

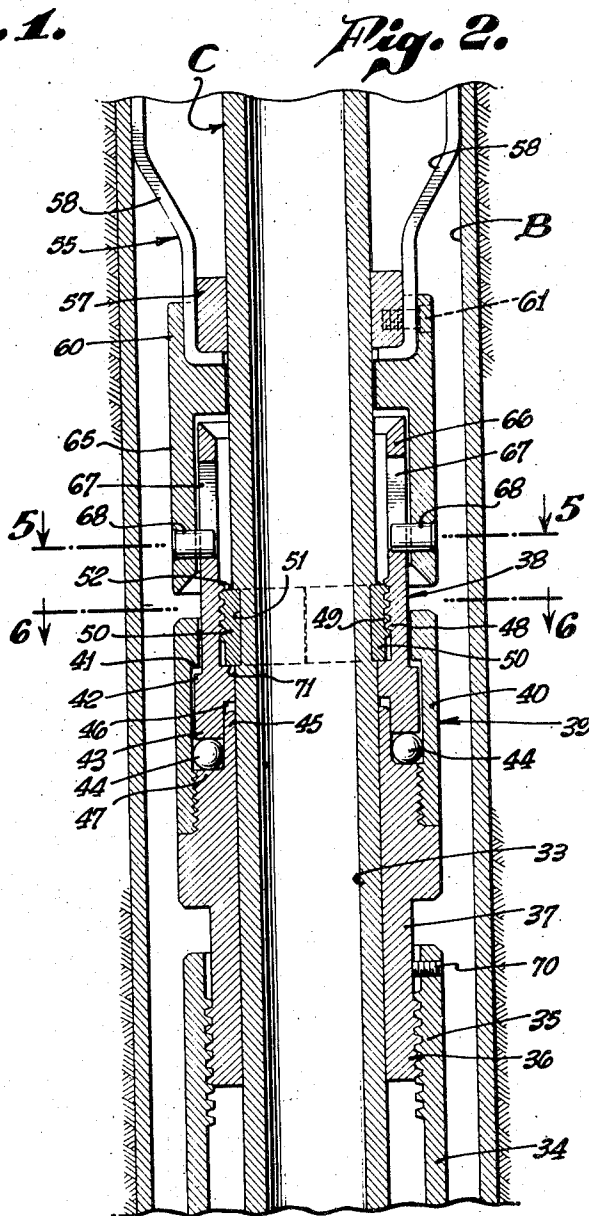
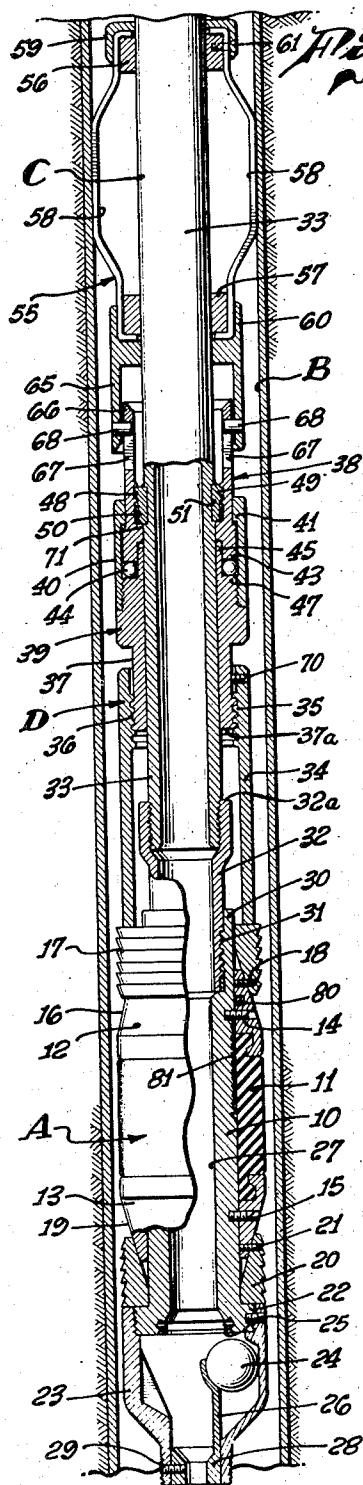
Aug. 13, 1957

R. C. BAKER
WELL TOOL APPARATUS

2,802,533

Filed Dec. 13, 1952

2 Sheets-Sheet 1



REUBEN C. BAKER,
INVENTOR.

BY
Mellin and Hanscom
ATTORNEYS

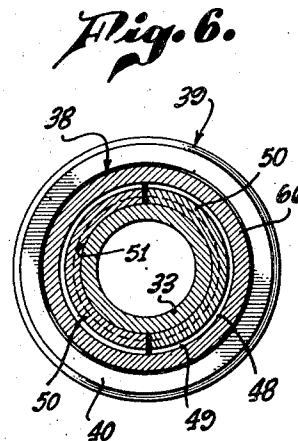
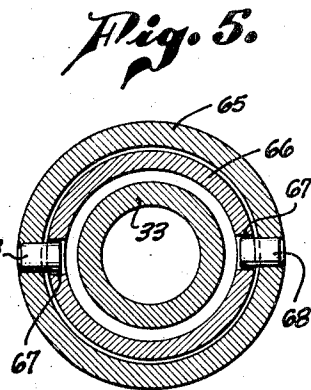
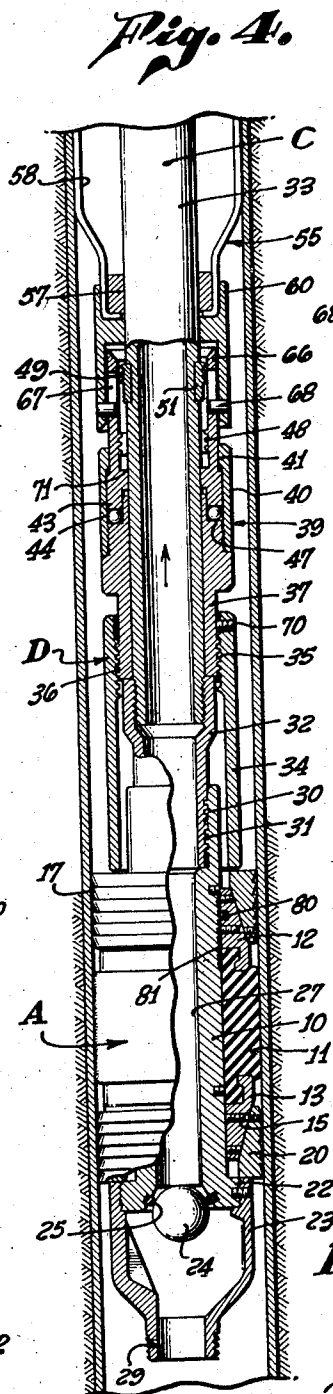
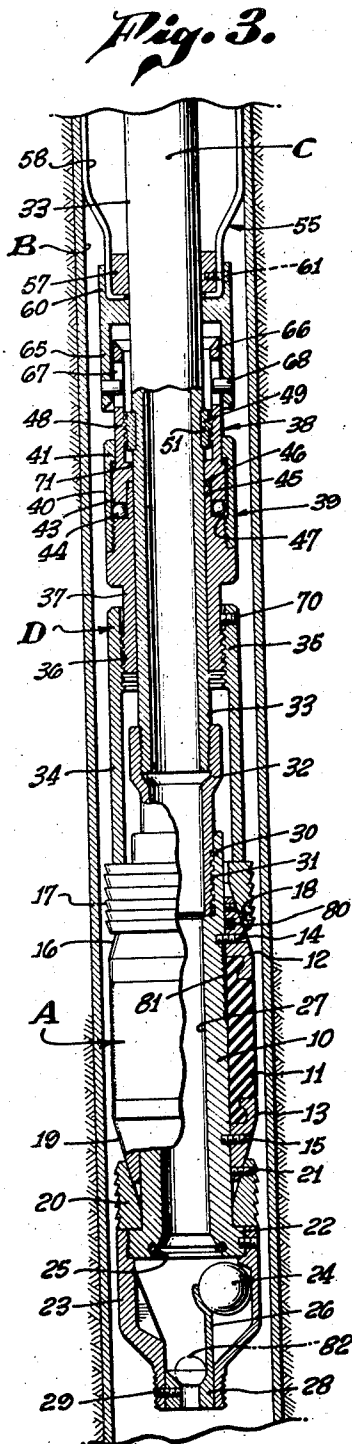
Aug. 13, 1957

R. C. BAKER
WELL TOOL APPARATUS

2,802,533

Filed Dec. 13, 1952

2 Sheets-Sheet 2



REUBEN C. BAKER,
INVENTOR.

BY
Mellin and Hanson
ATTORNEYS

1

2,802,533

WELL TOOL APPARATUS

Reuben C. Baker, Coalinga, Calif., assignor to Baker Oil Tools, Inc., Los Angeles, Calif., a corporation of California

Application December 13, 1952, Serial No. 325,867

12 Claims. (Cl. 166—124)

The present invention relates to well equipment, and more particularly to tools adapted to be run and operated in well bores.

An object of the present invention is to provide improved apparatus for setting or anchoring a well tool, such as a well packer in a well bore.

Another object of the invention is to reduce the time required in setting a well tool, such as a well packer, in a well casing, or similar well conduit.

A further object of the invention is to provide mechanical apparatus operable from the top of the well bore, to release positively a set of normally retracted slips and effect their outward expansion against the wall of a well conduit.

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 longitudinal section, with parts shown in elevation, of a well apparatus disposed within a well casing;

Fig. 2 is an enlarged fragmentary longitudinal section of a portion of the apparatus shown in Fig. 1;

Fig. 3 is a view of the apparatus, similar to Fig. 1, with parts occupying a different relative position;

Fig. 4 is a view of the apparatus, similar to Fig. 1, disclosing parts of the apparatus in still another relative position;

Fig. 5 is a cross-section taken along the line 5—5 on Fig. 2;

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

The invention is illustrated in the drawings as applicable to a well packer A that is to be run in a well casing B, or similar well conduit, on a tubular string C, and which is to be anchored in packed-off condition within the well casing by appropriate manipulation of a setting tool or device D carried by the tubular string, which actually forms part of the setting device. The well packer A disclosed may be of any suitable construction, the one specifically shown being of the type described in United States Letters Patent No. 2,121,050.

Essentially, the packer A consists of a tubular body 10 to which the setting tool D is detachably secured. The body has a packing sleeve 11 surrounding it, the upper and lower ends of the latter being suitably secured to upper and lower conical expanders 12, 13, respectively, attached to the body initially by one or more shear screws 14, 15. The outer surface 16 of the upper expander tapers upwardly and inwardly, engaging correspondingly

2

tapered upper segmental slips 17, which are secured to it initially in retracted position by shear screws 18. In similar fashion, the outer surface 19 of the lower expander 13 is tapered inwardly in a downward direction, engaging correspondingly tapered lower segmental slips 20 secured to the lower expander 13 initially in retracted position by shear screws 21. The lower end of the body 10 is provided with a lower abutment 22 in the form of an outwardly directed flange for engagement with the lower end of the lower segmental slips 20.

A valve housing and guide 23 is secured to the lower end of the body 10. This housing contains a back pressure ball valve 24, preferably buoyant in cement slurry, which is originally prevented from engaging its companion valve seat 25 at the lower portion of the body by a retainer arm 26 holding the ball against the housing to one side of the central passage 27 through the body. The arm 26 extends upwardly from a trip ball seat 28 secured initially in the lower end of the valve housing by a suitable shear screw 29.

The shear screws 18 holding the upper slips 17 to the upper expander 12 have a lesser shear value than the screws 14 holding the upper expander 12 to the body 10. The shear screws 15, 21 securing the lower expander 13 to the body 10 and the lower slips 20 to the expander 13 have a greater shear value than the shear screws 14 securing the upper expander 12 to the body. The relative strengths of the various shear screws are selected, in order that the upper slips 17 may first be released from their normally retracted positions through disruption of the slip screws 18, to enable the upper slips 17 to expand outwardly against the well casing B. Thereafter, the shear screws 14 attaching the upper expander 12 to the body 10 are disrupted, whereupon the remaining lower screws 15, 21 are disrupted, all in the manner hereinafter described.

The upper end of the packer body 10 is provided with a left-hand threaded box 30 receiving a companion left-hand threaded pin portion 31 of a sub 32 which is, in turn, threadedly secured to the tubular mandrel portion 33 of the tubular string, the tubular string extending to the top of the well bore. The mandrel portion 33 and sub 32 actually constitute part of the setting device for shearing the upper slip screws 18 and effecting the downward movement of the upper slips 17 along the upper expander 12 and radially outward into anchoring engagement with the wall of the well casing. To accomplish this purpose, a downward force is imposed on the upper slips 17 and an upward force is imposed upon the packer body 10. That is to say, the packer body 10 and the slips 17 are urged in opposite directions in obtaining the outward expansion of the upper slips along their companion cone 12 and radially into engagement with the wall of the well casing B.

The setting tool D includes a setting sleeve 34, the lower end of which may be caused to bear upon the upper end of the upper slips 17. This setting sleeve has an upper threaded box 35 adjustably and threadedly mounted on the lower threaded end 36 of a lower thrust member or sleeve 37 slidable along the tubular mandrel 33. This lower thrust member and sleeve is secured to an upper thrust member or sleeve 38 by means of a swivel connection 39, in order that the lower thrust member or sleeve 37 and the setting sleeve 34 may rotate, in the manner described below, without any requirement for the upper thrust member or sleeve 38 to rotate.

As specifically shown, the swivel connection includes an outer sleeve 40 threaded on the lower thrust member 37 and having an upper returned flange 41 disposed upon an outer shoulder 42 provided on the upper thrust member 38. The engagement of the flange 41 with the outer shoulder 42 prevents separating movement between the

upper and lower thrust members 38, 37. Any substantial movement of the members toward each other is prevented by engagement of the lower end 43 of the upper thrust member 38 with rollable thrust elements 44, in the form of balls, that are disposed within the outer sleeve 40, and which also surround a portion 45 projecting upwardly from the lower thrust member 37 within a counterbore 46 provided within the upper thrust member 38. Longitudinally directed forces between the upper and lower thrust members 38, 37 are transmitted between the lower end 43 of the upper thrust member, through the ball elements 44, to an opposed outer shoulder 47 formed at the upper portion of the lower thrust member 37.

The upper thrust member 38 is secured initially to the tubular member 33 by a left-hand threaded connection. Thus, the upper thrust member is provided with a left-hand female threaded portion 48 engaging a companion male threaded portion 49 formed on a two-part or split sleeve 50 surrounding the mandrel 33 and disposed within a groove 51 in the latter. The sleeve 50 is made in split, or two-part, form to facilitate its disposition around the mandrel 33 and within the groove 51, after which the segments of the sleeve 50 are secured to the mandrel, as by the aid of welding material 52. The longitudinal extent of the threaded engagement 49, 48 between the sleeve 50 and the upper thrust member 38 need not be very great, merely being sufficient to effect relative downward movement of the thrust members 38, 37 and setting sleeve 34 to shear the top slip screws 18. Because of the left-hand threaded connection 48, 49, rotation of the mandrel 33 in a right-hand direction, or clockwise, as seen from the top of the well bore, will produce downward feeding of the upper thrust member 38 along the mandrel 33, and, through the thrust balls 44, will transmit its motion to the lower thrust member 37 and setting sleeve 34 for action upon the upper set of slips 17. This longitudinal movement of the thrust members and sleeves along the mandrel can occur as a result of preventing rotation of the upper thrust member.

Rotation of the upper thrust member 38 is prevented by a drag device 55 bearing against the wall of the well casing B. This drag device includes longitudinally spaced upper and lower collars 56, 57 slidable on the mandrel 33. Longitudinally extending, outwardly bowed springs 58 are secured to both collars, as by means of upper and lower retaining rings 59, 60 attached to the collars in any suitable manner, as through use of the screws 61. The medial portions of the springs 58 frictionally engage the wall of the well casing B and tend to resist movement of the drag springs and the collars 56, 57 attached thereto, as well as the retainer rings 59, 60. The resistance to movement offered by the outwardly bowed springs 58 is transmitted to the upper thrust member 38 through a pin and slot connection.

As disclosed, the lower retainer ring 60 has a depending skirt 65 integral therewith, which is telescoped over an upwardly extending portion 66 of the upper thrust member 38, which is provided with a pair of diametrically opposite, longitudinally extending slots 67. Pins 68 are secured to the depending skirt 65 and are received within these slots. Because of the pin and slot connection 67, 68, the restraint to movement of the lower retaining ring 60 and its depending skirt 65, provided by the springs 58, is transferred to the upper thrust member 38, enabling the tubular mandrel 33 and its left-hand threaded member 50 to be rotated within the upper thrust member 38, for the purpose of feeding the latter in a downward direction. The downward movement of the upper thrust member 38, however, is not resisted by the drag device 55, in view of the elongate slots 67 provided in the upper thrust member, and the ability of the latter to slide downwardly along the pins 68 attached to the depending skirt 65.

The well packer A is secured to the lower sub 32 of the setting apparatus in the manner disclosed in Fig. 1, the

setting sleeve 34 being turned on the lower thrust member 37 until it just engages the upper end of the upper slips 17, whereupon the setting sleeve may be locked to the lower thrust member, as by use of a set screw 70 threaded transversely in the upper end of the setting sleeve 34 and bearing against the lower thrust member 37. The segmental sleeve 50 on the mandrel 33 is threaded to its full extent within the upper thrust member 38, as determined by engagement of its lower end with an inner shoulder 71 formed on the upper thrust member. The assembly is then run downwardly through the well casing B, the friction drag springs 58 sliding along the well casing wall, the drag assembly being pulled through the well casing by the engagement of the upper portion of the sleeve 66 defining the slots 67 with the pins 68.

When the location in the well casing B is reached at which the well packer A is to be anchored in packed-off condition therein, all that need be done is to rotate the mandrel 33, as in a right-hand direction. Such rotation will also rotate the segmental sleeve 50, as well as the sub 32 and the entire packer apparatus A. Since the setting sleeve 34 is bearing against the upper slips 17, it is quite possible that it, as well as the lower thrust member 37 secured thereto, and the outer sleeve 40, will also be rotated. But such rotation can readily occur without corresponding rotation of the upper thrust member 38, because of the swivel connection 39 provided between the upper and lower thrust members 38, 37. The upper thrust member 38, as stated above, will be prevented from rotating by the drag device 55 and the pin and slot connection 67, 68. As a result of rotation of the sleeve 50, and the fact that the drag device 55 prevents rotation of the upper thrust member 38, the latter is fed downwardly along the mandrel 33, its downward force being transmitted through the lower thrust member 37 and setting sleeve 34 to the upper slips 17, the force being sufficient to shear the top slip screws 18, which allows the latter to drop downwardly along the cone 12 and outwardly into anchoring engagement with the wall of the well casing B (Fig. 3).

Following disruption of the top slip screws 18, it is only necessary to rotate the mandrel 33 a few revolutions to a further extent to completely unscrew the segmental sleeve 50 from the female threaded portion 48 of the upper thrust member 38. When this complete unscrewing takes place, then the setting sleeve 34 and thrust members 37, 38 can drop downwardly, which will force the upper slips 17 downwardly along the upper expander cone 12, in the event they have not dropped down therealong to their full extent under the influence of gravity alone. In other words, the setting sleeve 34 and the thrust members 37, 38 provide additional weight for forcing the upper slips 17 down along the expander cone 12 and radially outward into anchoring engagement with the wall of the well casing.

After the upper slips 17 have been engaged with the well casing B, the tubular string C and its mandrel 33 are moved longitudinally upward and without rotation, this upward motion being transmitted through the sub 32 to the packer body 10. When the upward force is sufficient, it will shear the screws 14 securing the upper expander 12 to the packer body 10, and will move the lower slips 20 and lower expander 13 with the body toward the upper expander 12, thereby foreshortening the packing sleeve 11 and expanding it radially outward into sealing engagement with the wall of the well casing B. A continuation of the upward strain on the tubular string C, sub 32 and body 10 will then shear the screws 15, 21 securing the lower expander 13 to the body and the lower slips 20 to the lower expander, the lower slips being shifted upwardly along the lower expander 13 and radially outward into anchoring engagement with the wall of the well casing.

A sufficient upward strain is normally taken on the tubular string C and body 10 to insure the firm engage-

5

ment of both the upper and lower slips 17, 20 with the wall of the well casing and the firm sealing engagement of the packing sleeve 11 with the periphery of the body 10 and the well casing. The packer parts are held in their expanded positions by a suitable one-way lock device, which may consist of a ratchet ring 80 carried by the upper expander 12 and engaging companion ratchet teeth 81 formed in the periphery of the body. The ratchet teeth 81 and ring 80 are so arranged as to permit the body 10 to move upwardly within the upper expander 12 for the purpose of fully setting the well packer, but they will lock the body 10 to the upper expander 12, in the event the body tends to move downwardly there-within.

After the packer has been securely anchored in packed-off condition within the well casing, a suitable tripping ball 82 (see Fig. 3) can be dropped down the tubular string C, for the purpose of engaging the trip ball seat 28, whereupon pressure can be built up in the tubular string C and packer passage 27 to shear the screw 29 holding the trip ball seat 28 to the valve housing 23, ejecting the trip ball seat and retainer arm 26 from the housing 23, which frees the back pressure ball valve element 24 and allows it to move upwardly into engagement with its companion seat 25 (Fig. 4).

After the foregoing actions have taken place, the tubular string C can then be rotated to the right. The packer body 10 is prevented from rotating by engagement of the upper and lower slips 17, 20 with the well casing, causing the lower sub 32 to rotate within the packer body 10 and accomplish its complete unscrewing from the packer body by the unthreading of the pin 31 from the box 30. Upward movement of the sub 32 causes its upper end 32a to engage the lower end 37a of the lower thrust member 37 (Fig. 4), causing the entire setting tool to be elevated with the tubular string C and its mandrel 33 to the top of the well bore, leaving the packer A anchored in the well casing B.

Various operations can be performed with the apparatus once the packer A has been set in the well casing B. As an example, cement slurry, or other cementitious material, may be pumped down the tubular string C prior to disconnection of its sub 32 from the well packer 10, for outward passage through the well packer at its lower end. After the required amount of cementitious material has been displaced through the well packer, the pressure within the tubular string C can be relieved, allowing the back pressure valve 24 to engage its seat 25 and preclude return flow of the cement slurry through the well packer A. Thereafter, the tubular string C can be rotated, to disconnect the sub 32 from the upper end of the packer body 10, allowing the tubular string C and the entire setting tool D to be withdrawn from the well casing B.

The inventor claims:

1. In well apparatus: a well device having a body and normally retracted means on said body adapted to be expanded laterally outward into engagement with the wall of a well conduit; a setting tool connected to said body, said tool including a member attached to the body to rotate therewith, means on the member engageable with said normally retracted means to exert a force thereon to expand said normally retracted means outwardly, said means being removable from said normally retracted means after expansion of said normally retracted means, friction drag means engageable with the wall of the well conduit and connected to said expanding means to resist movement of said expanding means in the well conduit, coengaging threads on said member and expanding means for feeding said expanding means longitudinally with respect to said body whereby said expanding means exerts a force on said normally retracted means to expand said normally retracted means outwardly during rotation of said member relative to said expanding means, said threads becoming disengaged upon predetermined rotation of said member relative to said expanding means to permit non-rotary

6

longitudinal movement of said member relative to said expanding means; and means on said member engageable with said expanding means, after said threads are disengaged, to remove said expanding means from said normally retracted means.

2. In well apparatus: a well device having a body and normally retracted means on said body adapted to be expanded laterally outward into engagement with the wall of a well conduit; a setting tool connected to said body, said tool including a member attached to the body to rotate therewith, means on the member engageable with said normally retracted means to exert a force thereon to expand said normally retracted means outwardly, said means being removable from said normally retracted means after expansion of said normally retracted means, friction drag means engageable with the wall of the well conduit and connected to said expanding means to resist movement of said expanding means in the well conduit, axial cam means interconnecting said member and expanding means for feeding said expanding means longitudinally with respect to said body whereby said expanding means exerts a force on said normally retracted means to expand said normally retracted means outwardly during rotation of said member relative to said expanding means, said cam means becoming disengaged upon predetermined rotation of said member relative to said expanding means to permit non-rotary longitudinal movement of said member relative to said expanding means; and means on said member engageable with said expanding means, after said cam means are disengaged, to remove said expanding means from said normally retracted means.

3. In well apparatus: a well device having normally retracted means adapted to be expanded laterally outward into engagement with the wall of a well conduit, a setting tool connected to said well device, said tool including a member attached to the well device, means on the member engageable with said normally retracted means to exert a force thereon to expand said normally retracted means outwardly, friction drag means engageable with the wall of the well conduit, a lost motion connection between said friction drag means and expanding means to resist rotation of said expanding means in the well conduit while permitting longitudinal movement of said expanding means relative to said friction drag means, and coengaging threads on said member and expanding means for feeding said expanding means longitudinally whereby said expanding means exerts a force on said normally retracted means to expand said normally retracted means outwardly upon rotation of said member.

4. In well apparatus: a well device having normally retracted means adapted to be expanded laterally outward into engagement with the wall of a well conduit, a setting tool connected to said well device, said tool including a member attached to the well device, means on the member engageable with said normally retracted means to exert a force thereon to expand said normally retracted means outwardly, friction drag means engageable with the wall of the well conduit, a lost motion connection between said friction drag means and expanding means to resist rotation of said expanding means in the well conduit while permitting longitudinal movement of said expanding means relative to said friction drag means, and axial cam means interconnecting said member and expanding means for feeding said expanding means longitudinally whereby said expanding means exerts a force on said normally retracted means to expand said normally retracted means outwardly upon rotation of said member.

5. In well apparatus: a well device having normally retracted means adapted to be expanded laterally outward into engagement with the wall of a well conduit, a setting tool connected to said well device, said tool including a member attached to the well device to rotate therewith, first means on the member engageable with

said normally retracted means, second means on the member swivelly connected to said first means, friction drag means engageable with the wall of the well conduit and connected to said second means, and coengaging threads on said member and second means for feeding said second means and first means longitudinally in a direction to exert a force on said normally retracted means expanding said normally retracted means outwardly upon rotation of said member.

6. In well apparatus: a well device having normally retracted means adapted to be expanded laterally outward into engagement with the wall of a well conduit, a setting tool connected to said well device, said tool including a member attached to the well device to rotate therewith, first means on the member engageable with said normally retracted means, second means on the member swivelly connected to said first means, friction drag means engageable with the wall of the well conduit and connected to said second means, and axial cam means interconnecting said member and second means for feeding said second means and first means longitudinally in a direction to exert a force on said normally retracted means expanding said normally retracted means outwardly during rotation of said member.

7. In well apparatus: a well device having normally retracted means adapted to be expanded laterally outward into engagement with the wall of a well conduit, a setting tool connected to said well device, said tool including a member attached to the well device, first means on the member engageable with said normally retracted means, second means on the member swivelly connected to said first means, friction drag means engageable with the wall of the well conduit, a lost motion connection between said friction drag means and second means to resist rotation of said second means in the well conduit, and coengaging threads on said member and second means for feeding said second means and first means longitudinally in a direction to exert a force on said normally retracted means expanding said normally retracted means outwardly upon rotation of said member.

8. In well apparatus: a well device having normally retracted means adapted to be expanded laterally outward into engagement with the wall of a well conduit, a setting tool connected to said well device, said tool including a member attached to the well device, first means on the member engageable with said normally retracted means, second means on the member swivelly connected to said first means, friction drag means engageable with the wall of the well conduit, a lost motion connection between said friction drag means and second means to resist rotation of said second means in the well conduit, and axial cam means interconnecting said member and second means for feeding said second means and first means longitudinally to exert a force on said normally retracted means expanding said normally retracted means outwardly upon rotation of said member.

9. In a setting tool for subsurface well apparatus: a member adapted to be connected to a running-in string for operation in a well bore, first means movable longitudinally on the member, second means on the members swivelly connected to said first means, friction drag means engageable with the wall of the well bore, a lost motion connection between said friction drag means and said first means coupling said friction drag means and first means against relative rotation while permitting longitudinal movement of said first and second means relative to said friction drag means, and coengaging threads on said member and first means for feeding said first and second means longitudinally upon rotation of said member.

10. In well apparatus: a well device having a body and normally retracted means adapted to be expanded laterally outward into engagement with the wall of a well conduit; a setting tool connected to said body, said tool including a member threadedly connected to the body to rotate therewith; means on the member engageable with said normally retracted means to exert a force thereon to expand said normally retracted means outwardly, said means being removable from said normally retracted means after expansion of said normally retracted means, friction drag means engageable with the wall of the well conduit and connected to said expanding means to resist movement of said expanding means in the well conduit, coengaging threads on said member and expanding means for feeding said expanding means longitudinally with respect to said body whereby said expanding means exerts a force on said normally retracted means to expand said normally retracted means outwardly during rotation of said member relative to said expanding means, said coengaging threads becoming disengaged upon predetermined rotation of said member relative to said expanding means to permit non-rotary longitudinal movement of said member relative to said expanding means; and means on said member engageable with said expanding means, after said coengaging threads are disengaged, to remove said expanding means from said normally retracted means.

11. In well apparatus: a well device having normally retracted means adapted to be expanded laterally outward into engagement with the wall of a well conduit, a setting tool connected to said well device, said setting tool including a member attached to the well device, means on the member engageable with said normally retracted means to exert a force thereon to expand said normally retracted means outwardly, friction drag means engageable with the wall of the well conduit, a pin and slot lost motion connection between said friction drag means and expanding means coupling said friction drag means and expanding means against relative rotation while permitting longitudinal movement of said expanding means relative to said friction drag means, and axial cam means interconnecting said member and expanding means for feeding said expanding means longitudinally in a direction to exert a force on said normally retracted means expanding said normally retracted means outwardly upon rotation of said member.

12. In a setting tool for subsurface well apparatus: a member adapted to be connected to a running string for operation in a well bore, first means movable longitudinally on the member, second means on the member swivelly connected to said first means, friction drag means engageable with the wall of the well bore, a pin and longitudinal slot connection between said first means and friction drag means providing a lost motion connection between said friction drag means and said first means coupling said friction drag means and first means against relative rotation while permitting longitudinal movement of said first and second means relative to said friction drag means, and coengaging threads on said member and first means for feeding said first and second means longitudinally upon rotation of said member.

References Cited in the file of this patent

UNITED STATES PATENTS

2,248,211	Young	July 8, 1941
2,368,399	Baker	Jan. 30, 1945
2,564,240	Ware	Aug. 14, 1951
2,589,337	Burns	Mar. 18, 1952
2,589,506	Morrisett	Mar. 18, 1952
2,689,612	Sawyer	Sept. 21, 1954