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3,115,189

SUBSURFACE WELL TOOL CONTROL MECHANISM

Filed Aug. 17, 1959

2 Sheets-Sheet 1

Fig. 1.

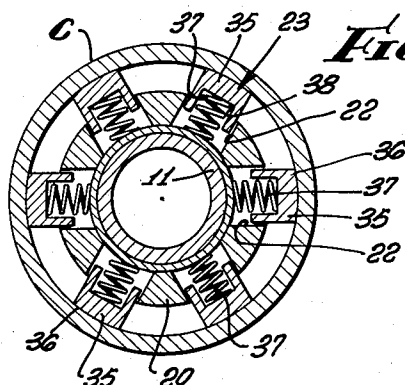
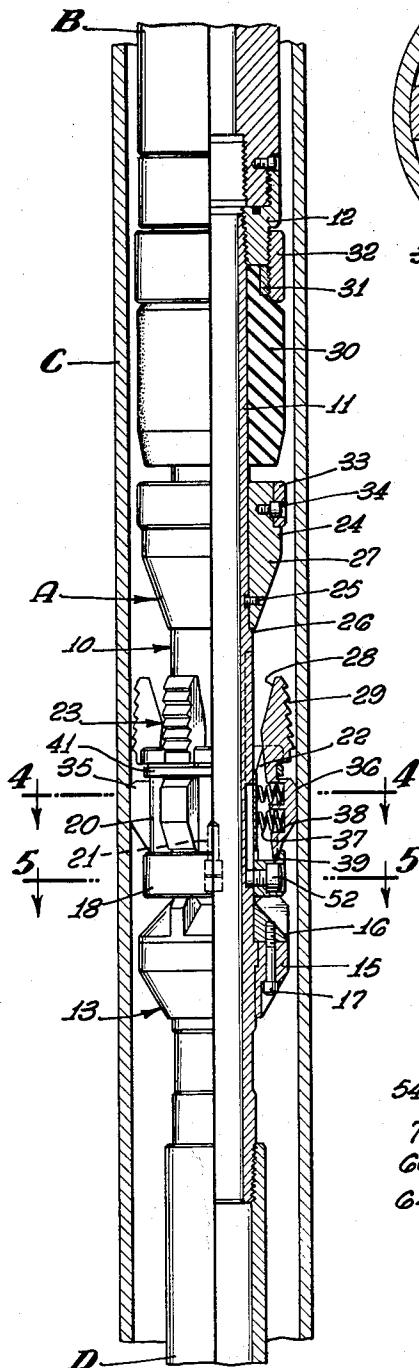


Fig. 4.

Fig. 5.

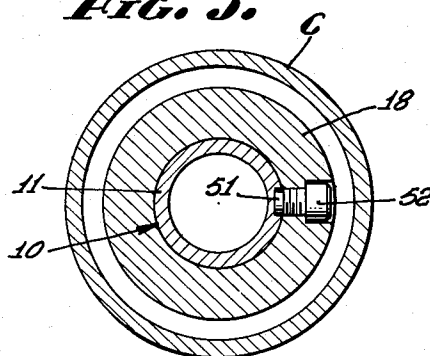
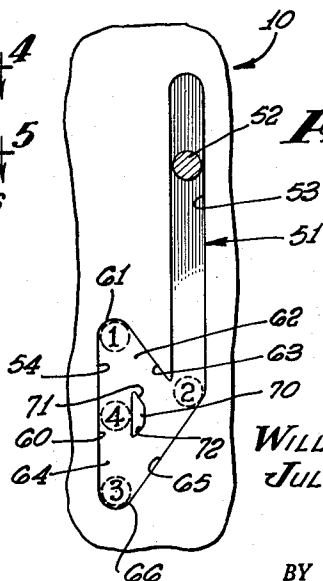


Fig. 6.



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2 Sheets-Sheet 2

FIG. 2.

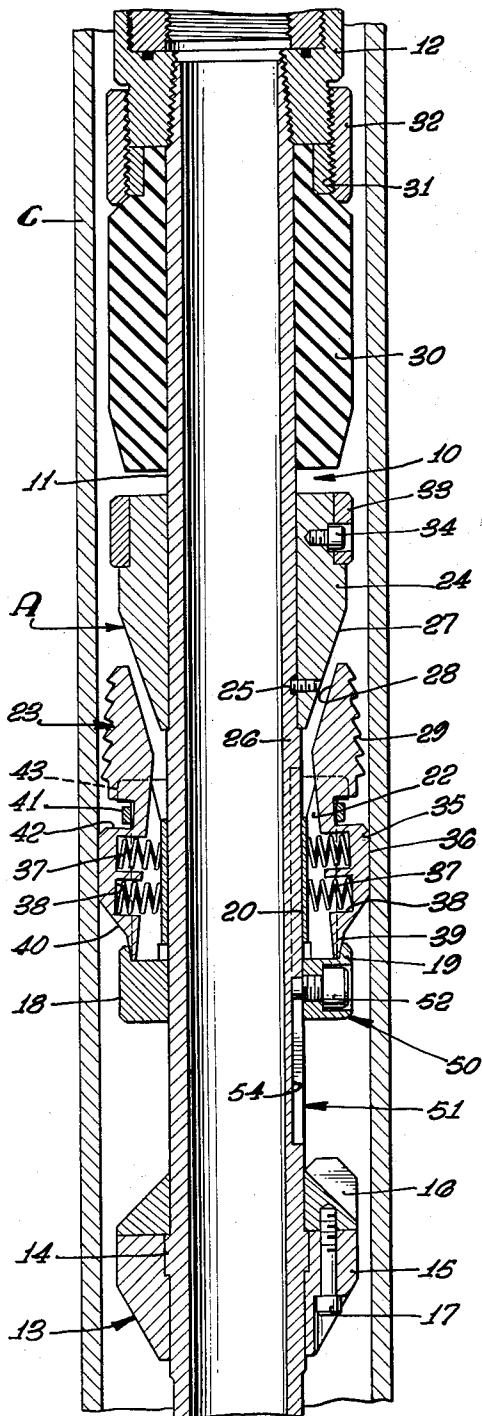
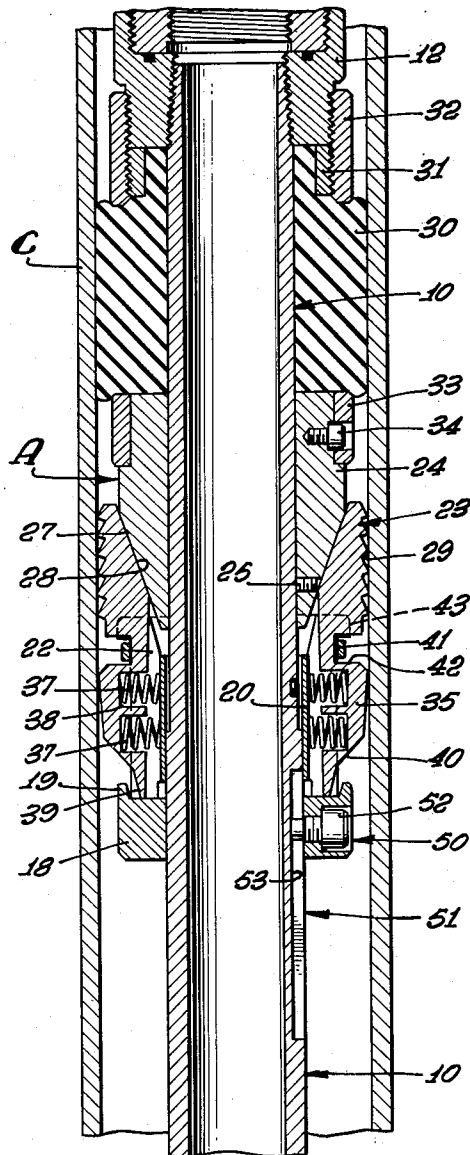


FIG. 3.



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3,115,189 SUBSURFACE WELL TOOL CONTROL MECHANISM

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9 Claims. (Cl. 166—240)

The present invention relates to subsurface well devices, and more particularly to devices embodying locking or control mechanisms for preventing relative movement between parts of the devices until desired.

An object of the present invention is to provide a subsurface well tool embodying a control mechanism or device that precludes inadvertent release of the control mechanism from its condition locking tool parts in a desired relation.

Another object of the invention is to provide a subsurface well tool embodying a control device that can only be released by a combination of rotation and longitudinal or vertical movement of the tubular string, by means of which the tool is lowered in a well bore, thereby preventing undesired tool operation such as might result from vertical movement of the tubular string alone, or rotary movement of the tubular string alone.

A further object of the invention is to provide a subsurface well tool embodying a control device capable of being placed selectively in a released or locked condition, replacement of the device in a locked condition resulting automatically from vertical or longitudinal movement of the running-in string on which the tool is lowered in a well bore, no rotary motion of the running-in string being required.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

FIGURE 1 is a combined longitudinal sectional and side elevational view of a subsurface well tool with certain of its parts locked in the position they occupy during longitudinal movement of the well tool through a well casing disposed in a well bore;

FIG. 2 is an enlarged longitudinal section through the well tool illustrated in FIG. 1, showing certain parts moved with respect to each other, but the tool still in its locked condition;

FIG. 3 is a view similar to FIG. 2 with the tool in its unlocked condition, whereby it can be operated or set in the well casing;

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

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

FIG. 6 is an enlarged side elevational view of the control slot forming part of the locking mechanism or control device embodied in the well tool.

The invention is illustrated in the drawings as being applied to a well packer A adapted to be secured to the lower end of another tool B, such as an anchor, or a tubular string, such as tubing or drill pipe extending to the top of the well bore. This combination is lowered in a conduit string C, such as well casing, and is to be anchored therein in packed-off condition at any desired location. After having been anchored in packed-off condition in the

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well casing, the well tool A can be released therefrom and moved longitudinally in the well casing to any other desired location, or completely removed from the well casing.

The well packer A includes a main body 10 having a central, generally cylindrical portion 11 threadedly secured to an upper body portion or sub 12, which is, in turn adapted to be threaded onto the lower end of the tubular string B, or tubular portion of the upper tool. The lower portion of the tool body may be threadedly secured to a lower tubing D. The lower portion also has a stop or guide device 13 secured thereto. As specifically disclosed, the lower portion of the body has an external flange 14 engaged on its lower side by a lower guide 15 and on its upper side by an upper guide 16, these two guides being secured together and clamped against the flange 14 by a plurality of longitudinally extending screws 17.

A slip stop and lock ring 18 is adapted to rest on the upper end of the guide 13, this ring having an upwardly extending rim portion 19 and receiving the lower portion of a slip sleeve 20 extending upwardly from the ring, the sleeve and ring being secured together by a plurality of longitudinally extending screws 21. The sleeve is provided with a plurality of circumferentially spaced longitudinally extending grooves 22 in which the lower portions of casing engaging slips 23 are contained. These slips extend upwardly from the sleeve and are cooperable with an expander 24 which is slidable relatively on the body 10, but which may preferably be initially secured thereto by one or more shear screws 25, the lower end of the expander being engageable with an upwardly facing stop shoulder 26 on the body to limit the extent of downward movement of the expander on the body. The expander is adapted to expand the slips 23 outwardly into engagement with the wall of the well casing C by reason of the cooperation between the downwardly and inwardly tapering external surface 27 on the expander and inner tapered surfaces 28 on the upper portions of the slips which are engaged by the external surface.

Downward movement of the expander 24 within the slips 23 will wedge the tapered surface of the expander into the slips and urge the latter laterally outwardly to imbed the external wickers 29 on the slips into the wall of the well casing. In the form of device specifically shown in the drawings, the slips are designed to anchor the tool against downward movement in the well casing, for which reason the wickers 29 face in a downward direction. Of course, the apparatus is also usable in an inverted position, in which event the slips 23 would anchor the tool to the casing against upward movement therewithin.

The upper end of the expander 24 is engageable with the lower portion of a packing structure 30, which may be in the form of a rubber or rubber-like packing sleeve surrounding the body. The upper portion of the packing sleeve is moulded to a threaded ring 31 that is threadedly attached to a connecting ring 32 threadedly mounted on the exterior of the upper body portion 12, and serving to secure the packing structure 30 to the body. The connecting ring 32 may also serve as a gauge ring to minimize the annular clearance space between the well tool A and the well casing C through which the rubber packing material may tend to squeeze or be extruded during use of the tool. In a similar fashion, the upper portion of the expander 24 may have a lower gauge ring 33 attached thereto, as by means of one or more screws 34, this lower gauge ring being contactable with the lower end of the rubber packing sleeve 30, which is also engaged by the upper end of the expander 24, the ring 33 reducing the clearance space between the tool A and the wall of the well casing C through which the rubber pack-

ing material may tend to squeeze under high pressure and/or temperature operating conditions.

The slips 23 are set upon downward movement of the expander 24 relative thereto. To secure such relative downward movement, retarding means are provided tending to resist longitudinal movement of the slips 23 in the well casing. As disclosed, the retarding device is formed on the lower portions of the slips themselves. The retarding devices include friction drag block portions 35 of the slip having outer faces 36 adapted to contact the wall of the well casing C. Frictional contact between the drag block portions 35 of the slips and the casing wall is secured by a plurality of helical compression springs 37 having their axes transverse to the axis of the body. One or a plurality of springs may be disposed in each slip groove 22, the inner portion of each spring engaging the base of the groove and its outer portion being located within a socket 38 in the slip adjacent its casing engaging or friction drag face 36.

The extent of lateral outward movement of each slip 23 is limited, there being a lower finger or leg portion 39 on each slip adapted to engage the rim 19 of the stop ring 18. Normally, when the tool is disposed within the well casing C these leg portions 39 are located inwardly by a substantial distance from the rim 19 of the stop ring. However, when the tool A is out of the well casing C, and in an unconfined condition, the springs 37 can urge the lower portions 39 of the slips outwardly to the extent limited by engagement of the leg portions 39 with the rim 19. When the tool is inserted in the well casing the upper end of the casing will engage the tapered surfaces 40 of the slips adjacent the foot portion 39, urging the slips 23 in an inward direction against the force of the springs 37.

Lateral outward movement of the slips is also limited by a retaining ring 41 encompassing the sleeve 20 and disposed in an external circumferential groove 42 formed in the intermediate portions of the slips 23 below their wickered surfaces 29 and above their drag portions 35. The upper end of this ring 41 is engaged by a transverse shoulder 43 extending outwardly from the upper end of the slip sleeve 20, the lower end of the ring 41 being adapted to engage the lower side of the slip grooves 42 for the purpose of pulling the slips 23 in a downward direction when the tool is being lowered in the well casing. The ring 41 also limits the extent of lateral outward movement of the slips under the influence of the springs 37, particularly when the tool A is unconfined and out of the hole, the base portions of the slip grooves 42 engaging the inner surface of the retaining ring 41.

Relative downward movement of the expander 24 within the slips 23 is prevented, until the latter are to be anchored against the well casing C at the desired setting point therewithin, by a suitable control mechanism or lock device 50. As disclosed, this lock device consists essentially of a J-type of slot 51 formed in the exterior of the body 10 of the tool and adapted to receive a control or lock pin 52 secured to the lower stop ring 18, as by being threaded thereinto. The lock slot has a longitudinal leg portion 53 and also a lock or foot portion 54 extending from the lower end of the leg portion. When the lock pin 52 is disposed in the lock or foot portion 54, sufficient relative movement between the body 10 and the slips 23 cannot occur for the purpose of causing the expander 24 to engage and shift the slips outwardly into anchoring engagement with the wall of the well casing. When the lock pin 52 is disposed in the longitudinal leg portion 53, the body 10 of the tool can be lowered to a sufficient extent with respect to the slips 23 as to move the expander 24 downward in the slips and rock the latter outwardly into anchoring engagement with the wall of the well casing.

During the location of the pin 52 in the foot portion 54 of the slot, downward movement of the body 10 will be transmitted through the pin 52 to the stop ring 18 and through the screws 21 to the slip sleeve 20, the sleeve

shoulder 43 engaging the retaining ring 41 which will engage the lower sides of the slip grooves 42 to move the slips 23 in a downward direction with the body 10. The expander 24 will also move downwardly with the body because of the presence of the shear screws 25. However, even in the absence of the shear screw or screws 25, the downward movement of the body 10 will be transmitted through the packing structure 30 to the expander 24 to shift the latter in a downward direction. Thus, sufficient relative longitudinal movement between the expander 24 and the slip structure 23 cannot occur when the lock or control pin 52 is in the foot portion 54 of the lock or control slot 51.

The slips 23 are capable of rocking or pivoting with respect to the expander 24 and the well casing C. It is to be noted that when the friction drag faces 36 of the slips are fully engaging the wall of the well casing, the inner tapered surfaces 28 of the slips are disposed at an angle to the companion tapered surface 27 on the expander 24, the tapered surfaces on the expander and slips diverging with respect to each other in a downward direction. Similarly, the wickered faces 29 of the slips are inclined to the wall of the well casing C, these faces and the wall diverging from each other in an upward direction, the angle of divergence being substantially the same as the angle of divergence between the expander surface 27 and the inner tapered slip surfaces 28. When the expander 24 is moved downwardly with respect to the slips 23, it rocks the latter about the upper end portions of the drag block 35, which serve as fulcrum points against the casing, urging the lower parts of the slips inwardly against the force of the springs 37, the expander surface 27 coming into full bearing engagement with the tapered slip surfaces 28, which places the wickered faces 29 of the slips substantially parallel to the wall of the well casing, whereby the wickered faces of the slips can be wedged along their entire length into the casing wall. When the expander 24 is moved relatively in an upward direction out of the slips 23, the springs 37 will rock the slips about their point of fulcrum contact with the well casing, urging the lower portions of the slips outwardly to cause the drag blocks 35 to fully engage the casing wall C, and swinging the upper wickered portions of the slips inwardly and completely out of engagement with the well casing.

In the running and operation of the tool in the well bore, the body 10 is elevated within the parts surrounding it, until the foot portion 54 of the slot structure 51 receives the lock pin 52, the body being turned sufficiently to the left so that the pin is disposed adjacent the vertical end wall 60 of the foot portion remote from the longitudinal leg portions 53. When in this condition, the parts occupy the position disclosed in either FIG. 1 or FIG. 2. During lowering of the tool in the well casing, the drag portions 35 of the slips will slide frictionally against the wall of the well casing, causing the lock pin 52 to occupy the position illustrated in FIG. 2 in which the pin is at the upper end 61 of the lock or foot portion 54. The slips 23 are caused to slide along the wall of the well casing during the descent of the tool therewithin.

When the location in the well casing is reached at which it is desired to set the tool in packed-off condition, the body 10 of the tool is appropriately manipulated, as more specifically described hereinbelow, to turn the slot portion 51 of the body relative to the lock pin 52 and place the latter in alignment with the longitudinal leg portion 53. Such relative motion can occur inasmuch as the drag block portions 35 of the slips are resisting turning of the entire slip structure, including the stop ring 18. The tubular string B and the body 10 of the tool connected thereto can now be lowered, the packing sleeve 30 and expander 24 moving downwardly with the body until the expander is shifted within the slips 23, its tapered surface 27 engaging the upper ends of the

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slips and urging them in a lateral outward direction, the slips rocking about the casing to move their wickered anchoring portions 29 into engagement with the wall of the casing, the lower portions 35, 39 of the slips being rocked inwardly against the force of the springs 37. The expander 24 moves downwardly until there is full engagement between its surface 27 and the slip tapered surfaces 28, the slips being shifted radially outward until the wickers 29 are engaged fully with the wall of the well casing C.

Further downward force imposed by the body 10 on the expander 24 will shear the screws 25 and permit the body 10 and packing structure 30 to move downwardly. The lower end of the packing sleeve 30 then engages the upper end of the expander 24, the upper body portion 12 moving downwardly toward the expander 24 to shorten the rubber packing sleeve 30 and expand it laterally outwardly into sealing engagement with the wall of the casing C, as well as into firm sealing engagement with the periphery of the body 10. During such downward movement of the body, the lock pin 52 can move relatively upwardly within the longitudinal leg portion 53 of the control slot.

The desired operation can now be performed in the well bore, and after it has been performed the apparatus is released merely by elevating the tubular string B and the body 10. The friction drag block portions 35 of the slips are still engaging the well casing C to resist upward movement of the slips 23. However, the body 10 is movable upwardly, the upper body portion 12 moving away from the expander 24 to permit the packing sleeve 30 to retract inherently to its initial position. The shoulder 26 on the body engages the lower end of the expander 24 and moves it upwardly out of the slips 23, the springs 37 then rocking the slips back to their initial position, in which the drag block portions 35 fully engage the wall of the well casing C, and the upper wickers or anchor portions 29 shift inwardly to their retracted positions. At this time, the lock pin 52 is located at the lower portion of the longitudinal leg 53 of the slot, permitting the body 10 to be turned to the left to relocate the pin in the lock or foot portion 54 of the slot. The apparatus A can now be elevated in the well casing and removed entirely therefrom if desired, or it can be lowered in the well casing to a new setting location, the disposition of the pin 52 in the lock or foot portion 54 of the slot preventing sufficient relative longitudinal movement between the expander 24 and slips 23 from occurring, to shift the latter outwardly into engagement with the wall of the well casing.

The J-slot 51 is specifically designed and arranged to preclude inadvertent movement of the lock pin 52 from the foot portion 54 of the slot into the longitudinal leg portion 53, and it is also designed such that the pin will move automatically from the longitudinal leg portion 53 into the foot portion 54 merely as a result of longitudinal movement, such as elevation of the body in the well casing. The lock or foot portion 54 of the slot is formed as an upper lock portion 62 extending upwardly from the lower end of the longitudinal leg portion 53. This upper lock slot portion 62 includes the end vertical side wall 60 of the foot portion and also a tapered wall 63 which is inclined in a downward direction toward the longitudinal leg portion of the slot. The tapered wall 63 and the side wall 60 meet at a corner 61 adapted to receive the lock pin 52.

The foot portion 54 also includes a lower lock portion 64 that is defined by the side wall 60 and also by a lower tapered wall 65 inclined upwardly toward the longitudinal leg portion 53, the lower tapered wall 65 and side wall 60 meeting at a lower corner 66 adapted to receive the lock pin 52. The upper tapered wall 63 and the lower tapered wall 65 make a sufficiently steep angle so that when either of them engages the lock pin 52 as a result

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of rotation of the body 10 of the tool, as to the right, the lock pin 52 will not slide or be cammed along the particular tapered wall toward the longitudinal leg portion 53. Instead, the drag portions 35 of the slips will slide around the inner wall of the well casing C. In other words, the drag device 35 will slide around the casing C before the pin 52 can slide relatively along either of the tapered walls 63, 65 as a result of rotation only of the body 10 of the tool.

In the event that the apparatus is being lowered in the well casing with the lock pin 52 occupying the position illustrated in FIG. 2, which is the No. 1 position shown diagrammatically in FIG. 6, any tendency for the body 10 of the tool to rotate to the right will merely be accompanied by dragging of the friction drag devices 35 around the wall of the well casing. The control device will not be placed in a released condition, in which the lock pin 52 moves relatively into alignment with the longitudinal leg portion 53 of the slot. The only manner of shifting the lock pin 52 into such longitudinal position is to turn the tubular string B and the body 10 of the tool to the right (in the specific tool illustrated) and at the same time elevate the body 10 of the tool, which will cause the upper tapered wall 63 to slide upwardly along the lock pin 52, until the latter is disposed in the No. 2 position illustrated diagrammatically in FIG. 6, whereupon the lowering of the tubular string B and the body 10 of the tool will be accompanied by the ability of the longitudinal leg portion 53 of the body to slide downwardly along the lock pin 52, allowing the expander 24 to be shifted behind the anchor portions 29 of the slips 23 and shift them into engagement with the wall of the well casing, allowing the full setting of the well packer A to occur in the manner described above.

In the event the parts of the apparatus are in their retracted positions and the tubular string B and body 10 of the tool have moved upwardly, such that the lock pin 52 is in the No. 3 position illustrated diagrammatically in FIG. 6, the body 10 of the tool cannot be turned to the right, to cam the lock pin to the No. 2 position shown in FIG. 6 merely as a result of such rotation, since the angle of the tapered wall 65 is sufficiently steep, as explained above, as to cause the drag device 35 to slide around the wall of the well casing B. With the lock pin in the No. 3 position as shown in FIG. 6, the only manner of placing the lock pin 52 in the released position in alignment with the longitudinal leg portion 53 of the slot is to exert a right-hand turning effort on the tubular string B and the body 10 of the tool, while at the same time lowering the tubular string and body of the tool, which will result in a downward sliding of the lower tapered wall 65 of the slot along the lock pin 52, until the lock pin is in the No. 2 position, whereupon downward movement of the body 10 of the tool relative to the lock pin 52 and the sleeve structure 18, 20 can occur to effect a setting of the well packer in packed-off condition within the well casing.

In the event that the lock pin 52 were to be located approximately midway between the No. 1 and No. 3 positions shown in FIG. 6, the inadvertent turning of the body 10 of the tool to the right could place the lock pin in the released position, designated as the No. 2 position in FIG. 6. To prevent this inadvertent action from occurring, an intermediate island or stop 70 is provided in the body in the foot portion 54 of the slot. This lateral projection is spaced from the side wall 60 of the foot a distance slightly greater than the diameter of the lock pin 52. It also has an upper tapered corner 71 which may be parallel to the upper tapered wall 63 and spaced therefrom a distance slightly greater than the diameter of the pin 52, as well as a lower tapered corner 72 substantially parallel to the lower tapered wall 65 and spaced therefrom a distance slightly greater than the diameter of the lock pin. The length of the island or stop 70 is

such that the lock pin 52, in clearing its upper portion as a result of right-hand turning of the body 10 will engage the upper tapered wall 63, and in clearing its lower end will engage the lower tapered wall 65 as a result of rotation of the body in the right-hand direction. Thus, if the pin 52 is between the No. 1 position and the upper end of the island 70, turning alone of the body 10, and without an accompanying upward motion of the body, will cause the pin to engage the tapered wall 63 and remain in engagement therewith. Similarly, in the event that the pin is between the No. 3 position and the lower end of the island 70, then turning of the body 10 to the right will cause the pin to engage the lower tapered wall 65 and remain in engagement therewith, in the absence of downward movement of the body 10 accompanying its right-hand rotation. If the lock pin 52 is between the side wall 60 and the island 70, such as designated position No. 4 in FIG. 6, then it is apparent that rotation only of the body 10 of the tool will cause the island 70 to engage the pin, preventing the latter from moving into alignment with the longitudinal leg portion 53.

Accordingly, it is evident that the pin 52 can only be moved into its released position as a result of a combination of rotation of the body 10 of the tool, as to the right, and its longitudinal movement. Such longitudinal movement must either be in an upward direction if the lock pin is in the No. 1 position, or in a downward direction if the lock pin is in the No. 3 position. With the specific tool disclosed, its setting can be effected by first setting down on the tubular string B and the body 10 of the tool which will insure the relative location of the lock pin in the No. 1 position whereupon the tubular string and the body of the tool are turned to the right while elevated slowly to cause the pin 52 to slide along the upper tapered wall 63 until the No. 2 position is reached, whereupon the body 10 of the tool can be lowered to effect setting of the well packer against the well casing.

If the lock pin is in the No. 3 position, or along the lower tapered wall 65 out of alignment with the longitudinal leg portion 53, the only manner of setting the tool is to lower the body 10 while turning it to the right. Inasmuch as the operator normally does not know just where the lock pin 52 is located, he will first lower the tool which will insure a relative shifting of the pin into the upper lock portion 61, whereupon he will elevate the body 10 while turning it to the right to move the pin relatively to the No. 2 position, after which setting of the well packer can occur.

In the event that the pin 52 happens to be between the island or stop 70 and the side wall 60 of the foot portion of the slot, then lowering of the tool will insure relative shifting of the lock pin to the No. 1 position, whereupon elevation of the body combined with its turning to the right will result in relative shifting of the lock pin to the No. 2 position, after which downward movement of the body 10 will effect setting of the well packer in the casing.

When the packer is to be released and the control mechanism placed in the locked condition, it is merely necessary to take an upward pull on the tubular string B and the body 10 of the tool. The longitudinal leg portion 53 of the slot will slide upwardly along the pin 52, which is prevented from moving by the engagement of the friction drag device 35 with the wall of the well casing. When the pin engages the lower tapered wall 65 its relatively steep angle will result in a rotation of the drag device 35 (the entire slip structure) around the wall of the well casing, the pin 52 shifting downwardly along the tapered wall 65 into the No. 3 position. A combination of rotation and longitudinal movement of the tubular string B and body 10 of the tool, as described above, is then essential to a relocation of the lock pin in its released position in alignment with the longitudinal leg portion 53 of the slot 51.

The inventors claim:

1. In a subsurface well tool: a body member adapted

to be lowered in a well bore on a running-in string; a companion member on said body member movable longitudinally with respect thereto; one of said members having a pin thereon; the other of said members having a control slot in which said pin is relatively movable, said control slot including a longitudinal slot adapted to receive said pin to permit relative longitudinal movement between said members, said control slot including a locking slot extending laterally from said longitudinal slot and merging therinto, said locking slot comprising upper and lower lock portions offset from said longitudinal slot, said upper lock portion having a tapered side wall inclined downwardly at a steep angle from the upper end of said upper lock portion toward and terminating at said longitudinal slot and said lower lock portion having a tapered side wall inclined upwardly at a steep angle from the lower end of said lower lock portion toward and terminating at said longitudinal slot, whereby said side walls converge towards each other in the direction of said longitudinal slot and define an opening for said pin between said locking slot and said longitudinal slot, one of said lock portions extending in the same direction as said longitudinal slot but being substantially shorter than said longitudinal slot; friction drag means secured to said companion member and frictionally engageable with the wall of the well bore to resist movement of said companion member therewithin; the inclinations of said tapered side walls being such that engagement between said pin and either of said tapered side walls will couple said members for rotation together and slide said drag means around the wall of the well bore.

2. In a subsurface well tool: a body member adapted to be lowered in a well bore on a running-in string; a companion member on said body member movable longitudinally with respect thereto; one of said members having a pin thereon; the other of said members having a control slot in which said pin is relatively movable, said control slot including a longitudinal slot adapted to receive said pin to permit relative longitudinal movement between said members, said control slot including a locking slot extending laterally from said longitudinal slot and merging therinto, said locking slot comprising upper and lower lock portions offset from said longitudinal slot, said upper lock portion having a tapered side wall inclined downwardly toward and terminating at said longitudinal slot and said lower lock portion having a tapered side wall inclined upwardly toward and terminating at said longitudinal slot, whereby said side walls converge towards each other in the direction of said longitudinal slot and define an opening for said pin between said locking slot and said longitudinal slot, one of said lock portions extending in the same direction as said longitudinal slot but being substantially shorter than said longitudinal slot; friction drag means secured to said companion member and frictionally engageable with the wall of the well bore to resist movement of said companion member therewithin; the inclinations of said tapered side walls being such that engagement between said pin and either of said side walls will couple said members for rotation together and slide said drag means around the wall of the well bore.

3. In a subsurface well tool: a body member adapted to be lowered in a well bore on a running-in string; a companion member on said body member movable longitudinally with respect thereto; one of said members having a pin thereon; the other of said members having a control slot in which said pin is relatively movable, said control slot including a longitudinal slot adapted to receive said pin to permit relative longitudinal movement between said members, said control slot including a locking slot extending laterally from said longitudinal slot and merging therinto, said locking slot comprising upper and lower lock portions offset from said longitudinal slot, said upper lock portion having a tapered side wall inclined downwardly toward and terminating at said longitudinal slot and said lower lock portion having a tapered side wall inclined upwardly toward and terminating at said longitudinal slot, whereby said side walls converge towards each other in the direction of said longitudinal slot and define an opening for said pin between said locking slot and said longitudinal slot, one of said lock portions extending in the same direction as said longitudinal slot but being substantially shorter than said longitudinal slot; friction drag means secured to said companion member and frictionally engageable with the wall of the well bore to resist movement of said companion member therewithin; the inclinations of said tapered side walls being such that engagement between said pin and either of said side walls will couple said members for rotation together and slide said drag means around the wall of the well bore.

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itudinal slot and said lower lock portion having a tapered side wall inclined upwardly toward and terminating at said longitudinal slot, whereby said side walls converge towards each other in the direction of said longitudinal slot and define an opening for said pin between said locking slot and said longitudinal slot, one of said lock portions extending in the same direction as said longitudinal slot but being substantially shorter than said longitudinal slot; said other of said members having a stop island in said locking slot between and spaced from said tapered side walls to allow relative combined rotary and longitudinal movement of said pin through the spaces between said tapered side walls and island and into said opening and into said longitudinal slot, said island being engageable with said pin to prevent relative shifting of said pin from said locking slot into said opening as a result of relative rotary motion only between said members.

4. In a subsurface well tool: a body member adapted to be lowered in a well bore on a running-in string; a companion member on said body member movable longitudinally with respect thereto; one of said members having a pin thereon; the other of said members having a control slot in which said pin is relatively movable, said control slot including a longitudinal slot adapted to receive said pin to permit relative longitudinal movement between said members, said control slot including a locking slot extending laterally from said longitudinal slot and merging therewith, said locking slot comprising upper and lower lock portions offset from said longitudinal slot, said upper lock portion having a tapered side wall inclined downwardly toward and terminating at said longitudinal slot and said lower lock portion having a tapered side wall inclined upwardly toward and terminating at said longitudinal slot, whereby said side walls converge towards each other in the direction of said longitudinal slot and define an opening for said pin between said locking slot and said longitudinal slot, one of said lock portions extending in the same direction as said longitudinal slot but being substantially shorter than said longitudinal slot; said other of said members having a stop island in said locking slot between and spaced from said tapered side walls to allow relative combined rotary and longitudinal movement of said pin through the spaces between said tapered side walls and island and into said opening and into said longitudinal slot, said island being engageable with said pin to prevent relative shifting of said pin from said locking slot into said opening as a result of relative rotary motion only between said members; friction drag means secured to said companion member and frictionally engageable with the wall of the well bore to resist movement of said companion member therewithin; the inclinations of said tapered side walls being such that engagement between said pin and either of said walls will couple said members for rotation together and slide said drag means around the wall of the well bore.

5. In a subsurface well tool: a body member adapted to be lowered in a well bore on a running-in string; a companion member on said body member movable longitudinally with respect thereto; one of said members having a pin thereon; the other of said members having a control slot in which said pin is relatively movable, said control slot including a longitudinal slot defined by spaced side walls and adapted to receive said pin to permit relative longitudinal movement between said members, said control slot including a locking slot extending laterally from said longitudinal slot and merging therewith, said locking slot comprising upper and lower lock portions offset from said longitudinal slot, said upper lock portion being defined by a longitudinal side wall and a tapered side wall spaced therefrom and inclined downwardly at a steep angle from the upper end of said upper lock portion toward and terminating at one of the side walls of said longitudinal slot, said lower lock portion being defined by said longitudinal side wall and a tapered side wall inclined upwardly at a steep angle from the lower end of said lower lock portion toward and termi-

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nating at the other of said side walls of said longitudinal slot, whereby said tapered side walls converge toward each other in the direction of said longitudinal slot and define an opening for said pin between said locking slot and said longitudinal slot, one of said lock portions extending in the same direction as said longitudinal slot but being substantially shorter than said longitudinal slot; friction drag means secured to said companion member and frictionally engageable with the wall of the well bore to resist movement of said companion member therewithin; the inclinations of said tapered side walls being such that engagement between said pin and either of said tapered side walls will couple said members for rotation together and slide said drag means around the wall of the well bore.

6. In a subsurface well tool: a body member adapted to be lowered in a well bore on a running-in string; a companion member on said body member movable longitudinally with respect thereto; one of said members having a pin thereon; the other of said members having a control slot in which said pin is relatively movable, said control slot including a longitudinal slot defined by spaced side walls and adapted to receive said pin to permit relative longitudinal movement between said members, said control slot including a locking slot extending laterally from said longitudinal slot and merging therewith, said locking slot comprising upper and lower lock portions offset from said longitudinal slot, said upper lock portion being defined by a longitudinal side wall and a tapered side wall spaced therefrom and inclined downwardly toward and terminating in one of the side walls of said longitudinal slot, said lower lock portion being defined by said longitudinal side wall and a tapered side wall inclined upwardly toward and terminating at the other of said side walls of said longitudinal slot, whereby said tapered side walls converge toward each other in the direction of said longitudinal slot and define an opening for said pin between said locking slot and said longitudinal slot, one of said lock portions extending in the same direction as said longitudinal slot but being substantially shorter than said longitudinal slot; friction drag means secured to said companion member and frictionally engageable with the wall of the well bore to resist movement of said companion member therewithin; the inclinations of said tapered side walls being such that engagement between said pin and either of said side walls will couple said members for rotation together and slide said drag means around the wall of the well bore.

7. In a subsurface well tool: a body member adapted to be lowered in a well bore on a running-in string; a companion member on said body member movable longitudinally with respect thereto; one of said members having a pin thereon; the other of said members having a control slot in which said pin is relatively movable, said control slot including a longitudinal slot defined by spaced side walls and adapted to receive said pin to permit relative longitudinal movement between said members, said control slot including a locking slot extending laterally from said longitudinal slot and merging therewith, said locking slot comprising upper and lower lock portions offset from said longitudinal slot, said upper lock portion being defined by a longitudinal side wall and a tapered side wall spaced therefrom and inclined downwardly toward and terminating in one of the side walls of said longitudinal slot, said lower lock portion being defined by said longitudinal side wall and a tapered side wall inclined upwardly toward and terminating at the other of said side walls of said longitudinal slot, whereby said tapered side walls converge toward each other in the direction of said longitudinal slot and define an opening for said pin between said locking slot and said longitudinal slot, one of said lock portions extending in the same direction as said longitudinal slot but being substantially shorter than said longitudinal slot; said other of said members having a stop island in said locking slot be-

tween and spaced from said longitudinal side wall and said tapered side walls to allow relative longitudinal movement of said pin between said longitudinal side wall and island and relative combined rotary and longitudinal movement of said pin between said tapered side walls and island into said opening and into said longitudinal slot, said island being engageable with said pin, when said pin is disposed between said longitudinal side wall and island, to prevent relative shifting of said pin from said locking slot into said opening as a result of relative rotary motion only between said members.

8. In a subsurface well tool: a body member adapted to be lowered in a well bore on a running-in string; a companion member on said body member movable longitudinally with respect thereto; one of said members having a pin thereon; the other of said members having a control slot in which said pin is relatively movable, said control slot including a longitudinal slot defined by spaced side walls and adapted to receive said pin to permit relative longitudinal movement between said members, said control slot including a locking slot extending laterally from said longitudinal slot and merging therewith, said locking slot comprising upper and lower lock portions offset from said longitudinal slot, said upper lock portion being defined by a longitudinal side wall and a tapered side wall spaced therefrom and inclined downwardly toward and terminating in one of the side walls of said longitudinal slot, said lower lock portion being defined by said longitudinal side wall and a tapered side wall inclined upwardly toward and terminating at the other of said side walls of said longitudinal slot, whereby said tapered side walls converge toward each other in the direction of said longitudinal slot and define an opening for said pin between said locking slot and said longitudinal slot, one of said lock portions extending in the same direction as said longitudinal slot but being substantially shorter than said longitudinal slot; said other of said members having a stop island in said locking slot between and spaced from said longitudinal side wall and said tapered side walls to allow relative longitudinal movement of said pin between said longitudinal side wall and island and relative combined rotary and longitudinal movement of said pin between said tapered side walls and island into said opening and into said longitudinal slot, said island being engageable with said pin, when said pin is disposed between said longitudinal side wall and island, to prevent relative shifting of said pin from said locking slot into said opening as a result of relative rotary motion only between said members; friction drag means secured to said companion member and frictionally engageable with the wall of the well bore to resist movement of said companion member therewithin; the inclinations of said tapered side walls being such that engagement between said pin and either of said tapered side walls will couple said members for rotation together and slide said drag means around the wall of the well bore.

9. In a subsurface well tool: a body member adapted

to be lowered in a well bore on a running-in string; a companion member on said body member movable longitudinally with respect thereto; one of said members having a pin thereon; the other of said members having a control slot in which said pin is relatively movable, said control slot including a longitudinal slot adapted to receive said pin to permit relative longitudinal movement between said members, said control slot including a locking slot extending laterally from said longitudinal slot and merging therewith, said locking slot comprising upper and lower lock portions offset from said longitudinal slot, said upper lock portion having a tapered side wall inclined downwardly at a steep angle from the upper end of said upper lock portion toward and terminating at said longitudinal slot and said lower lock portion having a tapered side wall inclined upwardly at a steep angle from the lower end of said lower lock portion toward and terminating at said longitudinal slot, whereby said tapered side walls converge toward each other in the direction of said longitudinal slot and define an opening for said pin between said locking slot and said longitudinal slot, one of said lock portions extending in the same direction as said longitudinal slot but being substantially shorter than said longitudinal slot; said other of said members having a stop island in said locking slot between and spaced from said tapered side walls to allow relative combined rotary and longitudinal movement of said pin through the spaces between said tapered side walls and island and into said opening and into said longitudinal slot, said island being engageable with said pin to prevent relative shifting of said pin from said locking slot into said opening as a result of relative rotary motion only between said members; friction drag means secured to said companion member and frictionally engageable with the wall of the well bore to resist movement of said companion member therewithin; the inclinations of said tapered side walls being such that engagement between said pin and either of said side walls will couple said members for rotation together and slide said drag means around the wall of the well bore.

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