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R. C. BAKER

2,665,763

WELL PACKER APPARATUS

Filed April 23, 1948

2 Sheets-Sheet 1

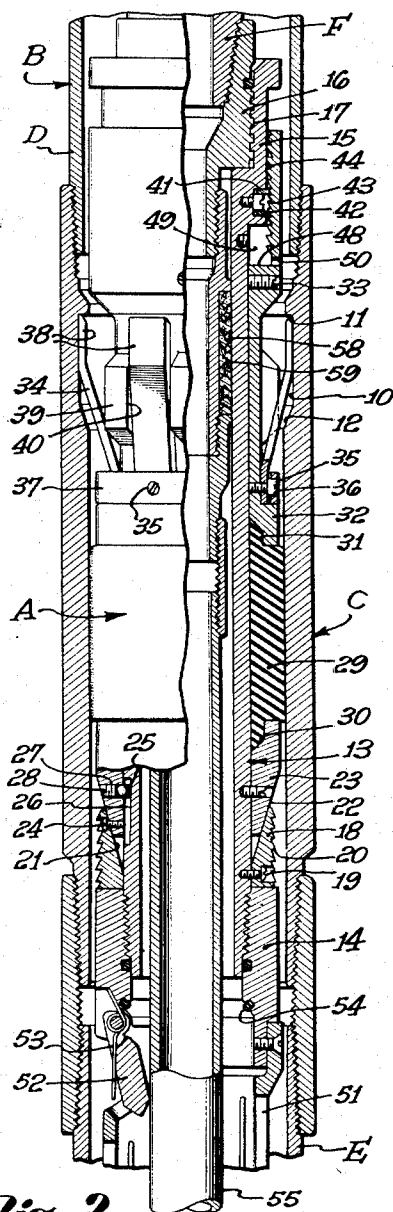
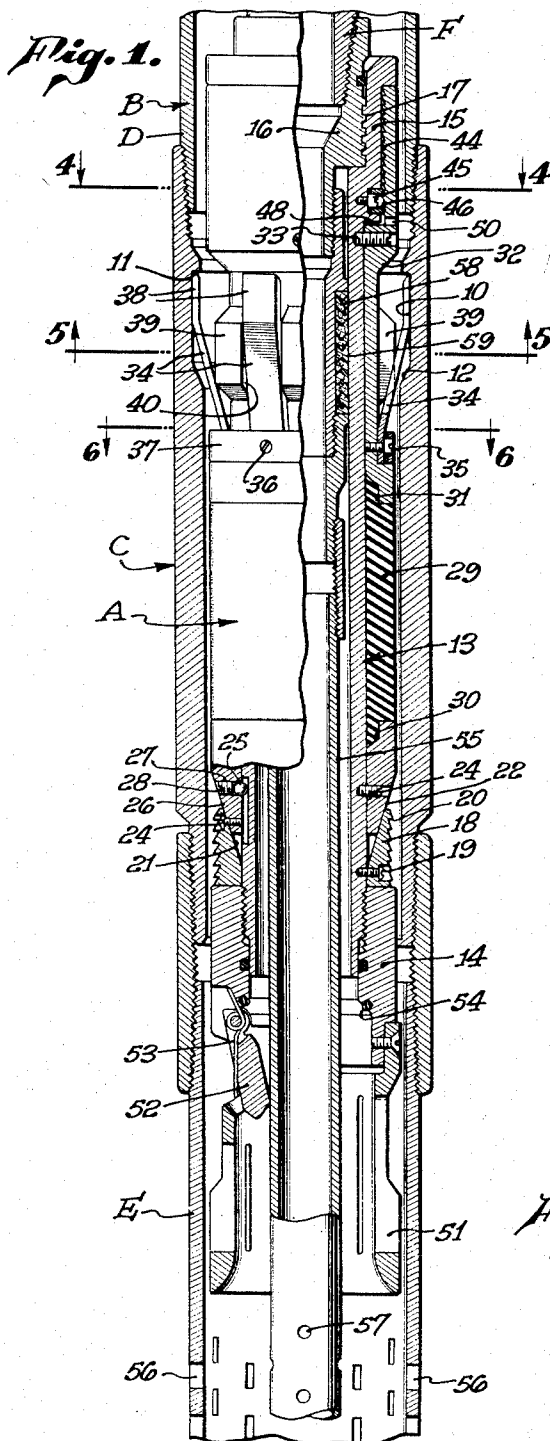


Fig. 2.

INVENTOR.
REUBEN C. BAKER,
 BY
Mellin and Henscom
 ATTORNEY.

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2 Sheets-Sheet 2

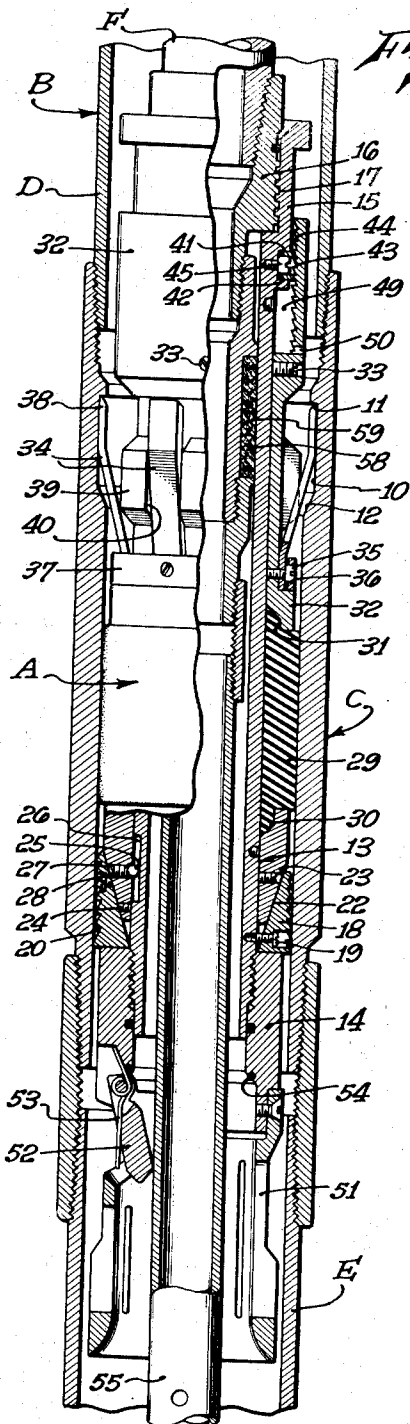


Fig. 3.

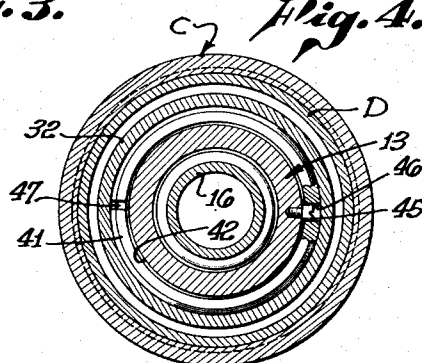


Fig. 4.

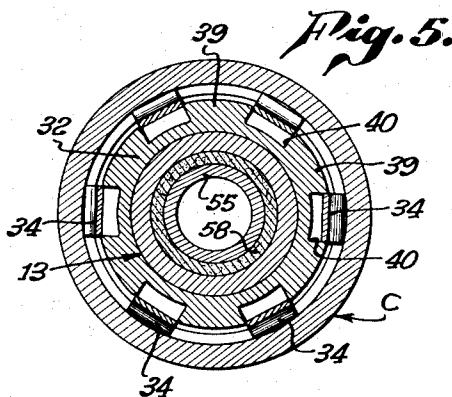


Fig. 5.

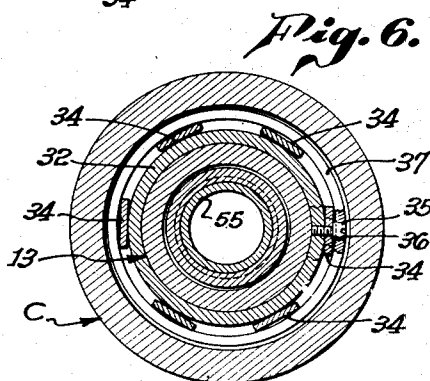


Fig. 6.

INVENTOR.
REUBEN C. BAKER,
BY
Mellin and Hancock
ATTORNEY.

UNITED STATES PATENT OFFICE

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WELL PACKER APPARATUS

Reuben C. Baker, Coalinga, Calif., assignor to
Baker Oil Tools, Inc., Vernon, Calif., a corpo-
ration of California

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17 Claims. (Cl. 166—12)

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The present invention pertains to well apparatus adapted to be anchored in well conduits, such as casing located in well bores.

An object of the invention is to provide a well tool, which can be anchored to a well casing against movement in both longitudinal directions by the simple expedient of moving the running-in string, to which the tool is attached, in one direction. More specifically, the tool is anchored against minutely slight longitudinal movement in the casing, as the result of moving the running-in string upwardly.

Another object of the invention is to provide an improved well packer which can be anchored immovably in pack-off condition within the well casing by moving the running-in string in one longitudinal direction.

A further object of the invention is to provide an improved well packer, which is simple to set and operate, and which is capable of withstanding high pressure and temperature conditions encountered in a well bore.

Still another object of the invention is to provide a well packer that can be run and set in the well casing on a tubing string without the need for special setting tools, thereby obviating the necessity for removing the tubing string from the well casing, and permitting the tubing string to function as a production conduit after the setting operation has been performed.

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 is embodied. This form is shown in the drawings accompanying and forming part of the present specification, and will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that this 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 section and partly in elevation, of a well packer apparatus disposed in a well casing, and with the parts in position prior to anchoring the packer in packed-off condition within the casing;

Fig. 2 is a longitudinal view, similar to Fig. 1, of the well packer partly anchored in packed-off condition within the casing;

Fig. 3 is a view similar to Fig. 1, with the well packer fully anchored in packed-off condition within the casing; and

Figs. 4, 5 and 6 are cross-sections taken along

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the lines 4—4, 5—5 and 6—6, respectively on Fig. 1.

The well tool disclosed in the drawings is a packer A adapted to be run in a well casing B to a predetermined setting point, at which it is to be anchored in pack-off condition against the wall of the casing string.

The casing string B includes a collar C adapted to connect upper and lower casing sections D, E in spaced relation. This collar has an internal, elongate circumferential groove 10 whose inside diameter is substantially greater than the normal inside diameter of the casing sections D, E themselves. The groove 10 terminates in an upper shoulder 11 substantially at right angles to the casing string axis, and also in a lower inclined surface 12 converging in a downward direction from the inner wall or recess to the smaller diameter wall of the collar.

The well packer A is adapted to be anchored to the well casing as a result of certain anchoring means entering the collar recess 10. This packer includes an elongate tubular body 13 having a guide or abutment 14 threaded on its lower end, and an integral upper head 15 threaded on to a sub 16 attached to the lower end of a tubing string F. The threaded connection 17 between the sub 16 and body head 15 is preferably left hand, to permit the tubing string F to be disconnected from the body 13, when desired, through a right hand rotation of the former member.

The body 13 is adapted to be anchored to the well casing against downward movement by a set of lower segmental slips 18, which may rest against the abutment 14, being held initially in retracted positions by one or more shear screws 19 threaded through the slips into the body 13. These slips have downwardly facing wickers or teeth 20 capable of embedding themselves into the casing or collar wall, and downwardly and inwardly converging tapered surfaces 21 cooperating with a corresponding external surface 22 on a conical expander 23, which is initially secured to the body by one or more shear screws 24.

It is preferred to prevent rotation between the expander 23 and body 13, while permitting their relative longitudinal movement, by a key or spline connection. As disclosed in the drawings, this connection may consist of a ball key 25 fitting within an elongated longitudinal keyway 26 in the exterior of the body 13. The ball 25 fits partially within the keyway 26 and partially within a hole 27 in the expander 23. The ball is held in proper assembled relation by a headless

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screw 28 threaded into the expander hole 27, with its inner end adjacent the ball 25.

It is also desired to effect a seal between the packer body 13 and the casing B. The sealing instrumentality disclosed may consist of a packing sleeve 29, of rubber or similar packing material, encompassing the body 13, with its lower end received within a pocket 30 defined between the conical expander 23 and the exterior of the body. The upper end of the packing is similarly received within a pocket 31 in a setting sleeve 32 slidable on the body 13, but initially secured to the body by one or more shear screws 33. When the shear screws 33, 24 holding the setting sleeve and expander to the body are intact, the sleeve 32 and expander 23 are spaced longitudinally a sufficient distance to allow the packing sleeve 29 to remain in retracted position against the body. However, upon disruption of those shear screws and upward movement of the body 13 within the setting sleeve 32, the expander 23 is moved toward the latter, in order to foreshorten the packing sleeve 29 and expand it outwardly into firm sealing engagement with the casing wall.

As above indicated, the lower slips 18 are to be engaged with the casing B, to secure the well packer A against downward movement. Upward movement of the well packer is prevented by a plurality of upwardly facing locking or latching elements 34 adapted to expand outwardly into the collar recess 10. These elements are spaced circularly around the setting sleeve 32, and have their lower ends secured to the tubular setting sleeve by screws 35 passing through them and threaded into the sleeve. The heads of the screws 35 may be received within holes 36 provided in a band 37 encompassing the lower ends of the leaf spring members 34, and thereby serving to retain them in position against the setting sleeve 32.

Each spring 34 extends upwardly from its point of attachment to the setting sleeve 32, and inherently tends to expand outwardly to place its upper foot portion 38 against the casing wall, and, when disposed opposite the collar recess 10, into the latter for upward contact with the shoulder 11 defining the upper end of the recess. The spring is preferably designed so that its foot portion 38 occupies a position substantially parallel to the axis of the casing when expanded outwardly into the recess 10. Moreover, the length of the foot portion is preferably longer than the usual collar spaces found at the casing string couplings, to cause such foot portions 38 to bridge this space and prevent their inadvertent outward movement thereinto, which might effect premature setting of the packer upon upward movement of the tubing string F. As is well known, the tubing string is moved in this fashion to a small extent, upon elevating a tubing section from the tubing slips at the top of the well bore.

For the purpose of preventing twisting of the springs 32, and to guide them along substantially radial paths in their outward expanding movement, the setting sleeve 32 has a plurality of circularly spaced projections 39, defining grooves 40 in which the spring members are movable. These grooves extend only along the mid-portion of the springs 32, being open at their upper and lower ends to prevent their plugging with drilling mud, or other substances, in the well casing B, which might prevent outward expansion of the springs 32 into the collar recess 10.

In order to prevent downward movement of the body 13 within the parts mounted externally of it, after the tool has been anchored in packed-

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off condition within the well casing B, a locking device is provided between the body head 15 and the upper portion of the setting sleeve 32. This lock device, although preventing downward movement of the body 13 within the setting sleeve 32, permits upward movement of the body in the latter member.

As specifically disclosed in the drawings, the lock device consists of a split ratchet ring 41 located within a peripheral head groove 42 and tending to expand outwardly inherently, in order to place its downwardly facing peripheral teeth 43 in engagement with companion internal teeth 44 in the upper portion of the setting sleeve 32. For economy of manufacture, the cooperable teeth 43, 44 are preferably formed as helical threads, which provides a large surface of engagement therebetween. In order to prevent rotation of the ratchet ring 41 in the body 13, which might tend to bind the ring against its groove 42, or against the helical thread 44 in the sleeve, a stop element 45, in the form of a screw, is threaded into the body 13, with its head projecting into a hole 46 in the ring diametrically opposite the split ends 47 of the ring.

In moving upwardly, the head 15 moves away from the shoulder portion 48 of the setting sleeve, providing an annular chamber 49 which may have a vacuum in it. To prevent creation of such vacuum, one or more bleeder holes 50 may be provided in the upper portion of the setting sleeve 32, immediately above the shoulder 48, and communicating with the interior of the upper portion.

In the specific tool shown in the drawings, a slotted junk pusher 51 is suitably attached to the lower end of the guide 14, to prevent foreign substances in the well bore from wedging between the slips 18 and casing, and possibly causing their premature setting. In addition, a back pressure valve 52, in the form of a flapper, is pivotally mounted on the guide and is adapted to be moved by a spring 53 upwardly into engagement with a cooperable seat 54 in the guide 14, to prevent upward flow of fluid through the well packer. This valve 52, however, is normally held to one side in an open position by a production tube 55 threaded on the lower end of the sub 16, and extending completely through the packer to a point therebelow.

After the packer A has been set in the well casing B, the well production may pass through casing perforations 56 below the packer A and through perforations 57 in the production tubing 55, flowing upwardly through the production tubing and through the tubing string F to the top of the well bore. Leakage between the production tubing 55 and inner wall of the packer body 13 may be prevented by a suitable packing assembly, which is disclosed as consisting of oppositely facing chevron type packing rings 58 sealingly engaging both the exterior of the production tubing 55 and the inner wall of the body 13. The packing rings are held longitudinally separated by suitable spacer members 59.

The well packer A, with its parts in retracted position, with the exception of the upwardly facing lock springs 34, is attached to the lower end of the tubing string F by means of the sub 16, and is run in the well casing B to a point below the collar recess 10. It is evident that during this running-in operation, the production tubing 55 extends through the packer body and holds the flapper valve 52 in open position. It is also to be noted that the upwardly facing lock springs

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34 will ride over casing couplings or collar spaces without preventing descent of the packer in the well casing.

After the packer has been lowered to a point below the collar recess 10, the tubular string F is elevated slowly until the upwardly facing lock springs 34 are disposed opposite the collar recess 10. In view of their inherent tendency to expand outwardly, the springs will move out into the recess 10, upward movement of the tubing string F and packer A continuing until the upper ends 38 of the springs engage the recess shoulder 11. Since the springs are anchored to the setting sleeve 32, such engagement prevents further upward movement of the latter (Fig. 1).

A continuation of the upward strain on the tubing string F then shears the screws 33 attaching the setting sleeve 32 to the body 13, since the setting sleeve is prevented from moving upwardly by the springs 34. The body 13 moves upwardly within the setting sleeve, moving the lower expander 23 toward the sleeve 32, foreshortening the packing 29 and expanding it outwardly into firm sealing engagement with the casing wall (Fig. 2). When the packing has been compressed fully between the lower end of the setting sleeve 32 and the conical expander 23, the latter member is prevented from moving upwardly to any further extent. Accordingly, a continuation of the upward strain on the tubing string F and body 13 will shear the screws 19, 24 holding the expander 23 and slips 18 to the body, moving the body upwardly within the expander 23 and causing the lower abutment 14 to shift the slips 18 upwardly along the expander and radially outward, until their wickers 20 are embedded firmly into the casing or collar wall (Fig. 3).

The well packer A has now been anchored in packed-off condition within the well casing B. Any tendency for the body 13 to move upwardly is prevented, since the upward force is transmitted through the lower slips 18, expander 23, packing element 29, setting sleeve 32, and springs 34 to the collar shoulder 11. Any tendency for the body 13 to move downwardly is prevented by the lower slips 18, the downward force being transmitted to the latter elements through the lock ring 41, (which has ratcheted freely in an upward direction along the setting sleeve ratchet teeth 44), setting sleeve 32, packing element 29, expander 23 to the slips 18, and thence through their wickers 20 to the collar C. Accordingly, the well packer cannot move in either longitudinal direction, and leakage through the annulus between the body 13 and well casing B is prevented by the compressed packing element 29.

In the event it is desired to disconnect the tubing string F from the packer A, the former need merely be turned to the right to unscrew the sub 16 from the body head 15. Rotation of the body 13 is prevented by the key and slot connection 25, 26 between the body and expander, and by virtue of the wedging action of the expander 23 in the embedded slips 18. Assurance is, therefore, had that the tubing string F may be disconnected completely from the body 13 for withdrawal, together with the production tubing 55, to the top of the well bore. As the production tubing moves above the flapper valve 52, the latter will engage its cooperable seat 54 and prevent upward passage of the well production through the packer A.

It is, accordingly, apparent that a well packer has been provided which can be fully set in packed-off condition against movement in both

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longitudinal directions through the simple expedient of longitudinally moving the tubing string in one direction, which, as specifically disclosed, is in the upward direction. The tubing string is anchored against even slight longitudinal movement or shifting, since the ends of the lock springs 34 engage the recessed shoulder 11 firmly and the slips 18 are in firm wedging engagement with the casing wall. There is no play, whatsoever, allowed between the anchored elements and the casing or collar to permit longitudinal movement. No special setting tools are required in anchoring the tool in the well casing. As a result, the same tubing string F used in running the tool and setting in the well bore, may remain attached to the well packer for use as the production tubing, thereby avoiding the necessity for removing the running-in string for the purpose of retrieving setting equipment, and then running the same, or another, tubing string back in the well for reconnection or reassociation with the well packer. This particular packer is capable of withstanding high pressures and temperatures encountered in well bores over extended periods.

The inventor claims:

1. In a well tool: a body adapted for lowering in a well conduit on a running-in string; tubular means slidable on said body; an outwardly expandable leaf spring on said tubular means engageable with a shoulder in said conduit for preventing movement of said tubular means in one direction; slip means on said body engaged and movable by said body in said one longitudinal direction toward said tubular means and into engagement with said conduit for preventing movement of said body in the opposite longitudinal direction; and means securing said body against longitudinal movement with respect to said leaf spring and slip means when said leaf spring and slip means are both engaged with said conduit to prevent longitudinal movement of said tubular means in one direction and said body in the opposite longitudinal direction.

2. In a well tool: a body adapted for lowering in a well conduit on a running-in string; tubular means slidable on said body; an outwardly expandable leaf spring on said tubular means engageable with a shoulder in said conduit for preventing movement of said tubular means in one longitudinal direction; slip means on said body engaged and movable by said body in said one longitudinal direction toward said tubular means and into engagement with said conduit for preventing movement of said body in the opposite longitudinal direction; and coengaging means on said body and tubular means for preventing longitudinal movement of said body within said tubular means in one direction when said leaf spring and slip means are both engaged with said conduit to prevent longitudinal movement of said tubular means in one direction and said body in the opposite longitudinal direction.

3. In a well tool: a body adapted for lowering in a well conduit on a running-in string; tubular means slidable on said body; an outwardly expandable leaf spring on said tubular means having an end engageable with a shoulder in said conduit for preventing movement of said tubular means in one longitudinal direction; slip means on said body engaged and movable by said body in said one longitudinal direction toward said tubular means and into engagement with said conduit for preventing movement of said tubular means in the opposite longitudinal direction; and

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packing means on said body adapted to be compressed between said tubular means and slip means into sealing engagement with said conduit.

4. In a well tool: a body adapted for lowering in a well conduit on a running-in string; tubular means slidable on said body; an outwardly expandible leaf spring on said tubular means having an end engageable with a shoulder in said conduit for preventing movement of said tubular means in one longitudinal direction; slip means on said body engaged and movable by said body in said one longitudinal direction toward said tubular means and into engagement with said conduit for preventing movement of said tubular means in the opposite longitudinal direction; packing means on said body adapted to be compressed between said tubular means and slip means into sealing engagement with said conduit; and coengaging lock means on said body and tubular member for preventing longitudinal movement in one direction of said body with respect to said tubular means.

5. In a well tool: a body adapted for lowering in a well conduit on a running-in string; a tubular member slidable on said body; an outwardly expandible leaf spring on said tubular means engageable with a shoulder in said conduit for preventing upward movement of said tubular member; slip means on said body movable upwardly by said body and into engagement with said conduit for preventing downward movement of said body; and coengaging means on said body and tubular member for preventing downward movement of said body with respect to said tubular member and slip means.

6. In a well tool: a body adapted for lowering in a well conduit on a running-in string; a tubular member slidable on said body; an outwardly expandible leaf spring on said tubular member having an upper end engageable with a shoulder in said conduit for preventing upward movement of said tubular member; an expander slidably mounted on said body; slips cooperable with said expander and movable upwardly by said body into engagement with the well conduit to prevent downward movement of said body; and packing means around the body adapted to be compressed between said tubular member and expander into sealing engagement with said conduit.

7. In a well tool: a body adapted for lowering in a well conduit on a running-in string; a tubular member slidable on said body; an outwardly expandible leaf spring on said tubular member having an upper end engageable with a shoulder in said conduit for preventing upward movement of said tubular member; an expander slidably mounted on said body; slips cooperable with said expander and movable upwardly by said body into engagement with the well conduit to prevent downward movement of said body; packing means around the body adapted to be compressed between said tubular member and expander into sealing engagement with said conduit; and coengaging means on said body and tubular member for preventing downward movement of said body with respect to said tubular member.

8. In a well tool: a body adapted to be lowered in a well conduit on a running-in string; a tubular member slidable on said body; frangible means securing said tubular member to said body; upwardly facing outwardly expandible leaf springs on said tubular member engageable with a shoulder in said conduit for preventing upward

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movement of said tubular member; an expander slidable on said body; slips engageable with said expander for anchoring said expander to said conduit against downward movement; frangible means securing said expander to said body; frangible means securing said slips to said body in retracted position; packing means on said body adapted to be compressed between said expander and tubular member into sealing engagement with said conduit; and coengaging means on said body and tubular member for preventing downward movement of said body with respect to said tubular member and expander.

9. In a well tool: a body adapted for lowering in a well conduit on a running-in string; tubular means slidable on said body; an outwardly expandible leaf spring on said tubular means having an end engageable with a shoulder in said conduit for preventing movement of said tubular means in one longitudinal direction; slip means on said body engaged and movable by said body in said one longitudinal direction toward said tubular means and into engagement with said conduit for preventing movement of said tubular means in the opposite longitudinal direction; and means on said body engaged by said tubular means and slip means for outward expansion into engagement with said conduit.

10. In combination: a well conduit having a recess therein; tubular means adapted for lowering in said conduit on a running-in string; a leaf spring on said tubular means expandible into said recess for engagement with a conduit shoulder for preventing movement of said tubular means in one longitudinal direction; and slip means on said tubular means engaged and movable with and by said tubular means in said one longitudinal direction into engagement with said conduit to prevent movement of said tubular means in the opposite longitudinal direction.

11. In combination: a well conduit having a recess therein; tubular means adapted for lowering in said conduit on a running-in string; upwardly directed leaf springs on said tubular means expandible into said recess for engagement with a conduit shoulder for preventing upward movement of said tubular means; and normally retracted slip means on said tubular means engaged and movable upwardly with and by said tubular means into engagement with said conduit for preventing downward movement of said tubular means.

12. In a well tool: a body adapted for lowering in a well conduit on a running-in string; tubular means slidable on said body; a leaf spring on said tubular means inherently tending to expand outwardly into engagement with the conduit for engagement with a shoulder in the conduit for preventing movement of said tubular means in one longitudinal direction; slip means on said body engaged and movable by said body in said one longitudinal direction toward said tubular means and into engagement with said conduit for preventing movement of said tubular means in the opposite longitudinal direction; and packing means on said body adapted to be compressed between said tubular means and slip means into sealing engagement with said conduit.

13. In a well tool: a body adapted for lowering in a well conduit on a running-in string; a tubular member slidable on said body; a leaf spring on said tubular member inherently tending to expand outwardly into engagement with the conduit for engagement with a shoulder in

the conduit for preventing upward movement of said tubular member; an expander slidably mounted on said body; slips cooperable with said expander and movable upwardly by said body into engagement with the well conduit to prevent downward movement of said body; and packing means around the body adapted to be compressed between said tubular member and expander into sealing engagement with said conduit.

14. In combination: a well conduit having a recess therein; a body adapted for lowering in the conduit on a running-in string; tubular means slidable on said body; an outwardly expansible leaf spring on said tubular means having an end engageable with the portion of said conduit defining an end of said recess for preventing movement of said tubular means in one longitudinal direction; slip means on said body engaged and movable by said body in said one longitudinal direction toward said tubular means and into engagement with said conduit for preventing movement of said tubular means in the opposite longitudinal direction; and packing means on said body adapted to be compressed between said tubular means and slip means into sealing engagement with said conduit.

15. In combination: a well conduit having a recess therein; a body adapted for lowering in said conduit on a running-in string; a tubular member slidable on said body; an outwardly expansible leaf spring on said tubular member having an upper end engageable with the portion of the conduit that defines the upper end of said recess for preventing upward movement of said tubular member; an expander slidably mounted on said body; slips cooperable with said expander and movable upwardly by said body into engagement with the well conduit to prevent downward movement of said body; and packing

means around the body adapted to be compressed between said tubular member and expander into sealing engagement with said conduit.

16. In a well tool: a body adapted for lowering in a conduit string on a running-in string; a tubular member slidable on said body; an outwardly expansible leaf spring on said tubular body having an upper end engageable with a shoulder in said conduit for preventing upward movement of said tubular member; an expander slidably mounted on said body below said tubular member; and slips cooperable with said expander and movable upwardly by said body along said conduit to prevent downward movement of said body.

17. In a well tool: a body adapted for lowering in a well conduit on a running-in string; tubular means slidable on said body; an outwardly expansible leaf spring on said tubular means having an upper end engageable with a shoulder in said conduit for preventing upward movement of said tubular means; and slip means on said body below said tubular means engaged and movable upwardly by said body toward said tubular means and into engagement with the well conduit to prevent downward movement of said body.

REUBEN C. BAKER.

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