April 7, 1953 R. C. BAKER ET AL 2,633,917

REMOVABLE SUBSURFACE WELL TOOL

Filed Sept. 13, 1948 4 Sheets-Sheet 1

Fig. 1.

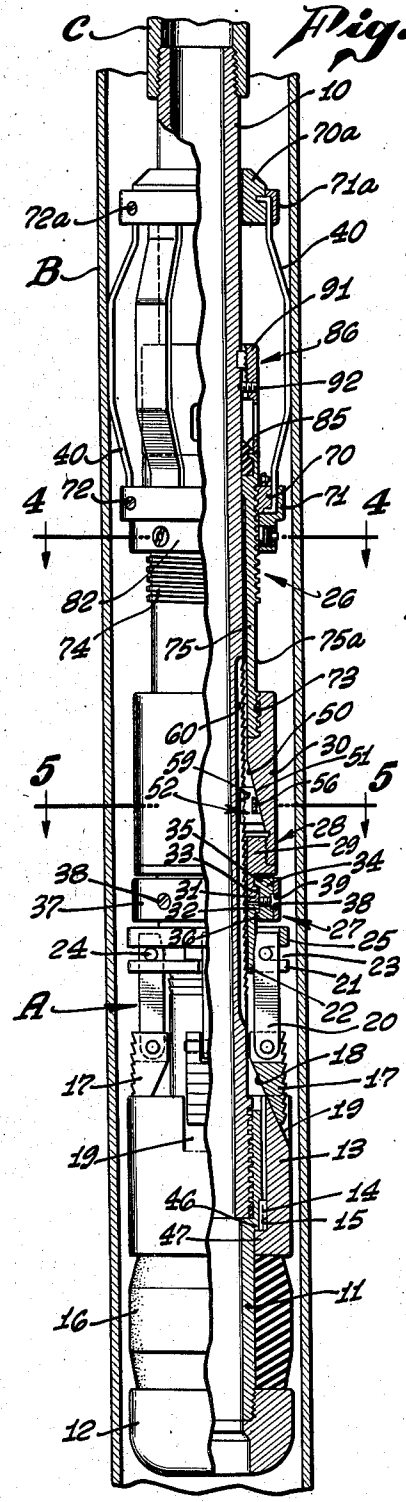
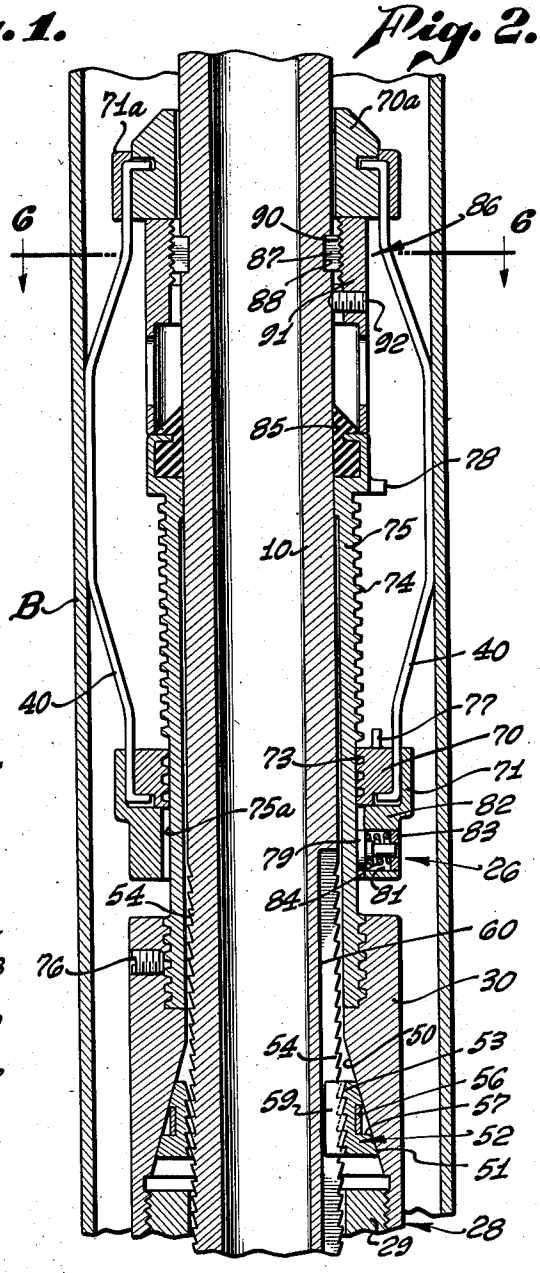


Fig. 2.



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Filed Sept. 13, 1948 4 Sheets-Sheet 2

Fig. 3.

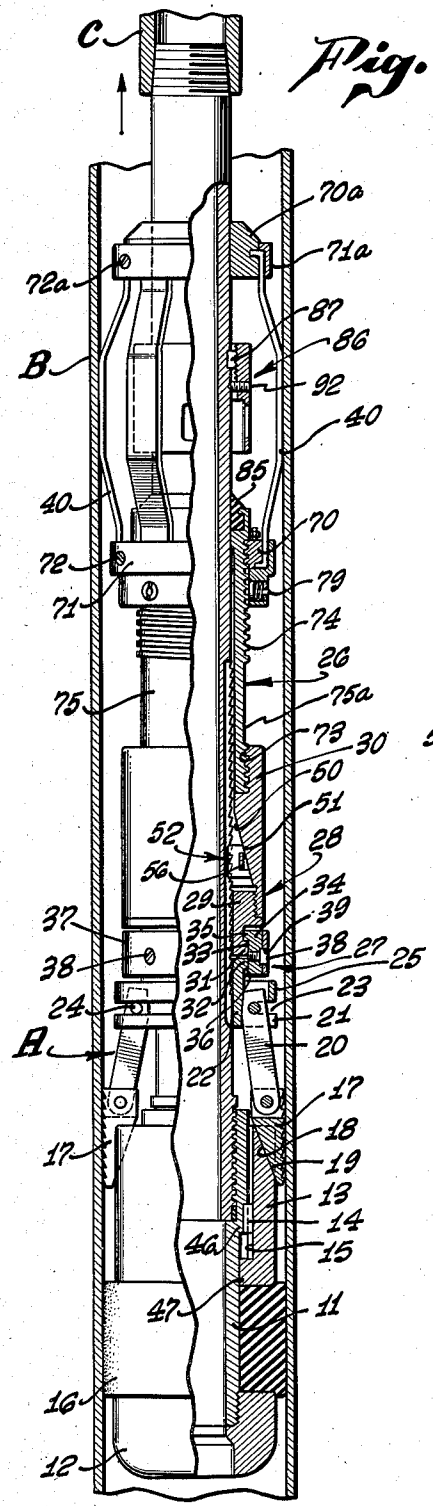


Fig. 4.

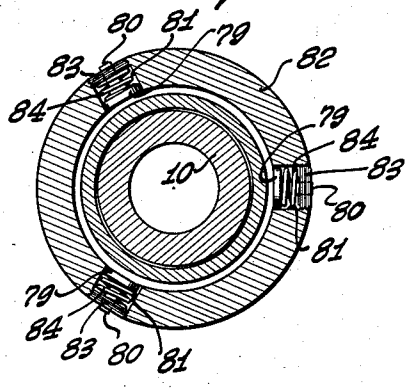


Fig. 5.

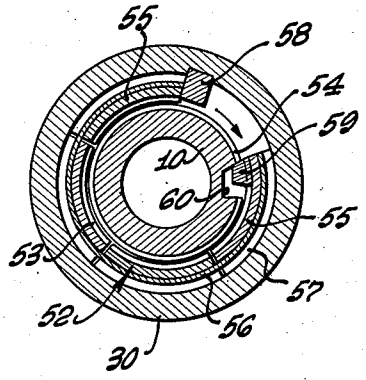
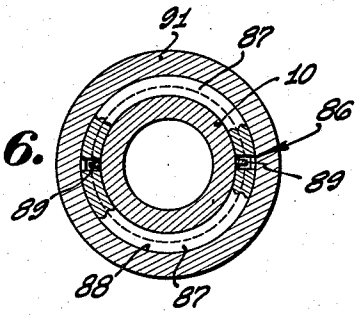


Fig. 6.



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Filed Sept. 13, 1948 4 Sheets-Sheet 3

Fig. 7.

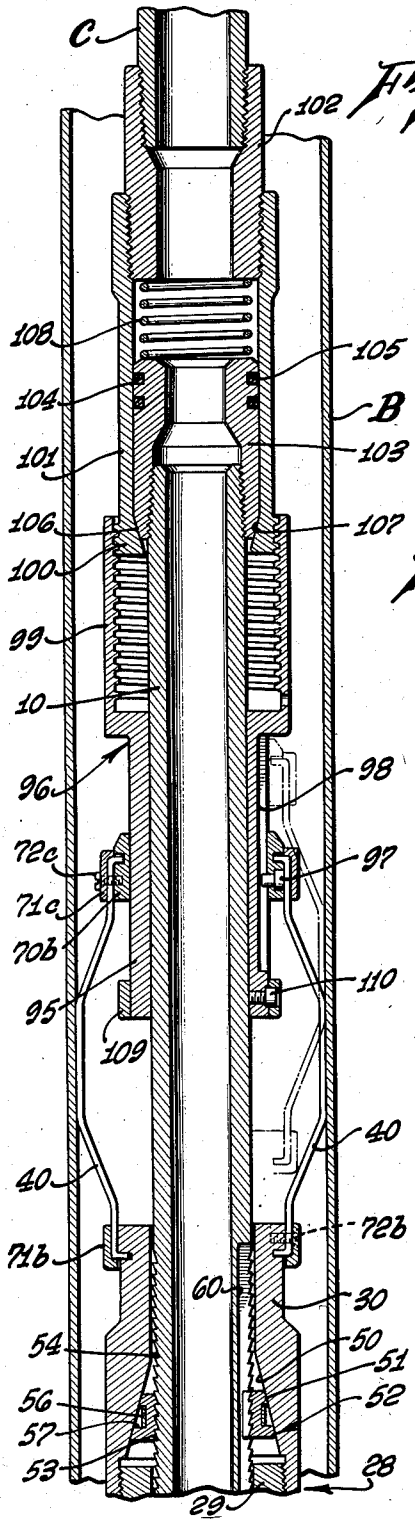
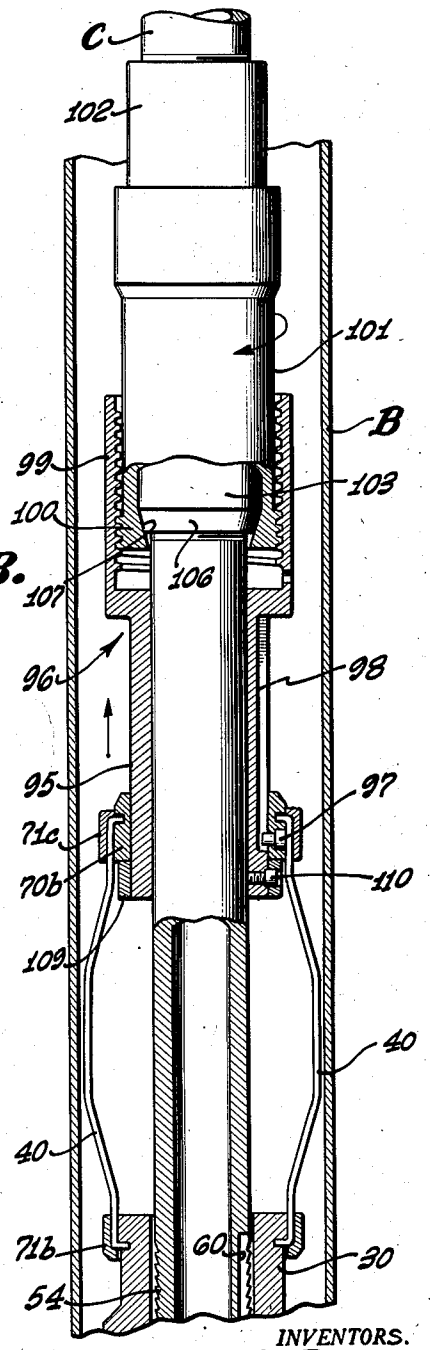


Fig. 8.



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Filed Sept. 13, 1948 4 Sheets-Sheet 4

Fig. 9.

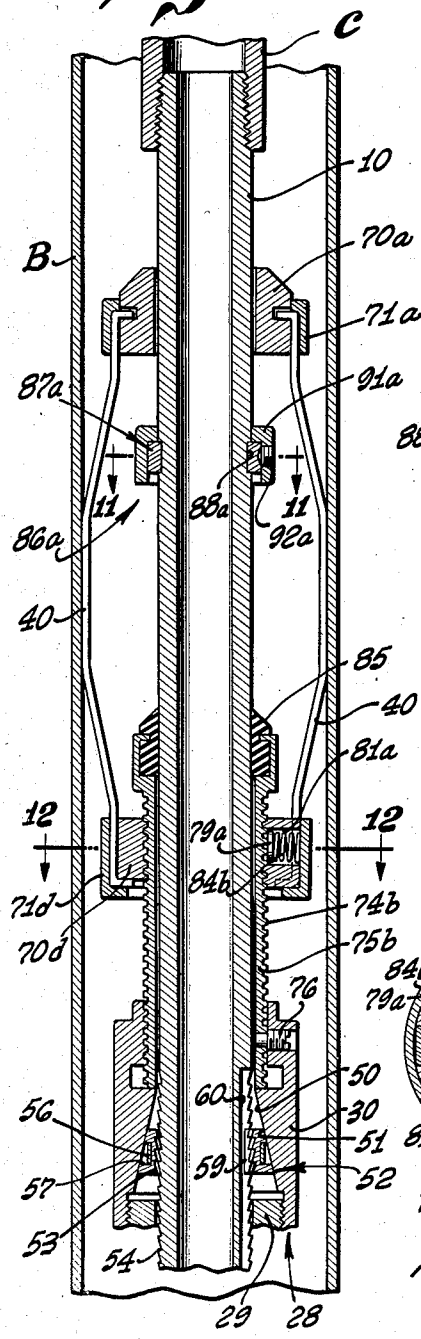


Fig. 11.

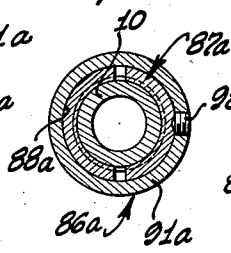


Fig. 10.

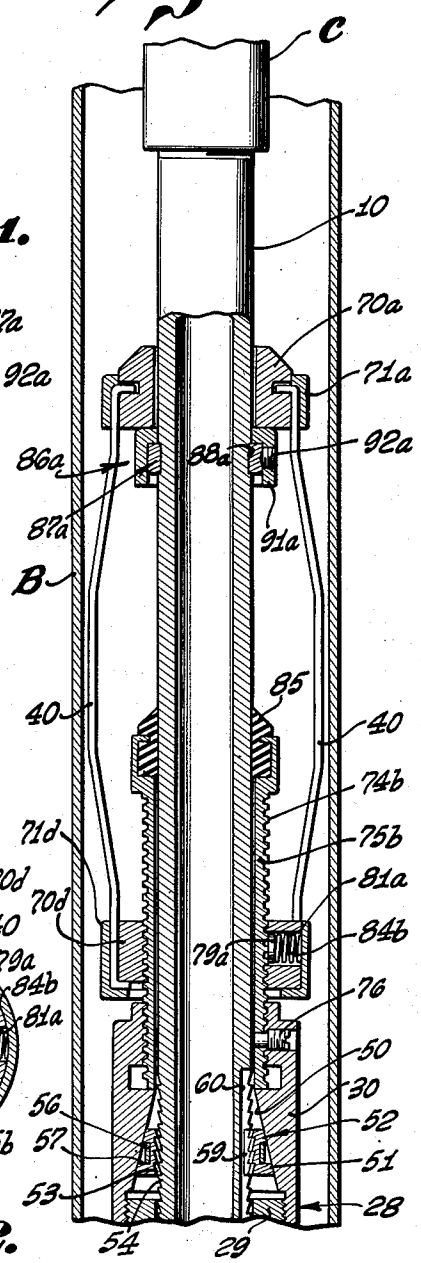
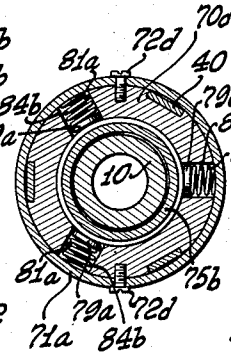


Fig. 12.



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UNITED STATES PATENT OFFICE

2,633,917

REMOVABLE SUBSURFACE WELL TOOL

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Application September 13, 1948, Serial No. 49,004

22 Claims. (Cl. 166—12)

1

The present invention relates to sub-surface well tools, and more particularly to tools useful in the performance of cementing, acidizing, washing, testing, anchoring, production and other operations in well bores.

The operation of certain types of well tools is effected by moving their parts relatively to each other through manipulation of tubular strings to which the tools are attachable. The relative movement may be obtainable by resisting or preventing movement of one or more of the tool parts through the use of instrumentalities engaging the wall of the well conduit or formation. Although resistance to movement is required during the performance of some of the operations in the well bore, such resistance is not always desirable. As an example, removal of a well tool from a casing is expedited if the tubing or drill pipe joints are unscrewed by holding the section above the rotary table stationary and rotating the remainder of the tubular string in the hole. This rotation also revolves the casing engaging instrumentalities, sliding or dragging them around and along the casing wall, with potential damage to the instrumentalities and to other parts of the well tool.

Accordingly, an object of the present invention is to avoid damage to the casing or formation engaging instrumentalities of a well tool during rotation of the tubular string to which the tool is attached.

Another object of the invention is to provide a sub-surface well tool having casing or formation engaging elements that are not dragged around or along the casing or formation wall during movement of the tool therein. More specifically, dragging of such elements is avoided during rotation of the tubular string to which the tool is attached.

A further object of the invention is to provide a tool embodying a drag device for controlling operation of the tool, in which the drag device need not be dragged frictionally around the casing wall during rotation of the tubular string to which the tool is attached.

Another object of the invention is to uncouple a drag device or the like from the well tool, of which it forms a part, in order that rotation of the drag device need not occur during rotation of the tubular string attached to the tool.

Still a further object of the invention is to disengage a drag device, or the like, from the wall of a well casing, to prevent frictional engagement of the device with such casing wall during rotation of the drag device.

Yet another object of the invention is to insure

2

the pulling of a drag device, forming part of a well tool, through a well conduit or formation regardless of the direction of longitudinal movement of the device.

Certain tools embody elements that are normally in retracted position and which are expandible outwardly against a well casing or similar conduit. As an example, slips may be expanded into anchoring engagement with a casing to prevent upward movement of a well tool, of which the slips form a part. Thereafter, the slips may be retracted to enable withdrawal of the tool from the well casing. Care must be exercised against inadvertent expansion of such slips during elevation of the tool, since it might result in serious damage to the tool, the running-in string attached to the tool, and other well equipment.

Another object of the invention is to insure against inadvertent expansion of the slips after they have been retracted from their outward position.

A further object of the invention is to lock the slips in retracted position to preclude their outward expansion.

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

Referring to the drawings:

Figure 1 is a longitudinal view, partly in elevation and partly in section, of a well tool embodying the invention disposed within a well casing, with its parts in retracted position;

Fig. 2 is an enlarged sectional view of the drag and lock portion of the tool shown in Fig. 1, with the drag device uncoupled from the remainder of the tool;

Fig. 3 is a view similar to Fig. 1 of the well tool anchored in packed-off condition within the well casing;

Fig. 4 is a cross-section taken along the line 4—4 on Fig. 1;

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

Fig. 6 is a cross-section taken along the line 6—6 on Fig. 2;

Fig. 7 is a longitudinal section through an-

other form of drag and lock device, forming the upper portion of the well tool disclosed in Fig. 1;

Fig. 8 is a partly sectional and partly elevational view of the device shown in Fig. 7 with its outwardly bowed leaf springs disengaged from the wall of the well casing;

Fig. 9 is a longitudinal section through still another embodiment of a drag and lock device, forming the upper portion of the tool shown in Fig. 1;

Fig. 10 is a longitudinal view, partly in section and partly in elevation, of the drag device disclosed in Fig. 9 shifted from engagement with the casing wall;

Fig. 11 is a cross-section taken along the line 11—11 on Fig. 9; and

Fig. 12 is a cross-section taken along the line 12—12 on Fig. 9.

The invention is exemplified in the drawings as applied to a well packer A of the retrievable type. It is to be understood, however, that the invention is also applicable to other well tools, and for controlling elements other than slips and packings hereinafter referred to.

The packer A is adapted to be run in a well bore or casing B on the end of a tubular running-in string C threadedly, or otherwise, attached to the upper end of the tubular mandrel or body portion 10 of the packer. The lower end of this mandrel or body portion 10 is threaded into the upper end of a lower tubular packer body 11, to which is attached a packing actuator 12 in the form of a guide.

A tapered expander 13 is mounted on the body part 11. It is preferably prevented from turning with respect to the latter by a key 14 secured to the exterior of the body and received within a keyway 15 in the expander; so as to permit relative longitudinal movement between the body 11 and expander 13 while preventing rotation therebetween. When the tubular string C and body 10, 11 are elevated, the packing actuator 12 is moved toward the expander 13 to compress an intervening packing sleeve 16, surrounding the body, and force it outwardly into engagement with the wall of the casing B. Such actuation of the packing sleeve 16 only occurs when the tapered expander 13 is prevented from moving upwardly, which results from shifting of the expander within a plurality of slips 17, and outward expansion of the latter against the wall of the casing.

The slips 17 have tapered inner surfaces 18 cooperating with companion tapered surfaces 19 on the expander, the inclination of such surfaces being such as to move the slips 17 outwardly toward the casing when the expander 13 is elevated. Conversely lowering of the expander 13 with respect to the slips 17 permits the latter to release from the casing wall and move inwardly to retracted position.

It is, accordingly, apparent that elevation of the tubular string C and packer body 10, 11 can effect anchoring of the tool, through engagement of the slips 17 with the casing B under the influence of the tapered expander 13. Such elevation can also effect compression or foreshortening of the rubber packing sleeve 16 between the expander 13 and guide 12, to produce its radial outward expansion into sealing engagement with the casing wall.

The slips 17 are held together for joint movement along the tapered expander 13 to and from engagement with the casing B by pin-connecting them to the lower ends of links 20, whose upper ends extend between the fingers 21 of a slip ring 22. This ring is also provided with a peripheral groove 23 into which pins 24, projecting in both directions from the sides of the links 20, may extend, in order to couple all of the links 20 and slips 17 for movement jointly with the slip ring 22. Outward movement of the upper ends of the links 20 is prevented by a stop ring 25 suitably secured to the slip ring 22.

The slip ring is connected to a drag and lock device 26 by a swivel mechanism 27, in order to permit rotation of the slips 17 and slip ring 22 without correspondingly rotating the drag device 26. The main purpose of the drag device 26 is to resist longitudinal movement of the slips 17 within the well casing B.

The drag device 26 includes an outer ratchet member 28, consisting of a lower ring 29 threaded into an upper ratchet sleeve 30. The ratchet ring 29 and slip ring 22 are adjacent one another, and are provided with outwardly directed flanges 31, 32 receivable within an internal circumferential groove 33 in a tie ring 34 having upper and lower inwardly directed flanges 35, 36 disposed above and below the ratchet ring and tie ring flanges 31, 32, respectively. For convenience of assembly, the tie ring 34 may be made in two halves that are moved radially inwardly to dispose the flanges 35, 36 above and below the ratchet ring and slip ring flanges 31, 32. This two-piece tie ring is prevented from coming apart by an encompassing circumferentially continuous sleeve 37, which is prevented from dropping off the ring by one or more screws 38 threaded into the ring and disposed within holes 39 in the sleeve. It is apparent that the tie ring 34 and the flanges 31, 32 on the ratchet ring 29 and slip ring 22 form a swivel connection 27 between the drag device 26 and the slips 17.

The drag and lock device 26 comprises the outer ratchet member 30, 29, which may slide relatively along the mandrel 10, or be coupled thereto. The sleeve 30 of this member is coupled to the lower end of the drag device 26, which includes a plurality of circumferentially spaced outwardly bowed leaf springs 40, extending upwardly along the mandrel 10, and frictionally engaging the casing B.

The frictional engagement of the springs 40 with the casing B tends to resist longitudinal movement of the slips 17 through the well casing. Upon reaching the desired setting point in the casing, if the tubular mandrel 10 is permitted to move upwardly with respect to the drag device 26, such elevation would also elevate the lower packer body 11, and, through the guide 12 and packing sleeve 16, elevate the expander 13 within the slips 17, since the latter are prevented from moving upwardly by the drag device. Such elevation of the expander 13 forces the slips 17 radially outward into anchoring engagement with the casing wall. With the slips 17 anchored to the casing B, the expander 13 is prevented from moving upwardly. Accordingly, a continuation of the upward movement of the tubular string C and body 10, 11 moves the guide ring 12 toward the expander 13, in order to foreshorten the packing sleeve 16 and shift it into firm sealing engagement with the casing B and the packer body 11.

Lowering of the tubular string C and packer body 10, 11 with respect to the drag device 26 permits retraction of the packing sleeve 16 from the casing, and produces corresponding downward movement of the tapered expander 13, by virtue of engagement of the body shoulder 46 with an expander flange 47, so that the slips 17 are moved inwardly to retracted position. Such in-

ward retraction will occur, since downward movement of the slips is prevented by the friction spring drag device 26.

It is to be noted that upward movement of the tubular body can effect anchoring of the packer A in packed-off condition within the well casing B, and that lowering of these members can effect release of the packer. In order to allow the tubular body 10, 11 to be elevated without anchoring the tool in the well casing, some means is provided for preventing the relative longitudinal movement between the slips 17 and tapered expander 13 upon elevation of the tubular body. In the present instance, such means is afforded by a ratchet or one-way clutch type of lock device disposed between the upper body or mandrel 10 and the ratchet sleeve 30.

The ratchet sleeve 30 has an inner surface 50 tapering upwardly and inwardly, that cooperates with a correspondingly tapered surface 51 on a segmented ring 52, to urge the ring inwardly, in order that the internal teeth 53 of the ring are disposed for clutching engagement with external ratchet teeth 54 formed on the periphery of the upper tubular body or mandrel 10. The segmented ring 52 includes a plurality of adjacent segments 55 (see Fig. 5) disposed a substantial distance around the periphery of the mandrel 10, such segments being urged inwardly by a split, contractile spring or snap ring 56 disposed within a peripheral groove 57 in the segments. This ring 56 tends to urge the segments 55 inwardly, to effect engagement of their ratchet teeth 53 with the companion teeth 54 on the mandrel. Such ratchet teeth may be constituted by an upwardly facing ratchet or buttress type of thread 54 on the mandrel 10, engaging with a companion downwardly directed ratchet thread 53 formed jointly within the segments 55.

A stop 58, in the form of a key, is secured to the ratchet sleeve 30, and engages one end of the segmented ring 52, to prevent rotation of the segmented ring relative to the ratchet sleeve. The other end of the ring 52 has an inwardly directed key or projection 59 disposed within a longitudinal keyway 60 in the mandrel 10.

Because of the ratchet or one-way clutch type of lock device described, the mandrel 10 can be moved downwardly without interference by the lock device, since the mandrel ratchet teeth 54 will merely ratchet freely over the companion teeth 53 on the segments 55. However, upward movement of the mandrel 10 will cause its teeth 54 to engage the segment teeth 53 and move the segments 55 upwardly with it, shifting them slightly toward the narrow portion of the tapered surface 50 in the ratchet sleeve 30, and wedging the segments firmly between the mandrel 10 and ratchet sleeve 30, which effectively couples the mandrel 10 and drag device 26 together against relative upward movement. In other words, the two parts 10, 26 are locked together for upward movement as a unit. Accordingly, the slips 17 are also locked to the mandrel 10 and will move upwardly with it.

When it is desired to shift the mandrel 10 upwardly within the drag device 26, and with respect to the slips 17, in order to anchor the slips to the casing B, the tubular string C and upper body or mandrel 10 connected thereto are rotated a partial revolution, preferably to the right. Such rotation causes the mandrel 10 to act upon the segment key 59 and expand the segments 55 outwardly to the extent in which their teeth 53 are completely out of engagement with the mandrel teeth 54. Such expansion will occur, since the other end of the segmented ring is prevented from moving by the stop 58 secured to the ratchet sleeve 30. When the mandrel is thus turned to free the segments 55 from its teeth 54, the mandrel 10 may be moved upwardly within the segments 55 and the ratchet sleeve 30, in order to shift the expander 13 upwardly within the slips 17 and urge the latter into anchoring engagement with the casing B. As above indicated, a continuation of this upward movement foreshortens the packing sleeve 16 and expands it outwardly against the casing.

When the slips 17 and packing 16 are to be retracted, it is merely necessary to lower the tubular string C and mandrel 10, which will lower the abutment 12 away from the expander 13, allowing the packing sleeve 16 to retract and also cause the body shoulder 46 to engage the expander shoulder 47, shifting the expander downwardly relative to the slips 17 and effecting retraction of the latter. Such downward movement can occur without regard to the imposing of turning effort on the tubular string C and packer body 10, 11 because of the one-way ratchet arrangement between the mandrel threads 54 and segmented ring threads 53.

With the segmented ring 52 released by reverse turning of the tubular string C and packer body 10, 11 upward movement of these latter members will again automatically couple the mandrel 10 to the ratchet sleeve 30 and drag device 26, in order that upward movement of the tubular string C and packer body 10, 11 will be ineffective to anchor the packer to the well casing. The well tool, therefore, can be removed to the top of the well bore.

As described above, the outwardly bowed leaf springs 40 engage the casing B to resist longitudinal movement of the slips 17 therewithin. These springs also resist rotation of the ratchet sleeve 30 and enable rotation of the tubing string C and mandrel 10 to effect unclutching of the segmented ring 52 from the mandrel teeth 54.

After the operation has been performed in the well bore, it is desired to remove the tool from the well casing. Such removal can be expedited by disconnecting the tubing string joints at the rotary table (not shown), through holding the stand of tubing above the table stationary, and through rotating the rotary table to rotate the tubing string C and the well tool A attached thereto. Such rotation ordinarily occurs to the right. If the drag device 26 shown in Figs. 1, 2, 3 were coupled directly to the ratchet sleeve 30, rotation of the tubing string C and mandrel 10 would revolve the drag springs 40 around the casing B, and might severely damage them. In the form of the invention disclosed in Figs. 1 to 6, inclusive, provision is made for uncoupling the drag device 26 from the remainder of the tool, in order that it need not rotate with the remainder of the tool.

In achieving the objective just mentioned, the lower ends of the springs 40 are connected to a lower drag collar 70 by an encompassing ring 71 and screws 72. The upper ends of the springs are similarly connected to an upper drag collar 70*a*, slidable on the mandrel 10, by an encompassing ring 71*a* and screws 72*a*. This lower drag collar has internal threads 73 adapted to engage and cooperate with external threads 74 formed on the upper portion of a coupling or drag sleeve 75 threadedly, or otherwise, secured to the ratchet sleeve 30. The threaded connection 73, 74 is preferably left hand. Inadvertent separa-

tion between the drag sleeve 75 and ratchet sleeve 30 is prevented by a suitable lock screw 76 threaded into the ratchet sleeve and bearing against the drag sleeve.

Originally, the lower drag collar 70 occupies a position at the upper end of the drag sleeve 75, the extent of the upward threading of the collar being determined by engagement of its lug or projection 77 with an outwardly directed lug or projection 78 on the drag sleeve. Rotation of the drag sleeve 75 to the right will effect downward feeding of the lower drag collar 70 along the sleeve 75, before the sleeve projection 78 can engage the collar projection 77, so as not to interfere with downward movement of the lower collar 70 along the sleeve. The projections 77, 78 will be engaged upon upward screwing of the lower collar 70 on the sleeve 75, to limit the extent of such upward movement and to prevent jamming of the threads 73, 74.

In order to prevent rotation of the ratchet sleeve 30 and drag sleeve 75 during manipulation of the segmented lock ring 52, a frictional restraint is imposed between the lower drag collar 70 and the drag sleeve 75. In the form disclosed in Figs. 1 to 6, inclusive, such frictional restraint is obtained by causing a plurality of circumferentially spaced brake shoes 79 to bear frictionally against the outer ends of the external threads 74. These brake shoes have stems 80 extending through bores 81 in a ring portion 82 depending from the lower collar ring 71. The stem 80 of each brake shoe is slidable through a spring seat 83 threaded within the bore 81. A helical spring 84 is disposed in each bore, bearing against the brake shoe 79 at one end and against the seat 83 at the other end.

The springs 84 provide enough frictional force of the shoes 79 against the sleeve threads 74 as to resist rotation of the ratchet sleeve 30 to an extent sufficient to insure expansion of the segmented ring 52 to its unclutched position, upon rotation of the tubing string C and mandrel 10 to the right, as described above. The brake shoes 79, however, do not exert sufficient frictional force to transmit rotary motion of the coupling or drag sleeve 75 to the drag springs 40 and revolve the latter around the casing. Instead, the brake shoes 79 will slip before that occurs.

A rubber wiper ring 85 may be secured in the upper end of the drag sleeve 75 to prevent foreign substances from moving downwardly through the clearance space between the drag sleeve 75 and mandrel 10, and possibly clog the ratchet clutch mechanism 50—54.

A stop device 86 is also provided for insuring the pulling of the drag device 26 through the well casing B, irrespective of its upward or downward movement through the well casing. This stop device is adjustable and includes a two-part stop ring 87 disposed within a circumferential groove 88 in the mandrel (see Figs. 1, 2, 3, 6). The two halves of this stop ring are separated by keys 89 welded or otherwise secured to the mandrel 10. The stop ring has external threads 90 which project beyond the mandrel keys 89 for cooperation with an internally threaded sleeve 91 extending downwardly toward the drag sleeve 75, with which it is engageable. The upper end of the stop sleeve 91 is also engageable with the upper drag collar 70*a*, that is freely slidable along the mandrel 10.

It is to be noted that the threads 74 on the drag sleeve 75 do not extend throughout its length, but terminate a substantial distance above the upper end of the ratchet sleeve 30. The unthreaded portion 75*a* of the sleeve has a diameter no greater than the root diameter of the threads 74, in order to permit the lower collar 70 to be disposed therealong. The unthreaded portion 75*a* of the sleeve is sufficient in length to permit complete unscrewing of the lower drag collar 70 from the threaded portion 74, and also to accommodate the brake shoes 79.

The well tool A is run in the well casing with the parts disposed in the position shown in Fig. 1, except that the segmented ring 52 may be in its inward or clutching position. The stop sleeve 91 is adjusted by rotating it on the threaded stop ring 87 until its lower end engages the upper end of the drag sleeve 75. It is maintained in this adjusted position by a suitable screw 92 threaded through the sleeve 91 and bearing against the mandrel 10. The lower drag collar 70 is at the upper end of the drag sleeve 75, and the upper drag collar 70*a* is disposed a substantial distance above the stop sleeve 91.

When the position in the well bore has been reached at which the tool is to be anchored in packed-off condition, the tubing string C and mandrel 10 are rotated to the right to unclutch the ratchet ring 52 from the mandrel, which permits the tubing string C and mandrel 10 to be elevated and effect engagement of the slips 17 and the packing 16 with the wall of the well casing. Upward movement of the mandrel within the drag device 26 is permitted, because of the space that has been allowed between the upper end of the stop sleeve 75 and the upper drag collar 70*a* (see Figs. 1 and 3). Moreover, rotation of the ratchet sleeve 30 during turning of the mandrel 10 is prevented by the frictional engagement of the brake shoes 79 upon the threads 74 of the drag sleeve 75, which is connected to the ratchet sleeve 30.

When the well tool A is to be removed from the well casing, the tubing string C and mandrel 10 are lowered to retract the slips 17 and the packing 16 to their initial positions shown in Fig. 1. The tubing string C is then rotated to rotate the mandrel 10. Such rotation will expand the ratchet ring 52, and, through the ratchet ring 52 and stop key 58, will rotate the ratchet sleeve 30 and the drag sleeve 75. Since the threaded interengagement 73, 74 between the drag sleeve 75 and lower drag collar 70 is left hand, and since the drag springs 40 engage the casing B to resist rotation of the lower drag collar, the rotation of the drag sleeve 75 to the right will thread the lower drag collar 70 downwardly along the sleeve 75, until the lower drag collar is completely unscrewed from the threaded portion of the drag sleeve. The friction force exerted by the brake shoes 79 against the drag sleeve threads 74 is only sufficient to insure unclutching of the ratchet ring 52, but it is far less than the frictional force exerted by the drag springs 40 against the casing wall. As a result, the brake shoes 79 are incapable of preventing rotation of the drag sleeve 75 within the drag collar 70.

When the lower drag collar has been unscrewed from the threaded portion of the lower drag sleeve, as shown in Fig. 2, the upper drag collar 70*a* has been lowered to a location adjacent the upper end of the stop sleeve 91.

It is evident that the lower drag collar 70 has been completely uncoupled from the drag sleeve 75, and that rotation of the drag sleeve 75 can

occur freely within the lower drag collar 70 and the springs 40 without tending to rotate the latter. The tubing string C and mandrel 10 may now be rotated to the extent desired in elevating the tool within the well bore for the purpose of uncoupling the sections above the rotary table, without fear of revolving the drag springs 40 frictionally along and around the walls of the well casing B.

In addition to its function of permitting rotation of the mandrel 10 without rotating the drag device 26, after having been unscrewed from the drag sleeve 75, the drag and lock device disclosed performs a further important function. It is to be noted that the unscrewing of the lower drag collar 70 from the drag sleeve 75 has located the upper drag collar 70*a* adjacent the stop sleeve 91. It is also to be noted that the lower end of the stop sleeve 91 is adjacent the upper end of the drag sleeve 75, this latter position having occurred upon lowering of the mandrel 10 to effect retraction of the slips 17 and packing 16 from the well casing. Accordingly, regardless of the coupling or uncoupling position of the ratchet ring 52, it is impossible to reset the slips 17 and packing 16 against the casing B, since the mandrel 10 cannot be moved upwardly substantially with respect to the slips 17. This action is prevented, because such upward movement is transmitted through the stop ring 87 and stop sleeve 91 to the upper drag collar 70*a*, through the drag springs 40 to the lower drag collar 70, and from the lower drag collar to the drag sleeve 75, because of the engagement of the uppermost thread 73 on the lower collar 70 with the lowermost thread 74 on the threaded portion of the drag sleeve 75. Since the drag sleeve 75 is coupled to the slips 17 through the ratchet sleeve 30, swivel 27 and linkage 20, it is apparent that upward movement of the mandrel 10 will also move the slips 17 upwardly with it, despite the unclutched position that the ratchet ring 52 might assume. The tool can be moved out of the hole as rapidly as possible without fear of inadvertently setting the slips 17, which might cause the tubing string on the tool to be pulled apart.

The stop sleeve 91 and drag device 26 arrangement accomplishes yet a further function. During lowering of the tool in the well casing, the lower end of the stop sleeve 91 engages the drag sleeve 75, and, through the threaded interconnection 74, 73, moves the lower drag collar 70 downwardly in order to pull the drag springs 40 through the casing. Similarly, during upward movement of the mandrel 10 in removing the tool from the well casing, the stop sleeve 91 engages the upper collar 70*a* and again exerts a pulling action on the drag springs 40. This pulling action insures against buckling of the springs 40, that might accompany a pushing action, and avoids damage to or breakage of the leaf springs.

The same general functions are performable with the form of invention disclosed in Figs. 7 and 8. In this embodiment, the lower ends of the drag springs 40 are connected directly to the ratchet sleeve 30 by means of an encompassing ring 71*b* and screws 72*b* extending through the ring and threaded into the sleeve. The upper ends of the springs 40 are connected to an upper drag collar 70*b* by means of an encompassing ring 71*c* and screws 72*c* extending through the ring and threaded into the collar. This collar 70*b* is slidable along the lower portion 95 of a spring retracting sleeve or housing 96, and is prevented from rotating with respect to this housing by a key or pin 97, mounted on the collar 70*b*, and extending into a keyway or groove 98 in the lower housing portion 95.

The lower portion 95 of the housing is slidably mounted on the mandrel 10. An enlarged upper housing portion 99 is spaced from the mandrel, being interiorly threaded for cooperation with a companion externally threaded head 100 on the lower end of an outer clutch member 101 threadedly attached to a sub 102 secured to the lower end of the tubular string C. The threaded connection between the portion 99 and head 100 is preferably right hand. An inner tubular clutch member 103 is mounted within the outer clutch member 101 and is threadedly attached to the upper end of the mandrel 10. Leakage between the clutch members 101, 103 is prevented by providing one or more seal rings 104 in suitable grooves 105 in the inner member 103, which bear against the inner wall of the outer clutch member 101.

The inner clutch member 103 has a tapered friction clutch face 106 converging in a downward direction and engaging a companion internal clutch face 107 in the outer clutch member 101. These clutch faces are urged into frictional engagement with one another by a compressed helical spring 108 bearing against the lower end of the sub 102 and against the upper end of the inner clutch member 103.

The well tool disclosed in Figs. 7 and 8 forms the upper portion of the well tool illustrated in Fig. 1. The only change resides in the substitution of one form of drag device 26 for the other. The well tool is run in the well bore with the slips 17 in retracted position, and with the threaded head 100 of the outer clutch member 101 disposed within the upper end of the upper portion 99 of the housing 96. The upper drag collar 70*b* is located at the upper end of the keyway 98 (Fig. 7, dotted line position), which places a stop ring 109, secured to the lower end of the housing by screws 110 or the like, a substantial distance below the upper drag collar 70*b*. When the tool has reached the setting point in the well casing, the tubing string C is rotated to the right, this rotational effort being transmitted through the coengaging clutch faces 106, 107 to the inner clutch member 103 and to the mandrel 10, which allows the ratchet ring 52 to be expanded and the tubular string C and mandrel 10 elevated in effecting setting of the slips 17 and packing 16 against the casing B. It is apparent that the stop ring 109 on the lower end of the housing 96 can move with the housing upwardly toward the upper drag collar 70*b*, because of the initial space allowed therebetween.

After the operation in the well bore has been performed, the tubing string C and mandrel 10 are lowered to locate the slips 17 and packing 16 in their initial retracted positions. Thereafter, the tubing string C is rotated to the right, which effects upward threading of the housing 96 along the outer clutch member 101, since this housing is prevented from rotating by the frictional engagement of the springs 40 against the casing B, and by virtue of the splined key connection 97, 98. As the housing moves upwardly, its stop ring 109 eventually engages the upper drag collar 70*b*, continued rotation of the tubing string causing the housing 96 to shift upwardly to a further extent, moving the upper drag collar 70*b* with it away from the ratchet sleeve 30 and elongating the springs 40, to retract them inwardly

until they no longer engage the casing frictionally (see Fig. 8).

The tool may now be elevated rapidly from the hole, the tubing string C being rotated, if desired, without dragging the springs 40 frictionally around the wall of the casing, since the latter have been pulled inwardly of the casing. In addition, the slips 17 and packing 16 cannot be set inadvertently, regardless of the condition of the ratchet clutch ring 52, since the upward movement of the tubing string C is transmitted to the mandrel 10 and also directly to the slips 17 through the clutch member 101, housing 96, drag device 26, ratchet sleeve 30, swivel 27 and linkage 20.

The friction clutch 101, 103 is engaged by just sufficient force to transmit the rotary effort of the tubular string C to the mandrel 10, in order to expand the ratchet ring 52 out of clutching engagement with the mandrel 10. This force, however, is insufficient to transmit the rotary effort imparted to the mandrel 10 to the ratchet sleeve 30 and the drag springs 40. That is to say, the drag springs engage the casing B with substantially greater force than the force of engagement between the clutch faces 106, 107, in order that the clutch will slip before the motion of the tubing string C can rotate the drag springs 40 around and along the wall of the well casing B during upward feeding of the housing 96.

When the drag springs 40 are to be retracted, the tubing string C is rotated to the right, as described above, in order to feed the housing 96 upwardly and move the upper drag collar 70b away from the lower ratchet sleeve 30. Such rotation cannot rotate the mandrel 10 and the drag springs 40, in view of the ability of the friction clutch 101, 103 to slip. Accordingly, the outer clutch member 101 can be rotated by the tubular string C with respect to the retracting sleeve or housing 96, which is held from rotation by engagement of the drag springs 40 with the casing wall, until the latter are distended to the point of losing contact with the casing wall.

The form of invention disclosed in Figs. 9 to 12, inclusive, is similar to the embodiment shown in Figs. 1 to 6, inclusive. It forms the upper portion of the tool shown in Fig. 1.

In Figs. 9 to 12, inclusive, the ratchet sleeve 30 is threadedly connected to the lower end of the coupling or drag sleeve 75b, disconnection between these two being prevented by a screw 76.

The upper drag collar 70a of the drag device 26 is freely slidable along the tubular mandrel 10, which is connected to the tubing string C. This collar 70a has the upper ends of the drag springs 40 attached to it in the same manner as the Figs. 1 to 6 embodiment. The lower ends of the drag springs 40 are secured to a lower drag collar 70d by an encompassing ring 71d and screws 72d, the lower drag collar 70d being threadedly connected to the coupling or drag sleeve 75d.

In order to offer resistance to rotation of the drag sleeve 75b and ratchet sleeve 30 during expanding movement of the ratchet ring 52, upon rotation or turning of the mandrel 10, one or more spring pressed brake shoes 79a are disposed in transverse holes 81a in the lower drag collar 70d. The shoes are urged into frictional engagement with the exterior of the drag sleeve threads 74b by helical springs 84b bearing upon the shoes 79a and upon the encompassing ring 71d. The brake shoes exert sufficient frictional force to insure expansion of the ratchet coupling ring 52 to uncoupling position, but such shoes will slip before the rotary effort of the mandrel 10 can be transmitted to the drag springs 40 with sufficient force to slide them around the wall of the casing B.

A stop device 86a is secured to the mandrel 10 between the upper and lower drag collars 70a, 70d. This stop device consists of a two part ring 87a received within a groove 88a in the mandrel 10, and held in place by an encompassing stop sleeve 91a attached to one ring member by a set screw 92a.

The tool disclosed in Figs. 9 to 12, inclusive, is run in the well bore with the upper drag collar 70a disposed a substantial distance above the stop sleeve 91a, and with the lower drag collar 70d threadedly engaging the upper end of the drag sleeve 75b. The tool is set in packed-off condition in the well casing at the desired location in the same manner as in the other forms of the device, upward pulling of the mandrel 10 to effect the setting being permitted because of the initial spacing of the stop sleeve 91a below the upper drag collar 70a.

When it is desired to withdraw the tool from the well casing, the mandrel 10 is lowered to retract the slips 17 and packing 16, whereupon the mandrel 10 may be rotated, the rotary force being transmitted through the key 59 and coupling ring 52 to the stop member 58 secured to the ratchet sleeve 30, and from the ratchet sleeve to the coupling or drag sleeve 26. Since the friction force exerted by the brake shoes 79a is less than that of the drag springs 40 against the casing wall, the lower drag collar 70d will remain non-rotatable; so that rotation of the drag sleeve 75b to the right will effect a downward feeding of the lower drag collar 70d along the drag sleeve 75b. This will pull the springs 40 downwardly along the casing B until the upper drag collar 70a engages the stop sleeve 91a. Continued rotation then feeds the lower drag collar 70d further downwardly along the drag sleeves 75b to extend the drag springs 40 lengthwise and pull them inwardly from engagement with the casing wall (see Fig. 10).

The tubing string C may now be rotated, in order to disconnect the tubing sections above the rotary table without dragging the springs 40 along the casing walls. Similarly, as in the other forms of the invention, the slips 17 cannot be set inadvertently during upward movement of the mandrel, even though the clutch ring 52 may be expanded from clutching engagement with the mandrel 10, for the reason that relative upward movement of the mandrel 10 with respect to the slips 17 and the clutch and drag device 26 is prevented. Such upward movement is transmitted through the stop ring 88a, stop sleeve 91a, upper drag collar 70a, drag springs 40, lower drag collar 70d, drag sleeve 75b, ratchet sleeve 30, swivel 27 and linkage 20 to the slips 17. The mandrel 10 can move downwardly, but any further downward movement could, at the most, only retract the slips 17 and the packing 16 to a further extent in the event they were not previously fully retracted.

It is also evident that during upward movement of the tubing string C and mandrel 10, the stop sleeve 91a engages the upper drag collar 70a and exerts a pulling action on the drag springs 40, moving such springs readily past any resisting elements that might be encountered in the well casing B.

The inventor claims:

1. In a well tool for use in a well conduit: a first member adapted for connection to a tubular string; a second member slidably and telescopically arranged with respect to said first member; means for transmitting the turning effort of said first member to said second member; conduit engageable means operatively connected with said second member for resisting movement of said second member in said well conduit; and means, comprising a left-hand threaded connection between said conduit engageable means and one of said members, for moving at least part of said conduit engageable means longitudinally of said members and the well conduit in response to rotation of said first member to a position enabling rotation of said first and second members without dragging said conduit engageable means along the inner surface of the well conduit.

2. In a well tool for use in a well conduit: a first member adapted for connection to a tubular string; a second member telescopically arranged with respect to said first member; means for transmitting the turning effort of said first member to said second member; conduit engageable means cooperable with said second member for resisting movement of said second member in said well conduit; means comprising a threaded connection between said conduit engageable means and one of said members for moving at least part of said conduit engageable means longitudinally of said members in response to rotation of said first member; and friction brake means between said second member and conduit engageable means for resisting movement of said second member relative to said conduit engageable means.

3. In a well tool for use in a well conduit: a first member adapted for connection to a tubular string; a second member slidably and telescopically arranged with respect to said first member; means for transmitting the turning effort of said first member to said second member; conduit engageable means cooperable with said second member for resisting movement of said second member in said well conduit; and means providing a connection between said conduit engageable means and said second member which will effect feeding of said conduit engageable means downwardly along said second member and the well conduit upon right-hand rotation of said second member by said first member relative to said conduit engageable means.

4. In a well tool for use in a well conduit: a first member adapted for connection to a tubular string; a second member telescopically arranged with respect to said first member; means for transmitting the turning effort of said first member to said second member; conduit engageable means cooperable with said second member for resisting movement of said second member in said well conduit; means providing a connection between said conduit engageable means and said second member which will effect feeding of said conduit engageable means along said second member upon rotation of said second member; and friction brake means on said conduit engageable means contacting said second member.

5. In a well tool for use in a well conduit: an inner member adapted for connection to a tubular running-in string; an outer member slidably and telescopically arranged with respect to said inner member; means for transmitting the turning effort of said inner member to said outer member; conduit engageable means cooperable with said outer member for resisting movement of said outer member in said well conduit; and means providing a connection between said conduit engageable means and said outer member which will effect feeding of said conduit engageable means downwardly along said outer member and well conduit upon right-hand rotation of said outer member by said inner member relative to said conduit engageable means.

6. In a well tool for use in a well conduit: a first member adapted for connection to a tubular string; a second member slidably and telescopically arranged with respect to said first member; means for transmitting the turning effort of said first member to said second member; conduit engageable means cooperable with said second member for resisting movement of said second member in said well conduit; means providing a connection between said conduit engageable means and said second member which will effect feeding of said conduit engageable means along said second member and the well conduit upon rotation of said second member by said first member relative to said conduit engageable means, and stop means on said first member engageable with said conduit engageable means.

7. In a well tool for use in a well conduit: a first member adapted for connection to a tubular running-in string; a second member slidably and telescopically arranged with respect to said first member; means for transmitting the turning effort of said first member to said second member; longitudinally spaced collars disposed around said members; conduit engageable drag springs secured to said collars; and means providing a connection between one of said collars and said second member which will effect feeding of said one of said collars along said second member upon rotation of said second member by said first member relative to said one of said collars.

8. In a well tool for use in a well conduit: a first member adapted for connection to a tubular running-in string; a second member slidably and telescopically arranged with respect to said first member; means for transmitting the turning effort of said first member to said second member; longitudinally spaced collars encompassing said members; both of said collars being movable with respect to both of said members; conduit engageable drag springs secured to said collars; and means comprising a threaded connection between one of said collars and said second member for moving said one of said collars longitudinally of said second member in response to rotation of said second member.

9. In a well tool for use in a well conduit: a first member adapted for connection to a tubular running-in string; a second member telescopically arranged with respect to said first member; means for transmitting the turning effort of said first member to said second member; longitudinally spaced collars disposed around said members; conduit engageable drag springs secured to said collars; means comprising a threaded connection between one of said collars and said second member for moving said one collar longitudinally of said second member in response to rotation of said second member; and stop means on said first member engageable with the other of said collars.

10. In a well tool for use in a well conduit: a first member adapted for connection to a tubular string; a second member slidably and tele-

scopically arranged with respect to said first member; means for transmitting the turning effort of said first member to said second member; conduit engageable means connected to said second member for resisting movement of said second member in said well conduit; and means providing a connection between said conduit engageable means and one of said members which will effect feeding of said conduit engageable means downwardly along said members in response to right-hand rotation of said first member and during rotation of said second member by said first member relative to said conduit engageable means.

11. In a well tool adapted to be lowered in a well conduit on a tubular string: normally retracted slip means; expander means for moving said slip means into engagement with said well conduit; tubular means operatively connected to said expander means and connectible to said tubular string; releasable lock means for selectively preventing or permitting substantial relative longitudinal movement between said slip means and tubular means; a drag device operatively connected to said slip means and frictionally engageable with said well conduit, said drag device including a first part rotatable and slidable on said tubular means and threadedly connected to a second part, means for rotating said second part by the tubular string relative to said first part in order that rotation of said tubular string will feed one of said parts longitudinally with respect to the other of said parts and also longitudinally of said tubular means.

12. In a well tool adapted to be lowered in a well conduit on a tubular string: normally retracted means; means for moving said normally retracted means into engagement with the well conduit; tubular means operatively connected to said moving means; releasable lock means for selectively preventing or permitting substantial relative longitudinal movement between said normally retracted means and tubular means; a threaded sleeve secured to said lock means; and friction means threaded on said sleeve and frictionally engageable with said conduit.

13. In a well tool adapted to be lowered in a well conduit on a tubular string: normally retracted means; means for moving said normally retracted means into engagement with the well conduit; tubular means operatively connected to said moving means; releasable lock means for selectively preventing or permitting substantial relative longitudinal movement between said normally retracted means and tubular means; a threaded sleeve secured to said lock means; friction means threaded on said sleeve and frictionally engageable with said conduit; and slippable brake means resisting relative rotation between said sleeve and friction means.

14. In a well tool adapted to be lowered in a well conduit on a tubular string: normally retracted means; means for moving said normally retracted means into engagement with the well conduit; tubular means operatively connected to said moving means; releasable lock means for selectively preventing or permitting substantial relative longitudinal movement between said normally retracted means and tubular means; a threaded sleeve secured to said lock means; friction means threaded on said sleeve and frictionally engageable with said conduit; and stop means on said tubular means engageable with said friction means.

15. In a well tool adapted to be lowered in a well conduit on a tubular string: normally retracted means; means for moving said normally retracted means into engagement with the well conduit; tubular means operatively connected to said moving means; releasable lock means for selectively preventing or permitting substantial relative longitudinal movement between said normally retracted means and tubular means; a sleeve secured to said lock means and having a threaded portion and an unthreaded portion; and friction means threaded on said threaded portion and frictionally engageable with said conduit, said friction means being movable along said threaded portion onto said unthreaded portion in response to rotation of said tubular means and sleeve.

16. In a well tool adapted to be lowered in a well conduit on a tubular string: normally retracted means; means for moving said normally retracted means into engagement with the well conduit; tubular means operatively connected to said moving means; releasable lock means for selectively preventing or permitting substantial relative longitudinal movement between said normally retracted means and tubular means; a sleeve secured to said lock means and having a threaded portion and an unthreaded portion; friction means threaded on said threaded portion and frictionally engageable with said conduit, said friction means being movable along said threaded portion onto said unthreaded portion in response to rotation of said tubular means and sleeve; and stop means on said tubular means engageable with said friction means upon its movement onto said unthreaded portion.

17. In a well tool adapted to be lowered in a well conduit on a tubular string: normally retracted means; means for moving said normally retracted means into engagement with the well conduit; tubular means operatively connected to said moving means; releasable lock means for selectively preventing or permitting substantial relative longitudinal movement between said normally retracted means and tubular means; a sleeve threadedly secured to said tubular means; and conduit engaging means connected to said lock means and slidably splined to said sleeve.

18. In a well tool adapted to be lowered in a well conduit on a tubular string: normally retracted means; means for moving said normally retracted means into engagement with the well conduit; tubular means operatively connected to said moving means; releasable lock means for selectively preventing or permitting substantial relative longitudinal movement between said normally retracted means and tubular means; a sleeve threadedly secured to said tubular means; conduit engaging means connected to said lock means and slidably splined to said sleeve; and stop means on said sleeve engageable with said conduit engaging means.

19. In a well tool adapted for use in a well conduit: a first member; a second member movable relative to said first member; conduit engageable means cooperable with said second member to resist movement of said second member within said well conduit; and means on said members engageable with said conduit engageable means to retract said conduit engageable means from said conduit.

20. In a well tool adapted for use in a well conduit: a first member; a second member movable relative to said first member; a drag device comprising a first collar mounted on said first member, a second collar mounted on said second

member, and springs connected to said collars and engageable with said conduit; and means on said members engageable with said collars and operable upon rotation of one of said members for increasing the distance between said collars to retract said springs from said conduit.

21. In a well tool for use in a well conduit: a first member adapted for connection to a tubular running-in string; a second member telescopically arranged with respect to said first member; means for transmitting the turning effort of said first member to said second member; longitudinally spaced collars disposed around said members; conduit engageable drag springs secured to said collars; means comprising a threaded connection between one of said collars and said second member for moving said collar longitudinally of said second member in response to rotation of said second member; and slippable friction means on said one collar engaging said second member.

22. In a well tool for use in a well conduit: a first member adapted for connection to a tubular running-in string; a second member slidably and telescopically arranged with respect to said

first member; means for transmitting the turning effort of said first member to said second member; longitudinally spaced collars encompassing one of said members; both of said collars being movable with respect to both of said members; conduit engageable drag springs secured to said collars; and means comprising a threaded connection between one of said collars and one of said members for moving said one collar longitudinally of said one member in response to rotation of said one member.

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