Feb. 18, 1969 P. E. DAVIS, JR 3,428,123

PACKER TOOL SETTING AND HOLD-DOWN ARRANGEMENT

Filed Oct. 5, 1967 Sheet 1 of 2

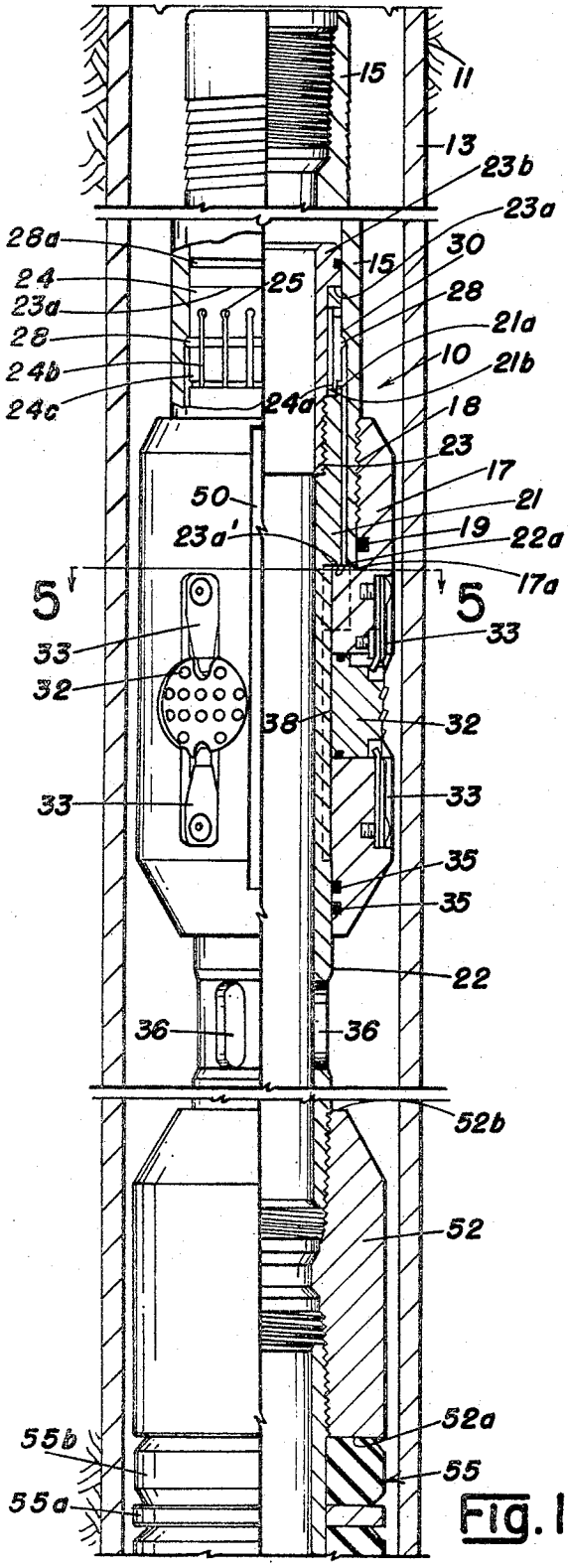

Fig. 1

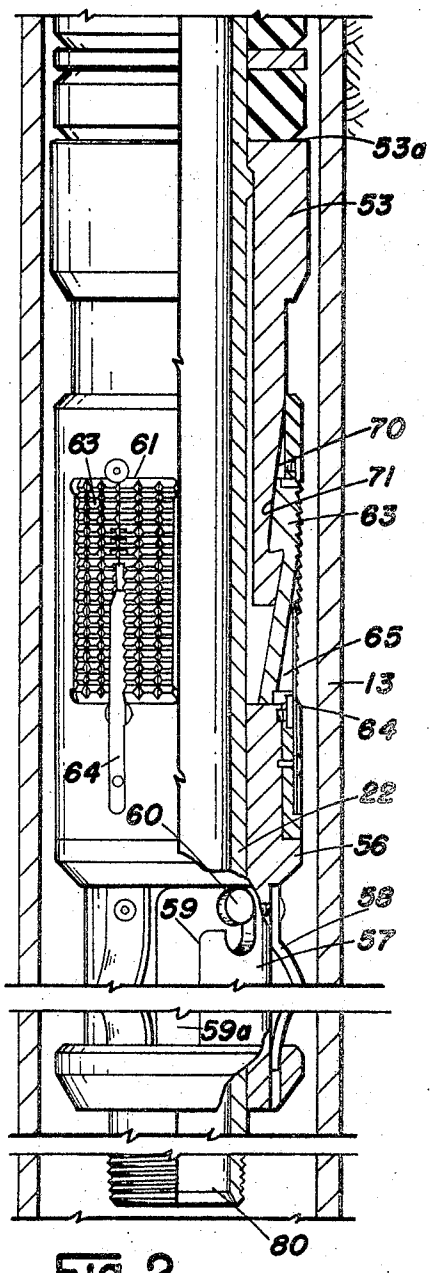

Fig. 2

PHILIP E. DAVIS, Jr.
INVENTOR.

BY Hayden & Pravel

ATTORNEYS

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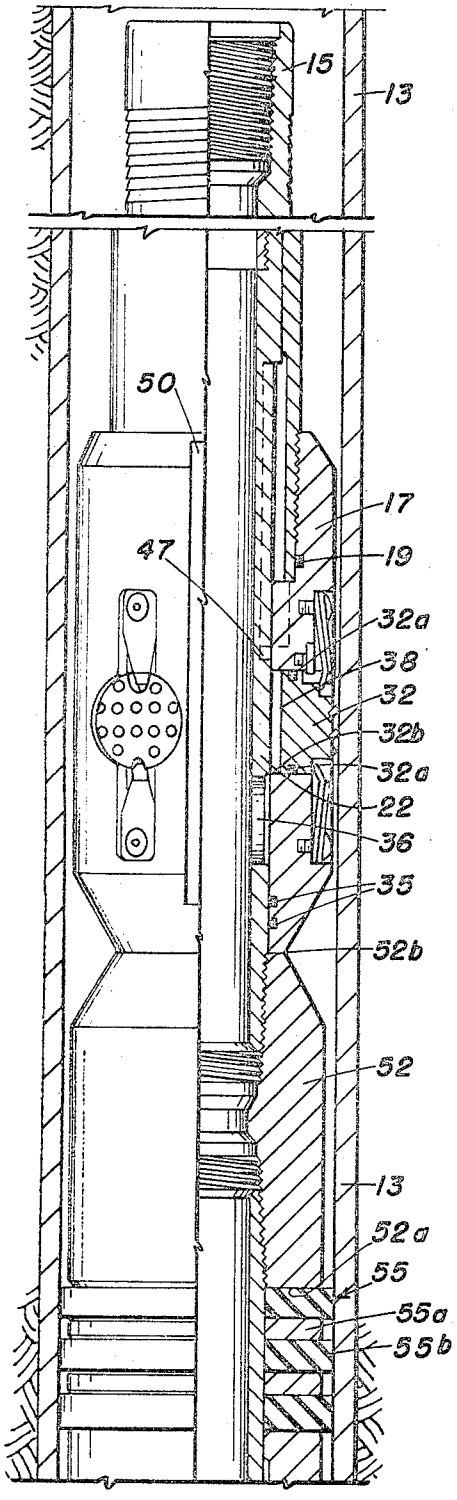

Fig. 3

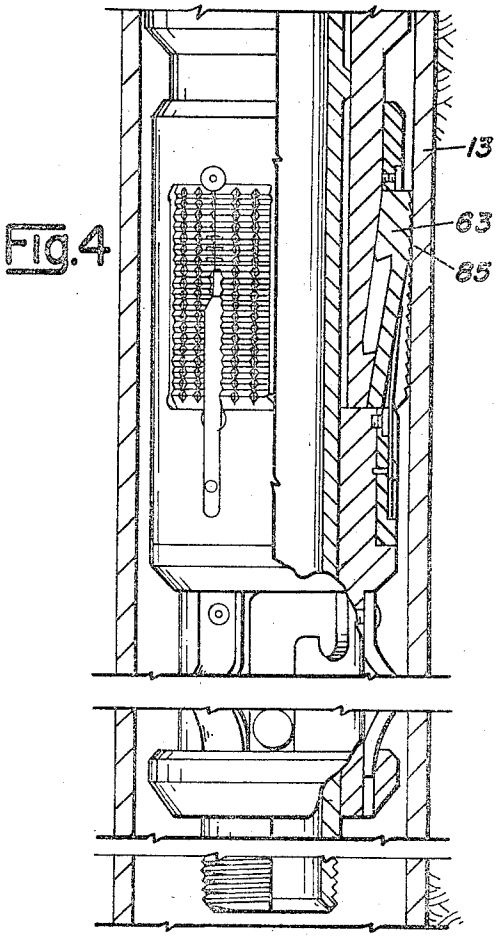

Fig. 4

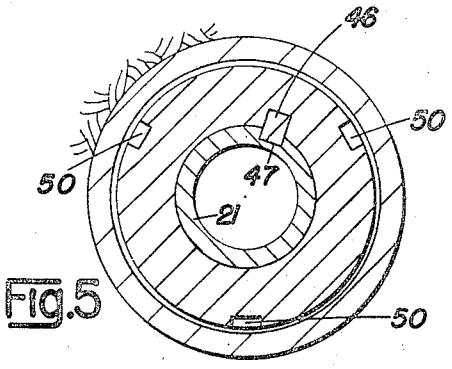

Fig. 5

PHILIP E. DAVIS, Jr.
INVENTOR.

BY Hayden & Prawel

ATTORNEYS

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PACKER TOOL SETTING AND HOLD-DOWN ARRANGEMENT

Philip E. Davis, Jr., P.O. Box 227,
Houston, Tex. 77001

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Int. Cl. E21b 23/06, 33/12

ABSTRACT OF THE DISCLOSURE

A packer tool setting and hold-down arrangement for lowering on a well string into a tubular member in a well bore which has port means arranged therein to enable the packer tool setting and hold-down arrangement to be moved through the tubular member with a minimum of fluid restriction, and thereafter to position the packer tool so that it seals against the tubular member with fluid pressure internally of the packer tool being utilized to aid in maintaining the packer tool in its set position in the tubular member.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to what is commonly termed in the art a squeeze-type packer tool wherein a resilient sealing element is mounted on a mandrel that is adapted to be secured to a well string and lowered into a tubular member in a well bore. Thereafter, a slip arrangement provided on the tool is actuated to position the tool in the tubular member and to maintain it in position as well as maintaining the seal means in sealing engagement with the tubular member.

Description of the prior art

Various types of squeeze packer tools have been known and used heretofore. Generally, as known to applicant, such tools are adapted to be secured to a well string and lowered into a well bore having a tubular member therein, the packer tool having resilient seal means which is adapted to be set by slips. Some attempt has been made at alleviating the restriction of fluid flow when the tool is lowered on the well string into the tubular member and also some attempt has been made to inhibit the slips from dragging against the tubular member as the tool is lowered therethrough so that when they are set they are not worn out. If the slips are appreciably worn by the time the packer is lowered to a desired level in the tubular member, it can be appreciated that pressure surges above and below the packer within the tubular member may tend to move the well string and the packer. It is not uncommon for such pressures to become excessive to the extent that the tubing or well string on which the packer tool is lowered into the tubular member corkscrews under such pressure, thus tending to shorten the tubing, and may in some instances tend to unseat the packer or move the bypass valve.

SUMMARY OF THE INVENTION

The present invention is directed to a tool which overcomes the above named disadvantages in that the internal pressure in the tubular member is isolated from the slips which tend to hold the packer in position, thus preventing them from dragging against the tubular member and thereby eliminating wear thereon as the packer is lowered into position. Thereafter, when the tool is actuated, the slips positively engage against the tubular member and have a better effect in holding the packer tool in position, or stationary, in the tubular member and inhibit corkscrewing of the well string or tubing with

which it is connected under pressure, or under other conditions. Also, the internal pressure within the tool is utilized to hold the bypass valve housing in closed position when it has once been moved to such position.

Also, the present invention is constructed in a manner to not only reduce the restriction to fluid flow thereabout as it is lowered through the tubular member, but it is constructed so that the internal pressure within the tubular member is utilized after the tool is set to lock or maintain it in position and any increase in pressure within the tubular member is transmitted to the setting or holding means to thereby aid in gripping the tool in position in the tubular member.

Also, the tool is constructed so that if cold water is pumped down the tubing which might tend to shrink the tubing, this same hydraulic pressure is effective on the slips to aid in maintaining the packer in position during such operation.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a broken quarter sectional view, part of the upper portion being cut away to better show the relationship of the upper portions of the tool of the present invention as it is being lowered through a tubular member in a well bore;

FIG. 2 is a quarter sectional view, partially broken and partly in elevation, and is a continuation of the form of the tool shown in FIG. 1;

FIG. 3 is a broken quarter sectional view similar to FIG. 1 but showing the tool after it has been actuated and the packers or resilient seal means engaged with the tubular member;

FIG. 4 is a quarter sectional view, partly in elevation, similar to FIG. 2 but showing the relationship of the lower slip means when the tool is engaged with the tubular member; and

FIG. 5 is a sectional view on the line 5—5 of FIG. 1 to illustrate in greater detail the relationship of certain structural components of the tool.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Attention is first directed to FIG. 1 of the drawings where the invention or tool is represented generally by the numeral **10**. A well bore is illustrated at **11** having a tubular member **13** positioned therein. The invention **10** is adapted to be lowered through the tubular member **13** of the well bore **11** on any suitable well string or tubing well known in the art (not shown). The lower end of the tubing or well string is connected to the housing extension by means of the internal threads at the upper end thereof shown in FIGS. 1 and 3 The housing extension **15** is connected with an annular bypass valve housing **17** by any suitable means such as threads **18**. The housing extension **15** forms a fishing neck for the tool in a manner well known in the art. A seal **19** is provided between the housing extension **15** and the bypass valve housing **17** to inhibit the passage of fluids between the housing extension **15** and housing **17**. The housing **17** telescopically receives the upper end **21** of the mandrel **22**. The mandrel **22**, in turn, is threadedly connected at its upper end to a collar **23** as shown in FIGS. 1 and 3. The outer periphery of the collar is cut away from one end extending toward the other end, but stopping short thereof to form annular shoulder **23***a* on collar **23**. A collet **24** surrounds the collar **23** and is positioned thereon against shoulder **23***a* before collar **23** is threadedly engaged with the upper end **21** of mandrel **22**. An annular lip **21***a* is formed on the upper end of the mandrel **22** and provides a space **21***b* to receive the lower end **24***a* of the collet. The collet is provided with a plurality of longitudinally extending slits **24***b* having openings **25** at each

upper end with the lower end of each slit extending to the lower end of the collet, thus providing a plurality of separate fingers 24*c*. The space between each slit 24*b* has an external enlargement 28 which forms an interrupted ridge that abuts against the ridge 30 or shoulder formed by the counterbore in housing extension 15. The weight of the invention 10 is suspended by the abutting shoulders 22*a* and 23*a'* formed on the housing 17 and mandrel 22, respectively, as seen in FIG. 1. An O-ring seal 28*a* is provided between the portion 23*b* of the collar and adjacent inner periphery of the housing extension 15 to prevent fluid pressure from acting on slip segments 32 prematurely.

The housing 17 is provided with any suitable number of slip means 32, such slip means normally being maintained in retracted position relative to the internal wall of the tubular member 13 by the spring means 33. Any suitable number of slips may be used and generally three or four are in openings 32b spaced circumferentially of the housing as desired. Seal means as shown at 35 are provided for sealing off between the housing 17 and the upper end 21 of the mandrel 22 when the tool is shown in the position in FIG. 1 to inhibit the passage of fluid from the tubular member or from the mandrel through the port means 36 between the mandrel and the housing which would tend to act on the nether side 38 of the slips and urge them outwardly.

The housing 17 is sildably but nonrotatably mounted adjacent the upper end 21 of the mandrel 22 by suitable means such as the key 46 which may be integrally formed on the housing 17 which fits within the keyway 47 formed on the outer surface adjacent the upper end 21 of the mandrel 22.

To accommodate fluid bypass around the housing 17 as it is moved through the tubular member 13, a plurality of longitudinally extending slots as illustrated at 50 may be provided to inhibit restriction of fluid flow around the invention as it is lowered through the tubular member 13 into its desired position therein.

An upper enlargement 52 is formed on the mandrel 22 and is spaced from the lower enlargement 53 to provide shoulders 52*a* and 53*a*, respectively, which receive therebetween the resilient seal means referred to generally by the numeral 55. A slip housing 56 surrounds the mandrel 22 and has a depending skirt 57 thereon on which are mounted bow springs 58 at circumferentially spaced points. The skirt 57 also is provided with a J-slot referred to by the numeral 59, and the mandrel 22 is provided with the projection 60 for fitting within the J-slot to maintain the slip housing 56 in a predetermined longitudinal position relative to the mandrel 22 as it is passed or lowered through the tubular member 13.

The slip housing 56 is of a generally well-known configuration and includes circumferentially spaced openings of a suitable number such as three or four, referred to at 61, which are adapted to receive the slip segments 63 therein. Spring fingers 64 fit within slots 65 formed in the slip segments 63 and aid in retaining them in a retracted position as the tool 10 is lowered into the tubular member 13.

It will be noted that the lower enlarged portion 53 is provided with a plurality of tapered surfaces 70 which is adapted to receive the tapered surfaces 71 formed on the nether side of the slips 63 which co-operate to set the lower slips in a manner as will be described hereinafter.

As the tool of the present invention is lowered through the tubular member 13, internal fluids and pressure therein will pass upwardly through the lower open end 80 of the mandrel and be discharged either through the port 36 or will continue to fill the tubing as it is lowered into the well bore, joint by joint. The ports 36 are of substantial size to accommodate rapid fluid egress from internally of the mandrel 22 to the surrounding annulus between the housing extension 15 and tubular member 13, and the slots 50 co-operate to pass the pressure within the tubular member 13 around the tool so that the tool can be more easily and more readily lowered into position within the tubular member 13. During this operation, it will be noted that the seals 35 prevent fluid communication to the nether side 38 of the slips 32 so that they are maintained in retracted position and are thereby prevented from engaging with or dragging against the internal periphery of the tubular member 13 during the lowering operation. This prevents premature wearing of the slip segments 32 so that when the tool reaches its desired position within the tubular member 13 and is actuated, such segment serves to firmly grip the internal periphery of the tubular member and maintain the tool in its desired position as will be described shortly.

After the tool 10 has been lowered to the desired depth in the tubular member 13, the lower set of slips may be set by picking up on the tubing or well string at the earth's surface slowly. As illustrated in FIG. 2 of the drawings, the projection 60 is illustrated in a position when the housing extension 15 has been lifted slightly at the earth's surface, and in this position, it will be noted that it will have moved out of the end of the J-slot since the bow springs 58 drag against the internal periphery of the tubular member 13 and thereby enable the mandrel 22 to move slightly upwardly relative thereto. Thereafter or simultaneously, the tubing can be turned to the right to move the projection 60 into the portion 59*a* of the J-slot so that when the tubing is lowered, the slips 63 will move upwardly along the tapered surface 70 to assume the position represented at 85 wherein they are firmly engaged with the internal periphery of the tubular member 13. After the slips 63 have been set and engaged against the internal periphery of the tubular member 13, the tubing or well string may be lowered and when between 6,000 and 10,000 pounds of weight have been set on the tubing string, the shoulder 30 acts against the ridge or enlargement 28 formed on each finger 24*c* to deflect them inwardly to permit the collar 23 and mandrel 22 to move upwardly. When this occurs, the housing 17 telescopes downwardly over the mandrel 22 until it abuts the shoulder 52*b* of the upper annular enlarged portion 52. Since the lower enlarged portion is held against movement by engagement of the slips 63 with the pipe 13, continued downward movement of the bypass valve housing 17 against enlargement 52 will compress the resilient seal means 55 outwardly into sealing engagement with the internal periphery of the tubular member 13 to form a seal therewith. If desired, metal back-up rings 55*a* may be positioned between the annular rings 55*b* which form the seal means 55.

Also, the housing 17 is then in a position so that the seal means 35 are then spaced below the port means 36 formed in the mandrel 22 and internal fluid pressure within the mandrel and within the tubular member 13 is conducted to the nether side 38 of the slips 32 to force them out into sealing and locking engagement with the internal periphery of the tubular member 13.

From the foregoing, it can be appreciated that the seal means 35 along with the seal means 19 and seal means 28*a* inhibit the passage of fluid to the nether side of the slips 32 as the tool is lowered through the tubular member 13. This prevents the slip segments 32 from dragging against the internal periphery of the tubular member 13 and wearing out as the tool is lowered into position. However, when the port 36 is covered by housing 17, the seals 32*a* between the segments 32 and recesses 32*b* in which they are seated and seal 35 co-operate to pass fluid pressure to the nether side 38 of each slip 32. The seals 32*a* are arranged between the forward and nether surface of each segment.

After the tool has been lowered and seated as shown in FIGS. 3 and 4 of the drawings, the well can be treated, tested, circulated, squeezed, or reversed and reperforated with the utmost in dependability and efficiency.

The invention also, by its arrangement, inhibits corkscrewing of the tubing due to excessive internal pressures

within the tubular member 13 and within the tubing since the slips 32 and the slips 63 not only hold the tool firmly in position, but any increase in pressure is transmitted to the nether side 38 of the slip segments 32 to thereby more firmly engage them with the tubular member 13.

Fluid pressure thus acts to hold bypass housing 17 over port 36 and thus maintain it closed. Also, the tool is held in stationary position since the pressure exerted on slips 32 increases with any increase in pressure.

In order to release the tool of the present invention, the pressure between the tubing and the casing or tubular member 13 is equalized. Thereafter, by picking straight up on the tubing at the earth's surface, it is possible to come out of the tubular member 13. When the tubing is elevated, the housing 17 and housing extension 15 will be moved to their initial position as illustrated in FIG. 1 of the drawings and the bypass will open so that as the tool is withdrawn, fluid may reverse its direction of circulation and restriction thereof is greatly reduced.

It can be appreciated that the present invention provides an arrangement which permits the packer to be reset as many times as desired.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape, and materials as well as in the details of the illustrated construction may be made within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. A squeeze-type packer tool for setting in a tubular member in a well bore comprising:
   (a) a tubular mandrel for lowering into a tubular member on a tubular string;
   (b) said mandrel including spaced upper and lower annular enlarged portions thereon;
   (c) resilient packer elements carried between said enlarged portions on said mandrel;
   (d) slip means carried by said lower annular portion, said slip means having a tapered nether surface;
   (e) said lower annular portion having tapered surface means abutting said tapered surface on said slip means for forcing said slip means into engagement with the tubular member upon relative longitudinal movement between said tapered slip surfaces and said tapered surface on said annular portion;
   (f) means interconnecting said mandrel and said slip means for maintaining said slip means in retracted position relative to the tubular member;
   (g) means carried by said slip means and engageable with the tubular member to unlock said interconnecting means upon rotation of the tubular string and mandrel whereupon said slip means may be moved longitudinally relative to said lower annular portion for engaging said slip means against the tubular member;
   (h) an annular housing connected to the well string to telescopically receive the upper end of said mandrel;
   (i) said mandrel having port means therein between said upper annular portion and said housing for communicating the interior of said mandrel with the surrounding tubular member in which the packer tool is to be set;
   (j) slip means carried by said annular housing;
   (k) seal means positioned between said slip means in said housing and said port means in said mandrel for sealing between said mandrel and annular housing;
   (l) means connecting the well string and said mandrel to normally maintain said housing in spaced relation to said port means and said upper annular portion, said means releasing when a predetermined weight is set on the well string to enable said housing to move down and cover said port means in said mandrel;
   (m) said housing slip means having seal means between its nether and forward surfaces; and
   (n) said mandrel port means communicating fluid to the nether surface of said mandrel port means when said housing covers said port means to engage said slip means in said housing with the tubular member.

2. The invention of claim 1 including co-operating engaging means between said mandrel and housing for accommodating relative longitudinal movement, but preventing relative rotational movement between said housing and said mandrel.

3. In a squeeze packer tool for lowering into a tubular member on a well string wherein resilient seal means are mounted on a mandrel between spaced shoulders with slip means mounted on the mandrel in normally retracted position, but releasable upon rotation and lowering of the well string to seat against the tubular member, the improvement comprising:
   (a) an annular housing connecting to the well string to telescopically receive the upper end of the mandrel;
   (b) there being port means in the mandrel below said housing and above the resilient seal means for passage of fluid from the interior of the tool;
   (c) slip means on said housing;
   (d) spring means normally maintaining said slip means in retracted position relative to the tubular member;
   (e) seal means between said mandrel and housing to inhibit fluid passage between said housing and mandrel;
   (f) means for connecting the well string and housing together to maintain the port means open to the exterior of the tool, said means being releasable when a predetermined weight is set on the well string whereupon said housing moves to seal the seal means with the tubular member and cover the port means, with said seal means on said housing being below the port means; and
   (g) seal means between said slip means and housing whereupon fluid communicated from the port means flows between said mandrel and housing to urge said slips in said housing into engagement with the well string to maintain the seal means in sealing engagement with the tubular member.

4. The invention of claim 3 including co-operating engaging means between the mandrel and said housing for accommodating relative longitudinal movement, but preventing relative rotational movement between said housing and mandrel.

5. The invention of claim 3 including seal means between the well string and said housing to inhibit fluid flow therebetween.

6. The invention of claim 4 including seal means between the well string and said housing to inhibit fluid flow therebetween.

7. In a squeeze-type packer tool for lowering on a well string and setting in a tubular member, said tool including a mandrel supporting a slip housing with slip means thereon engageable with a tubular member in a well bore, seal means carried by said mandrel above said slip housing, there being port means in said mandrel above said seal means for communicating the interior of the packer tool with the tubular member, an annular bypass valve housing above said port means and having slip means carried thereon, the invention comprising:
   (a) co-operating means between said mandrel and bypass valve housing to maintain said housing in a position on said mandrel to uncover said port means, said bypass valve housing telescoping downwardly over said mandrel to cover said port means when a predetermined weight is set on said housing;
   (b) seal means between said bypass valve housing and mandrel to inhibit fluid pressure passing therebetween when said housing uncovers said port means;
   (c) seal means between said bypass valve housing and the well string to inhibit fluid pressure passing beneath said housing; and
   (d) seal means between said bypass valve housing and slip means therein whereby fluid pressure acts on said

slip means when said housing covers said port means to aid in holding said bypass valve housing in closed position over said port means.

8. In a squeeze-type packer tool for lowering on a well string and setting in a tubular member, said tool including a mandrel supporting a slip housing with slip means thereon engageable with a tubular member in a well bore, seal means carried by said mandrel above said slip housing, there being port means in said mandrel above said seal means for communicating the interior of the packer tool with the tubular member, an annular by pass valve housing above said port means and having slip means carried thereon, the invention comprising:

(a) co-operating means between said mandrel and bypass valve housing to maintain said housing in a position on said mandrel to uncover said port means, said bypass valve housing telescoping downwardly-over said mandrel to cover said port means when a predetermined weight is set on said housing;

(b) seal means between said bypass valve housing and mandrel to inhibit fluid pressure passing therebetween when said housing uncovers said port means; and

(c) seal means between said bypass valve housing and the well string to inhibit fluid pressure passing beneath said housing before said bypass valve housing covers said port means to thereby inhibit movement of said slip means on said housing until said housing covers said port means in said mandrel.

9. In a squeeze-type packer tool for lowering on a well string and setting in a tubular member, said tool including a mandrel supporting a slip housing with slip means thereon engageable with a tubular member in a well bore, seal means carried by said mandrel above said slip housing,

there being port means in said mandrel above said seal means for communicating the interior of the packer tool with the tubular member, an annular bypass valve housing above said port means and having slip means carried thereon, the invention comprising:

(a) co-operating means between said mandrel and bypass valve housing to maintain said housing in a position on said mandrel to uncover said port means, said bypass valve housing telescoping downwardly over said mandrel to cover said port means when a predetermined weight is set on said housing; and

(b) seal means between said mandrel and bypass valve housing and between said bypass valve housing and the well string to inhibit fluid pressure acting between said mandrel and housing and on said slip means carried thereby.

10. The invention of claim 9 including seal means between said bypass valve housing and slip means therein whereby fluid pressure acts on said slip means when said housing covers said port means to aid in holding said bypass valve housing in closed position over said port means.

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JAMES A. LEPPINK, *Primary Examiner.*

U.S. Cl. X.R.

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