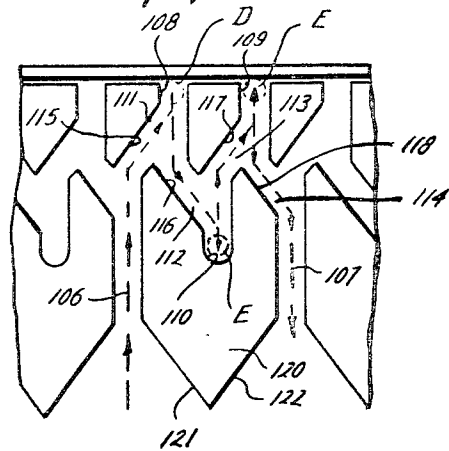
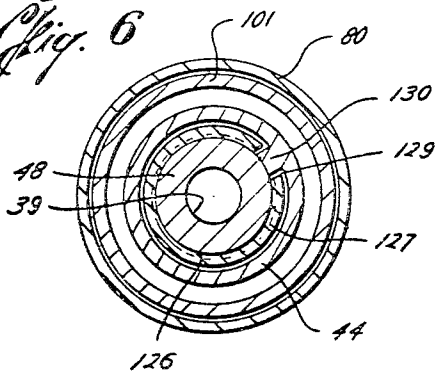


Fig. 6

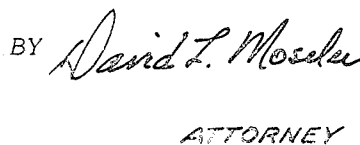


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3 Sheets-Sheet 3



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## WELL PACKER HAVING A SELECTIVELY POSITIONABLE VALVE MEANS

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Divided and this application Dec. 16, 1968, Ser. No. 802,705

Int. Cl. E21b 23/06, 33/128

U.S. Cl. 166—128

7 Claims

### ABSTRACT OF THE DISCLOSURE

The particular embodiment disclosed to illustrate the principles of the present invention is a well packer apparatus including a mandrel having a flow passage, rotary valve means for opening and closing the flow passage, and means to enable running the well packer into the well with the valve means in either open or closed condition. A safety coupling is also disclosed having a clutch member which can be engaged in response to rotation in one direction of the tubular string to permit unthreading of a joint by further rotation in the same direction.

This is a division of application Ser. No. 673,175, filed Oct. 5, 1967.

This invention relates generally to well tools used in well bores, and more specifically to a well packer apparatus adapted to be set in a well conduit and having a flow control valve which can be utilized to control fluid flow in the well conduit.

In one aspect, the present invention provides a new and improved well packer apparatus having a flow control valve and adapted to be lowered into a well bore on a tubular running string, the flow control valve being selectively positionable in open or closed condition. Thus on the one hand, the flow control valve can be closed to enable running-in under pressure or to permit testing of the tubular string for leakage during running. On the other hand, the flow control valve can be opened so that the string can fill with well fluids during running.

Accordingly, the present invention comprises a well packer having a mandrel with a flow passage, valve means for opening and closing the passage, and a tubular valve actuating member sealably slidable in the flow passage for conducting fluid and for moving the valve means between positions opening and closing the passage to fluid flow. Releasable locking means are provided which coacts with the actuating member and mandrel to relatively position the actuating means and mandrel such that the valve means can be positioned in open condition. Moreover, the valve means and actuating member are arranged for selective relative positioning in a manner whereby the valve means is positioned in closed condition. In either case, the actuating member can be manipulated to repetitively open and close the valve means upon release of the locking means.

In another aspect, the present invention provides a new and improved apparatus to enable selective uncoupling of tubular members in a well bore. Where one member is telescoped within another member which is anchored in a well bore and constructed and arranged to be relatively movable by longitudinal and rotational movement within the anchored member, the risk will be appreciated by those skilled in the art that sedimentation or debris may collect between the members and can lodge one member within the other. Should this occur, the members may become stuck in the well and it is desirable to be able to release the one member from the anchored member so that the one member can be removed from the well.

Accordingly, the present invention provides a releasable safety coupling between members which can be released in a simple manner should the members become lodged in the well. The safety coupling comprises a first member which can be rotated relative to a second member and means for rotatively coupling the members to one another. Clutch means is provided and arranged for movement between longitudinally spaced positions on said members for permitting relative rotation of said members in one position of said clutch means, and for securing said members together for co-rotation in another position of said clutch means. A third member can be threadedly coupled to said first member in a manner to be unscrewed by co-rotation of said first and second members relative to said third member. Thus it will be apparent that should said third member become stuck in a well bore, said first and second members can be uncoupled therefrom for withdrawal from the well.

The present invention has other aspects and advantages which will become more clearly apparent in connection with the following detailed description. Preferred embodiments are shown in the accompanying drawings, in which:

FIGURES 1A and 1B are longitudinal sectional views, with portions in side elevation, of an apparatus which embodies the principles of the present invention with parts in relative positions for lowering into a well bore, FIGURE 1B forming a lower continuation of FIGURE 1A;

FIGURE 2 is an isometric view of the rotary valve element;

FIGURE 3 is a fragmentary developed view of a coupling mechanism used with the present invention;

FIGURE 4 is a fragmentary developed view to illustrate the torque transmission structure between the extension and valve sleeve in accordance with the present invention;

FIGURE 5 is a fragmentary developed view of the extension slot used with the present invention;

FIGURE 6 is a cross section on line 6—6 of FIGURE 1A; and

FIGURES 7A and 7B are views similar to FIGURES 1A and 1B except with various parts of the apparatus in their cooperative positions when set in a well bore.

With initial reference to FIGURES 1A and 1B, apparatus which will illustrate the principles of the present invention includes a mechanical setting tool A and a well packer B having a valve system C. The setting tool A is utilized in setting the packer B in a well bore so that the packer B can function to pack-off the well bore. The valve system C controls fluid communication to the well bore below the packer B. The entire apparatus can be lowered into the well on a running-in string 10 of tubing or drill pipe which provides a fluid conduit extending to the top of the well, as well as a mechanical member which can be manipulated at the top of the well bore to effect operation of the setting tool A and the valve assembly C.

As shown in FIGURE 1B, the packer B has a central body or mandrel 11 having a bore 12 which provides a fluid passageway and further has a lower guide portion 13 which supports lower slips 14. The slips 14 can take any desired form, such as frangible, segmented, or integral expandable type slips. A lower expander cone 15 is arranged to shift the lower slips 14 outwardly and a conventional packing structure 16 surrounds the mandrel 11 between the lower expander cone and an upper expander cone 17. Typical anti-extrusion rings 18, 18a can confine the end portions of the packing 16, and shear pins 19, 19a or other suitable means can releasably couple the expander cones 15 and 17 to the mandrel 11 to control the relative motion sequence between parts in any desired manner. A conventional split ratchet ring 20 is

arranged between the upper expander cone 17 and the mandrel 11 and cooperates with external teeth 21 on the mandrel to trap compression loading in the packing structure 16 when the well packer B is set.

The lower guide portion 13 of the mandrel 11 is constituted as a valve body having a central flow passage 24 which is closed in a fluid tight manner at its lower end by a plug 25. Diametrically opposed side ports 26 in the valve body 13 are provided to communicate with the well annulus below the packing element 16. A valve sleeve 27 is located within the passage 24 adjacent to the side ports 26 and is arranged for movement between various rotational positions about the longitudinal axis of the mandrel 11 to control fluid flow from the passage 24 through the side ports 26. In one rotational position, lateral ports 28 in the valve sleeve 27 are aligned with the side ports 26 in the valve body 13 to permit fluid flow. In other rotational positions of the valve sleeve 27, the ports 26 and 28 are not in registry and the passage 24 is closed to fluid flow in either direction.

As shown in FIGURE 2, the valve sleeve 27 is generally tubular in form and has appropriate external grooves for a seal structure which can include upper and lower annular seals 29 and 30 which are connected by vertically extending seals 31 and 32 located on either side of the ports 28. With this type of seal configuration, the side seals 31 and 32 together with the seal portions 33 and 34 above and below the ports 28 prevent fluid flow through the ports, while the entirety of the upper and lower seals 29 and 30 precludes flow through the body ports 26. In the alternative, it will be appreciated that the seal arrangement could include face seals which surround the sleeve ports 28 to prevent flow in either direction through the sleeve ports, along with upper and lower annular sleeve seals above and below the face seals to prevent flow in either direction through the body ports 26. Radially inwardly extending pins 35 on the valve sleeve 27 provide a means for applying rotation force or torque to the valve sleeve 27 to rotate it between its various positions.

With particular reference to FIGURE 1A, the setting tool assembly A includes a central operating mandrel 38 having an open bore 39 and which can be connected to the lower end of the tubing string 10 by a threaded collar 40 or the like. The lower end portion of the operating mandrel 38 is provided with a swivel connection 41 to a tubular extension assembly which includes an enlarged sub 42 arranged to engage the upper end of the packer mandrel 11 and a tubular extension 45 which telescopes within the bore 12 of the packer mandrel. The sub 42 and extension 45 are threaded together at 43 in a fluid tight manner. A swivel sleeve 44 is coupled to the upper portion of the sub 42 and has an inwardly extending shoulder section 46 forming an annular space 47 which rotatably received an outwardly extending section 48 on the operating mandrel 38. Accordingly, it will be apparent that the extension 45 and sub 42 can turn or rotate relative to both the operating mandrel 38 and the tubing 10. Appropriate seals such as O-rings 49 and 50 can be provided, the lower seal 50 preventing fluid leakage from the bore of the mandrel 38 at the swivel connection 41, and the upper seal 49 protecting the swivel connection from ambient well fluids and debris.

The extension 45 is telescoped within the bore of the packer mandrel 11 and has arcuate coupling lugs 52 which can engage within an elongate internal mandrel recess 53. The recess 53, shown in an inside developed view in FIGURE 3, is open to the top of the packer mandrel 11 by vertically extending slots 54 and 55 located on circumferentially opposite sides of the bore of the mandrel. Thus, the coupling lugs 52 can be inserted into the recess 53 via the slots 54 and 55 and rotation of the extension 45 relative to the mandrel 11 will position the lugs 52 underneath mandrel shoulders 56 formed between the slots. With this relationship of parts, engagement of the coupling lugs 52 with the shoulders 56 will

limit upward movement of the extension 45 relative to the mandrel 11, and engagement of the sub 42 with the upper end surface of the mandrel 11 will limit downward movement. Accordingly, when the lugs 52 are underneath the shoulders 56, the extension 45 is coupled for limited reciprocating motion relative to the mandrel 11, and when the lugs are aligned with the slots 54, 55, the extension can be inserted within, or withdrawn from, the bore 12 of the mandrel 11.

The lower end of the extension 45 is open at 57 and side ports 58 are provided for fluid flow. When the extension 45 is telescoped within the packer mandrel 11 as shown in FIGURE 1B, the lower end portion 59 of the extension 45 is located within the valve sleeve 27. A torque sleeve 60 is threaded onto the lower end portion 59, and properly positioned thereon as by a screw 61 or the like and has upwardly extending side guide slots 62 which are flared and open at the lower end of the sleeve 60. The slots 62 receive the valve sleeve pins 35 so that rotation of the extension 45 will impart corresponding rotation to the valve sleeve 27. Each of the side slots 62, one of which is shown in developed view in FIGURE 4, has a longitudinal portion 63 of sufficient vertical extent whereby the extension 45 can be moved upwardly and downwardly a predetermined amount and still be co-rotatively coupled to the valve sleeve 27. Moreover, the slots 62 each have an upper circumferentially enlarged portion 64 to permit the valve sleeve 27 to be rotated to a certain extent relative to the extension 45 and in a direction which is opposite to its normal direction of rotation for purposes which will be hereafter explained. The upper end of the torque sleeve 60 can be made to terminate below an outwardly extending shoulder 65 on the extension 45 to provide an annular recess in which a seal structure 66 is located. The seal structure 66, which can take many forms, is shown as one or more metallic rings 67 having inner and outer grooves which receive suitable seals 68 and 69. Thus arranged, the seal structure 66 prevents fluid leakage between the packer mandrel 11 and the extension 45 when the latter is telescoped within the former.

Upper slip segments 72 are mounted at the upper end portion of the packer mandrel 11 adjacent to the upper expander cone 17. The segments 72 have upward facing wickers or teeth 73 on their outer peripheries, as well as inner inclined surfaces 74 which are engageable with outer inclined surfaces 75 on the expander cone 17 for shifting the segments outwardly into gripping engagement with well casing. The extension sub 42 and the packer mandrel 11 are respectively provided with annular grooves 76 and 77 and the slip segments 72 can have corresponding shoulders 78 and 79 which engage within the grooves to limit vertical movement of the slip segments in their retracted positions as well as initially coupling the extension sub 42 in fixed relation to the packer mandrel 11. A retainer sleeve 80, which forms a part of the setting tool A, extends downwardly in encompassing relation over upper portions 81 of the slip segments to retain them inwardly in retracted positions as long as the retainer sleeve occupies the relative position shown in FIGURES 1A and 1B. It will be appreciated that due to the engaging conditions of the shoulders 78 and 79 within the grooves 76 and 77, and to the holding action of the retainer sleeve 80, the slip segments 72 are quite rigidly held inwardly in retracted positions to prevent any likelihood of premature setting during lowering into a well.

Further to the setting tool assembly A, a control sleeve 88 (FIGURE 1A) is slidably and co-rotatively secured to the operating mandrel 38 by splines 89 or the like. The control sleeve 88 is initially locked in an upper position on the mandrel 38 by several latch lugs 90 which engage in a mandrel detent 91. A drag mechanism 92 including a tubular cage 93 is initially secured in a lower position on the control sleeve by coengaging right-hand threads 94. Typical drag blocks 95 are carried by the cage 93 and are urged outwardly by coil springs 96 to frictionally engage casing and resist motion in a conventional manner. An

inner surface 97 on the cage 93 holds the latch lugs 90 inwardly in engagement with the mandrel detent 19 while the parts are in the relative positions for lowering into a well bore.

The slip retainer sleeve 80 extends downwardly from the cage 93 to encompass the upper end portions 81 of the upper slip segments 72 as was previously described. When desired, it will be appreciated that right-hand rotation of the operating mandrel 38 by the running-in string 10 will rotate the control sleeve 88 relative to the drag mechanism 92, and, due to the interengagement of the threads 94, cause the drag mechanism and the retainer sleeve 80 to feed upwardly along the control sleeve 88, thereby removing the retainer sleeve from encompassing relation to the upper portions of the slips 72. Upward feeding of the drag mechanism 92 will also position an internal cage recess 100 opposite the latch lugs 90 and permit them to move outwardly and release from the mandrel detent 91, thereby permitting upward movement of the operating mandrel 38 relative to the control sleeve 88 and the drag mechanism 92.

A slip setting sleeve 101 extends downwardly from the control sleeve 88 and terminates in spaced relation to the upper portions 81 of the slips 72. When the retainer sleeve 80 is removed upwardly, the slips 72 are not restrained and can move outwardly to engage the well casing. Outward movement of the slips will, of course, remove the shoulders 78 and 79 from engagement with the mandrel and sub grooves 76 and 77 and thereby uncouple the packer mandrel 11 from the extension assembly. With this condition of parts, the extension 45 can telescope upwardly relative to the packer mandrel 11 until the coupling lugs 52 engage the recess shoulders 56. Then upward extension movement will shift the packer mandrel 11 upwardly relative to the setting sleeve 101, the latter part not moving upward by virtue of the engagement of the friction drag blocks 95 with the well casing. Accordingly, it will be appreciated that the slip segments 72 cannot move upwardly due to the holding action of the setting sleeve 101, and that the expander cone 17 can be moved upwardly and behind the slips 72 to shift them outwardly into firm anchoring engagement with the well casing. Once the upper slips 72 are set, the expander cone 17 cannot move any further upwardly and continued upward movement of the mandrel 11 will advance the lower cone toward the upper cone to expand the packing 16. The lower slips 14 are shifted over the lower expander cone 15 and outwardly into gripping engagement with the well casing. The ratchet ring 20 will lock the parts in expanded position in conventional manner.

In response to upward and downward motions of the extension 45 relative to the packer mandrel 11 occasioned by like motions imparted to the running-in string 10 once the packer B is set, the extension 45 is caused to rotate through various rotational positions due to interengagement of index pins 104, extending inwardly within the bore of the mandrel 11, with an extension slot system 105 to be described below. Rotation of the extension 45 within the packer mandrel 11 serves the primary function of selectively rotating the valve sleeve 27 between open and closed positions. As shown in plain view in FIGURE 5, the slot system 105 is formed about the periphery of extension 45 and includes vertically disposed entrance and exit slots 106 and 107 located on opposite sides of the extension. Inasmuch as the slot system is symmetrically arranged around the circumference of the extension 45, for purposes of brevity, only one-half of the total slot system structure will be described and it will be appreciated that each slot portion mentioned hereafter has an identical counterpart location on the opposite side of the extension. Between these entrance and exit slots 106 and 107 are upper pockets 108 and 109, the left upper pocket 108 being located, for example, about 50 degrees from entrance and exit slot 106 and the right upper pocket 109 being located, for

example, about 40 degrees from entrance and exit slot 107. An intermediate pocket 110 is located between the upper pockets 108 and 109 and can be located about 50 degrees from the left upper pocket 108. The entrance and exit slot 106 is connected to the upper pocket 108 by a channel 111 which extends upwardly and to the right, and the upper pocket 108 is connected to the intermediate pocket 110 by a channel 112 which extends downwardly and to the right. The intermediate pocket 110 is connected to the upper pocket 109 by a channel 113 which extends upwardly and to the right like channel 111, and the upper pocket 109 is connected to the entrance and exit slot 107 by a channel 114 which extends downwardly and to the right like channel 112. The intersections of the channels 111 and 112, and 113 and 114, are located somewhat to the left of the respective centers of the upper pockets 108 and 109 so that the index pin 104 is constrained to enter the channel 112 when leaving pocket 108, and channel 114 when leaving pocket 109. Moreover, the intersection of channels 112 and 113 is located somewhat to the left of the intermediate pocket 110 so that the index pin 104 will enter the channel 113 when leaving the pocket 110.

It will be apparent that the slot system 105 provides a guideway in which the pins 104 engage to cause a predetermined sequence of rotational movements of the extension 45 relative to the mandrel 11 in response to upward and downward motions of the extension. Thus, movement of the index pin 104 from entrance and exit slot 106 to the left upper pocket 108 will cause the extension 45 to rotate about 50 degrees in a clockwise direction (viewed from above) within the packer mandrel 11, such rotation being occasioned by engagement of the upper inclined wall 115 of channel 111 with the index pin. Movement of the index pin 104 from the upper pocket 108 to the pocket 110 will cause another 50 degrees rotation of the extension 45 when the lower inclined wall 116 of the channel 112 engages the index pin 104, and further movement from the pocket 110 to the right upper pocket 109 will cause an additional 40 degrees relative rotation when the index pin engages the upper inclined wall 117 of the channel 113. Finally, movement of the index pin 104 from the right upper pocket 109 down through the channel 114 with inclined lower wall 118 and out of the entrance and exit slot 107 will effect another 40 degrees relative rotation of the extension 45 for a total of 180 degrees. Each increment of extension rotation will cause a corresponding amount of rotation of the valve sleeve 27 by virtue of engagement of the valve sleeve pins 35 with the walls 63a of the slots 62 in the torque sleeve 60. Of course the direction of rotation of the extension 45 and the valve sleeve 27 is a function of the slot system 105 and, although the arrangement shown is preferred, it will be appreciated that the slot system 105 could be arranged in reverse manner so that the extension and valve will rotate in the left-hand direction.

The coupling lugs 52 on the extension 45 are vertically aligned relative to the entrance and exit slots 106 and 107, and the mandrel recess openings 54 and 55 (FIGURE 3) aligned relative to the index pins 104, such that when the index pins 104 engage within the entrance and exit slots, the coupling lugs 52 are vertically aligned with the mandrel recess openings and can readily pass into, and out of, the mandrel recess 53. When the index pins 104 engage the upper wall surfaces 118 of the channels 111 which are inclined upwardly and to the right, the extension 45 is caused to rotate or swivel in the clockwise direction to position the coupling lugs 52 underneath the mandrel shoulders 56. The lugs 52 will remain in positions underneath the mandrel shoulders 56 as long as the entrance and exit slots 106, 107 are not aligned with the index pins 104. The entrance and exit slots 106 and 107 are also circumferentially located relative to the torque sleeve slots 60 so that when the

index pins 104 are within the slots 106 and 107, and thus when the coupling lugs 52 can pass through the recess openings 54 and 55, the valve sleeve 27 is always in a closed rotational position. The bosses 120 formed between the entrance and exit slots 106 and 107 can have lower converging cam surfaces 121 and 122 to insure that the mandrel index pins 104 will enter one or the other of the slots 106 and 107 regardless of the initial rotational position of the extension 45 relative to the packer mandrel 11 when the extension is inserted. Moreover, the pins 104 can have flattened peripheral portions to reduce bearing loads as the pins work within the slot system 105.

Should it ever be desired to disconnect the setting tool A from the well packer B, leaving the extension 45 within the bore of the packer mandrel 11, for example, where the extension 45 has become lodged within the mandrel by sedimentation or junk in the well, a safety feature is provided for this purpose. With particular reference to FIGURES 1A and 6, the swivel section 48 has a reduced diameter portion 125 which is externally threaded with buttress type teeth 126 facing upwardly. A clutch ring 127 is cut through at 129 and is capable of sufficient lateral expansion and contraction for ratcheting action over the teeth 126 in an upward direction. A longitudinally extending key 130 on the swivel sleeve 44 engages within the cut 129 to co-rotatively and slidably secure the ring to the sleeve. The section 48 further has an upper outwardly extending annular shoulder 131 having an inwardly and upwardly inclined lower face 132 which is shaped in complimentary manner to the inclined upper end surface 133 of the clutch ring 127.

It will be appreciated that due to the configuration of the slot system 105 and its coaction with the indexing pins 104, the extension 45 will always rotate relative to operating mandrel 35 in the same direction, for example, with the slot arrangement shown in FIGURE 5, in the clockwise or right-hand direction viewed from above. Accordingly, the threads 126 and 128 on the section 125 and clutch ring 127 respectively can be formed as right-hand threads. Thus, clockwise rotation of the swivel sleeve 44 and the clutch ring 127 relative to the operating mandrel 38 will tend to cause downward feeding of the clutch ring. However, by virtue of engagement of the ring 127 with the sub shoulder 134 as shown in FIGURE 1A, the clutch ring will remain stationary and merely ratchet upwardly over the threads 126 in response to continued rotation of extension assembly relative to the operating mandrel during normal operation of the tool. However, if the operating mandrel 38 is rotated in a clockwise or right-hand rotation of the running-in string 10 at the top of the well bore, the clutch ring 127 will feed upwardly along the threads 126 until the inclined surfaces 132 and 133 engage, thereby exerting inward force on the clutch ring and clutching the operating mandrel 38 to the swivel sleeve 44 since the clutch ring cannot ratchet downwardly along the threads 126. The clutch ring 127 can also have a lower annular shoulder 134 which is sized for snug engagement within the bore of the sleeve 44 when the ring is in its upper position to further hold the ring inwardly in gripping engagement with the threads 126. Thus, continued rotation in the same direction of the running-in string 10 will effect unscrewing of the threads 43 between the swivel sub 42 and the extension 45, which threads are formed as left-hand threads, so that the entire setting tool A except for the extension 45 can be withdrawn from the well.

#### OPERATION

In operation, the parts are assembled as shown in the drawings with the extension 45 telescoped within the packer mandrel 11. The slips 15 and 72 and the packing 16 are in normally retracted positions, the upper slips 72 being retained inwardly by the retainer sleeve 80. The

drag blocks 95 can slide along in frictional engagement with the well casing as the tool is lowered into a well bore to setting depth. If it is desired to lower the packer with the valve sleeve 27 in open conditions so that the running-in string 10 can fill with well fluid during lowering, the extension 45 is merely inserted into the packer mandrel 11 during assembly and the index pins 104 will probably index the extension until the pins are in the left upper pockets 108, or positions D, FIGURE 5. This rotational position of the extension 45 will properly align the sleeve and body ports 28 and 26 in registry with one another. The shoulders 78 and 79 on the respective upper slip segments 72 are engaged within the extension and mandrel grooves 76 and 77 so that the extension 45 cannot move longitudinally with respect to the mandrel 11. Thus the valve sleeve 27 will remain in open condition during lowering. On the other hand, if it is desired to run the tool in the well with the valve sleeve 27 in closed condition, the plug 25 at the lower end of the mandrel 11 can be conveniently removed to gain access to the valve sleeve 27 and the valve sleeve rotated relative to the extension 45 to position the pins 35 within the enlarged slot portions 64 on the torque sleeve 60. This will orient the valve sleeve 27 in a rotationally closed position, which enables tubing testing by pressurizing the string during lowering, as well as running the packer into the well under pressure. Inasmuch as the valve sleeve 27 is always rotated in the same direction by the extension 45, the enlarged portions 64 have no effect on the operation of the valve sleeve 27 after the well packer is set. In other words, the straight sides 63a of the longitudinal slot portion 63 always engage the sleeve pins 35 to rotate the valve sleeve.

When it is desired to set the packer B, the running-in string 10 is first rotated a number of turns to the right. Since the drag mechanism 92 cannot rotate due to engagement of the drag blocks 95 with the casing, the control sleeve 88 will be rotated relative to the drag mechanism 92 with resultant upward feeding of the retainer sleeve 80 out of encompassing relation to the upper portions 81 of the upper slips 72. In actuality, the entire apparatus in the well except for the drag mechanism 92 and retainer sleeve 80 will be rotated by the running-in string 10. When the retainer sleeve 80 moves sufficiently upwardly, the slips 77 are free to move outwardly and the lower end of the setting sleeve 101 is cleared for engagement with upper end surfaces of the slips 72. The cage recess 100 is now positioned adjacent to the latch lugs 90 so that the lugs can move outwardly and release from the mandrel detent 91. The operating mandrel 38 is thus free to be moved upwardly relative to the control sleeve 88, the drag mechanism 92 and the setting sleeve 101.

The running-in string 10 is then elevated to set the packer B. When the slips 72 are released, as previously described, the extension 45 can move upwardly to a limited extent relative to the packer mandrel 11. As this relative movement occurs, the extension 45 is rotated as the index pins 104 move within the intermediate pockets 110, or positions E, FIGURE 5. This rotation of the extension also positions the coupling lugs 52 underneath and in engagement with the mandrel recess shoulders 56, the lugs moving from positions G to positions H as shown in FIGURE 3. If the valve is initially open, rotation of the extension 45 will also cause corresponding rotation of the valve sleeve 27 to closed position. On the other hand, if the valve sleeve 27 is initially closed during lowering, rotation of the extension 45 will have no effect on the valve sleeve because the enlarged slot portions 64 in the torque sleeve 60 will permit this extension rotation to occur without imparting corresponding rotation to the valve sleeve. Thus, the valve sleeve 27 will remain in closed position.

Inasmuch as the coupling lugs 52 are moved into engagement with the mandrel shoulders 56, continued upward movement of the extension 45 will elevate the

packer mandrel 11, and thus the upper expander cone 17, toward the lower end surface of the setting sleeve 101. The slips 72 will thus be shifted outwardly into gripping engagement with the casing, the holding force of the drag blocks 95 being transmitted through the cage 93, threads 94, control sleeve 88 to the setting sleeve 101 to prevent its upward movement. The slips 72 will accordingly be held against upward movement by the setting sleeve 101 and sufficient upward movement of the packer mandrel 11 will bring the expander core 17 behind the slips 72 to shift them outwardly into gripping engagement with the casing as shown in FIGURE 7B. When the upper slips 72 grip the casing, the upper expander cone 17 cannot move any further upwardly, and continued upward movement of the packer mandrel 11 will cause expansion of the packing element 16 and then shifting of the lower slips 14 over the lower expander cone 15. The external body teeth 21 will ratchet through the ratchet ring 20 and the ring will trap the mandrel 11 in the highest position to which it is moved. Accordingly, the packing and slips are locked in expanded positions and when a predetermined upward strain is taken on the running-in string, the packer B will be firmly set.

After thus setting the packer B, the weight of the running-in string 10 is slackened off. This will occasion downward movement of the extension 45 within the packer mandrel 11 with consequent rotation of the extension and the valve sleeve 27 until the index pins 104 are within the right upper pockets 109 of the slot system, positions E in FIGURE 5. The valve sleeve 27 is still in one of its closed rotational positions. Accordingly, the running-in string 10 is closed-off at its lower end and can be pressure tested for leakage at this time. The weight of the running-in string 10 can be conveniently imposed upon the packer B so that pressurizing the string 10 will not cause the extension as to be lifted upwardly by the pressure. The feature of being able to impose tubing weight on the tool when testing tubing is an important advantage over packers of this type having reciprocating sleeve valves because the imposition of tubing weight may open the valve systems of these packers.

After such testing, the running-in string 10 is simply picked up at the surface to disengage the extension 45 from within the bore of the packer mandrel 11. As the extension 45 is moved upwardly, the index pins 104 will cause the extension and the valve sleeve 27 to rotate again as the index pins move within the entrance and exit slots 107. The valve sleeve 27 is still closed. In this relative rotational position of parts the coupling lugs 52 are moved from positions K, FIGURE 3, into vertical alignment with the mandrel recess openings 54, 55. Accordingly, the extension 45 is conditioned to be withdrawn from the bore of the packer mandrel 11. It will be noted that whenever the extension 45 is withdrawn, the valve sleeve 27 is always left in a closed rotational position, whereby the well packer B completely bridges the well bore to prevent fluid flow in either longitudinal direction.

To perform a pressure operations such as squeeze cementing, the extension 45 is reinserted within the bore 12 of the packer mandrel 11 by downward movement of the running-in string 10. Regardless of the initial random rotational position of the extension 45, the bosses 120 and the lower cam surfaces 121 and 122 will cooperate with the index pins 104 to properly orient the extension 45 such that the index pins are vertically aligned within the entrance and exit slots 106 and 107. With the slots 106 and 107 thus aligned, the coupling lugs 52 are also aligned with the mandrel recess openings 54, 55, and the side slots 62 in the valve torque sleeve 60 are properly positioned with respect to the valve sleeve pins 35 so that the lower end portion 59 of the extension can be lowered inside the valve sleeve 27. When the extension 45 has moved sufficiently downwardly within the bore

of the packer mandrel 11, the index pins 104 will engage the upper inclined surfaces 115 of the channels 111 and cause the extension and the valve sleeve 27 to rotate during further downward movement until the index pins are within the left upper pockets 108. As this rotation occurs, the valve sleeve ports 28 will become radially aligned with the valve body ports 26 to open the valve. The coupling lugs 52 are also rotated to positions within the mandrel recess 53 such that the lugs are underneath the recess shoulders 56. With the valve open, cement slurry can be displaced through the running-in string 10 and out into the well bore below the packer.

When sufficient displacement has occurred and it is desired to trap the squeeze, e.g., to retain the cement slurry at developed pressures below the packer B, the valve sleeve 27 can be moved to a rotationally closed position by simply picking the running-in string 10 upwardly to index the extension 45 until the index pins 104 are within the intermediate pockets 110, thereby rotating the valve sleeve 27 to closed position. The coupling lugs 52 will engage the mandrel shoulders 56 to positively prevent separation of the extension 45 from the mandrel 11, thereby enabling complete control of tubing and annulus pressures. Thus it will be appreciated that adequate annulus pressures can be maintained to prevent dumping cement into well bore when the extension 45 is purposely disengaged. The extension 45 can be withdrawn from the packer mandrel 11, leaving the valve sleeve 27 in closed position, by imparting a pair of vertical motions to the running-in string 10, one downward, and one upward. The corresponding reciprocation of the extension 45 will cause the index pins 104 to traverse the channels 113 and 114 and into the entrance and exit slots 106, whereupon the coupling lugs 52 are vertically aligned with the mandrel recess openings 54, 55 and the extension 45 is free for upward movement, leaving the valve sleeve 27 in closed condition. The setting tool A can be withdrawn from the well, or conventional circulation or reverse circulation procedures can be undertaken. Of course, the extension 45 can be reinserted within the packer mandrel 11 for further operations as desired.

Although the packer B is disclosed as settable on the mechanical setting tool A, it will be appreciated that the packer can be set by the various wireline or other setting tools which are conventional in the art. In case of wireline setting, of course other upper slips such as conventional frangible or solid type slips, can be utilized, and the plug 25 at the lower end of the mandrel 11 is provided with internal threads for connecting to the tension member of the setting tool. Thus it will be apparent that apparatus of the present invention is quite versatile and can be used for a variety of down hole applications as will be appreciated by those skilled in this art.

Since certain changes or modifications may be made in the present invention by those skilled in the art without departing from the concepts involved, it is intended that the appended claims cover all such changes or modifications falling within the true spirit and scope of the present invention.

I claim:

1. A well tool comprising: a valve body having a flow passage; valve means in said valve body arranged for rotational movements between positions opening and closing said flow passage; valve actuating means extendible into said flow passage; normally engageable means for releasably coupling said actuating means to said valve means to enable rotation of said valve means by said actuating means in one rotational direction; and means for disengaging said normally engageable means to permit selective rotation of said valve means relative to said actuating means in the opposite rotational direction.

2. The well tool of claim 1 wherein said normally engageable means includes recess means in said actuat-

11

ing means, and drive means for said valve means extending into said recess means.

3. The well tool of claim 2 wherein said disengaging means comprises an enlargement of said recess means in which said drive means can be positioned.

4. In combination with a well packer apparatus having a mandrel providing a flow passage and valve means mounted for rotational movement in said flow passage, valve actuating means sealingly slidable in said flow passage and movable longitudinally and rotationally therein, means for translating longitudinal movement of said actuating means to rotational movement thereof, means for coupling said actuating means and valve means whereby rotational movement of said actuating means imparts corresponding rotational movement to said valve means, and releasable means for locking said actuating means to said mandrel in a longitudinal position of said actuating means corresponding to a selected rotational position of said valve means with respect to said flow passage.

5. The combination of claim 4 wherein said releasable means includes normally retracted means moveable between retracted and expanded positions relative to said mandrel and engageable with said actuating means and mandrel when in said retracted positions.

6. The combination of claim 4 wherein said releasable means includes normally retracted slip means moveable

12

between retracted and expanded positions relative to said mandrel and engageable with said actuating means and mandrel when in said retracted positions, and wherein said combination further includes means for retaining said normally retracted means slip in retracted positions, and means for disabling said retaining means.

7. The combination of claim 4 wherein said coupling means includes means to enable rotation of said valve means relative to said actuating means to another selected rotational position of said valve means with respect to said flow passage.

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166—124, 226