Dec. 19, 1961 M. B. CONRAD 3,013,610

RETRIEVABLE DOUBLE GRIP WELL PACKER

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FIG. 1.

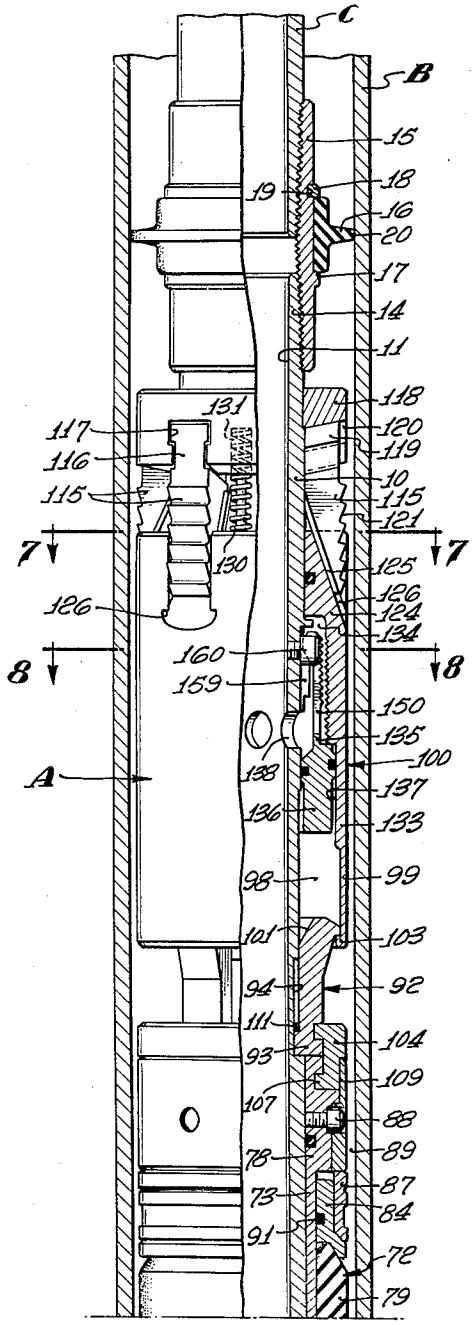
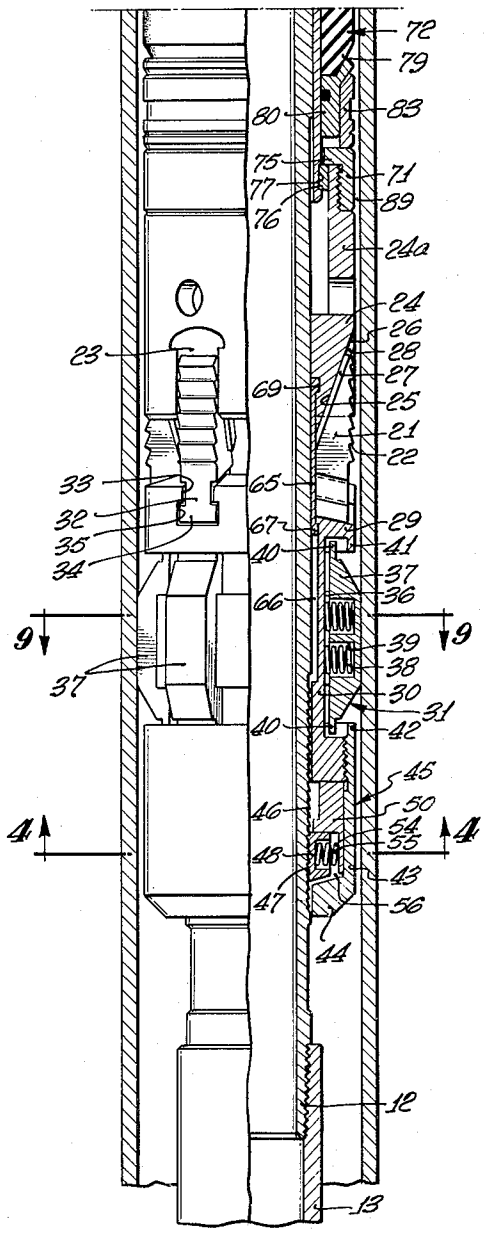


FIG. 1a.



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FIG. 2.

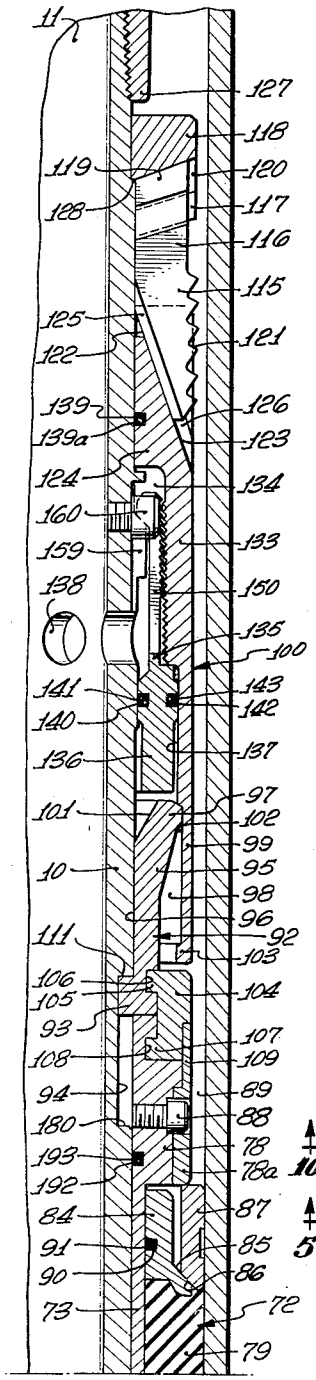


FIG. 2a.

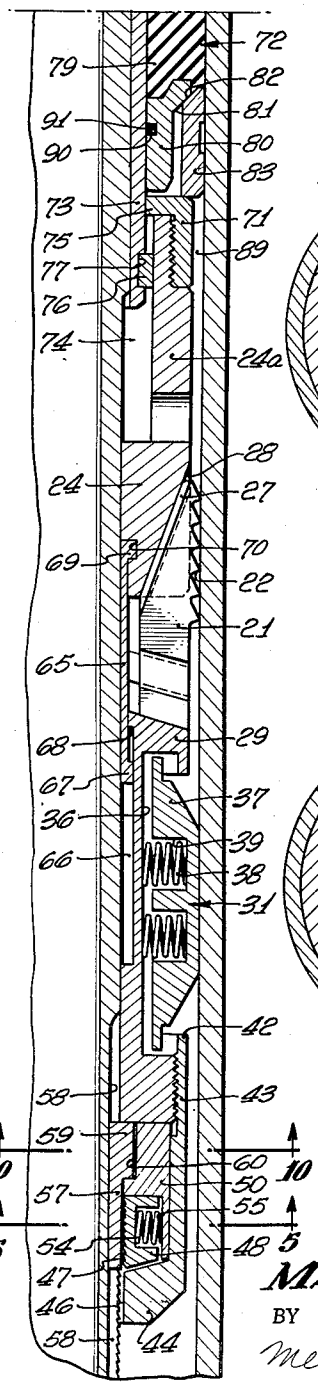


FIG. 4.

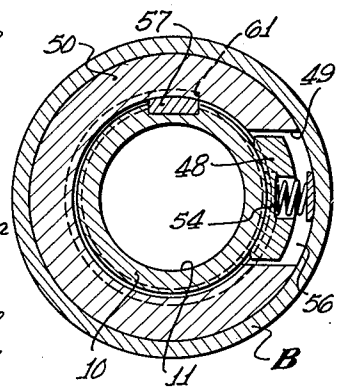
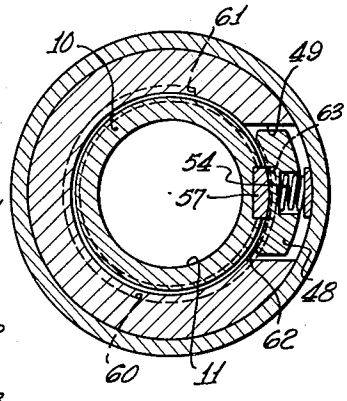


FIG. 5.



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FIG. 3.

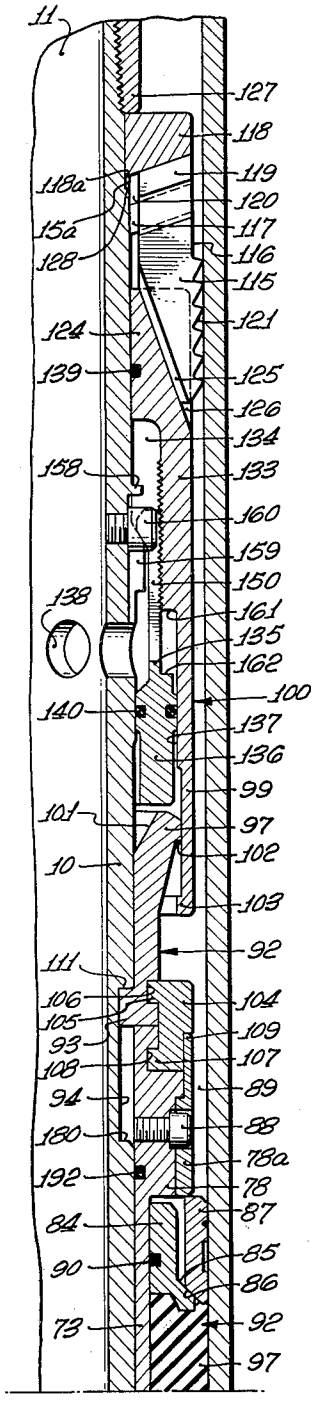


FIG. 3a.

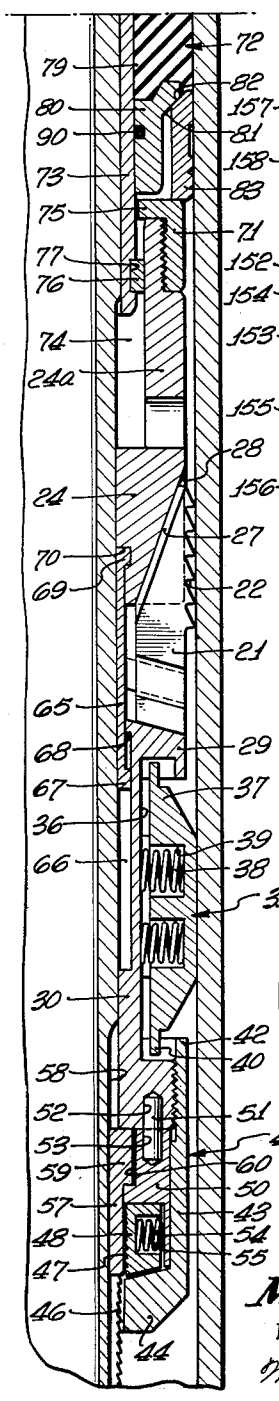


FIG. 6.

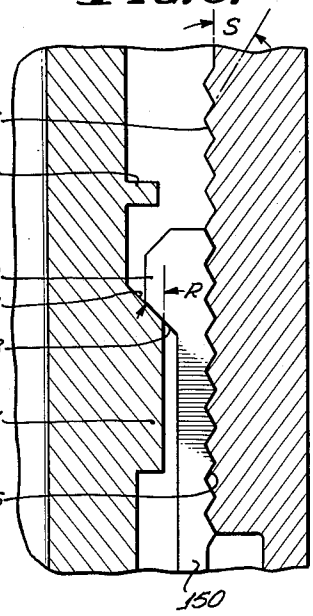
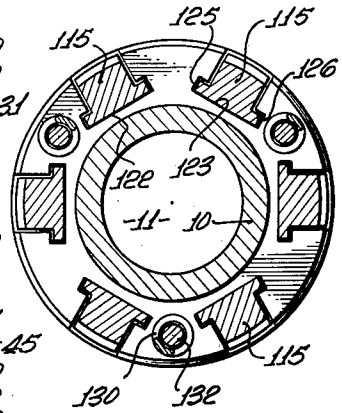


FIG. 7.



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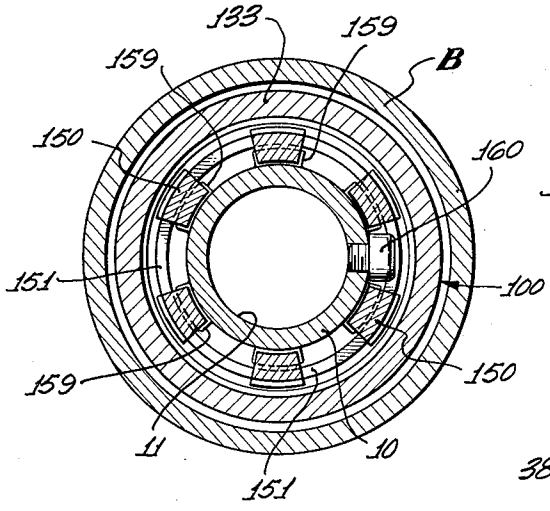


FIG. 8.

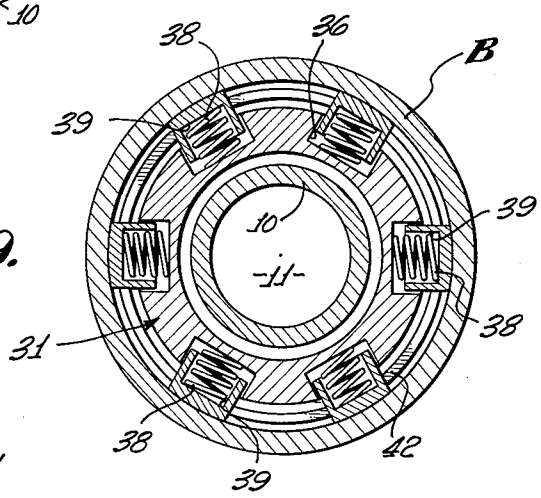


FIG. 9.

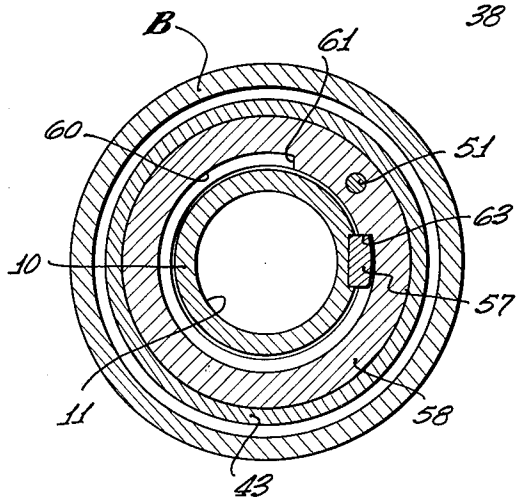


FIG. 10.

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3,013,610

RETRIEVABLE DOUBLE GRIP WELL PACKER

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Filed Apr. 21, 1958, Ser. No. 729,971
26 Claims. (Cl. 166—134)

The present invention relates to subsurface well bore equipment, and more particularly to well packers adapted to be anchored in packed-off condition in well casings, liners, and similar conduit strings disposed in well bores.

Retrievable well packers have been lowered in well casings and anchored in packed-off condition therewithin against both upward and downward movement. Anchoring is ordinarily accomplished by use of initially retracted sets of slips adapted to be expanded into gripping engagement with the casing wall. Expansion of a set of slips may be effected by hydraulic pressure within the tool after the latter has been lowered to its setting point in the well casing. As an example, the well tool may include a set of upper slips to anchor the tool in the well casing against upward movement, and a set of lower slips to anchor the tool in the well casing against downward movement. After the tool has reached its setting point in the well casing, the lower slips are expanded into anchoring engagement with the well casing by movement of the mandrel or body portion of the tool, while the upper slips are expanded into anchoring engagement with the well casing by the application of hydraulic pressure to the tool.

Difficulty has been encountered with such hydraulically actuated tools, since the pressure built up in the tool during its lowering through the fluid in the well casing expands the slips against the casing, the slips then sliding along the casing wall as lowering of the tool continues, their external wickers or teeth becoming dull. As a result, the slips cannot be anchored appropriately to the well casing after the tool has been lowered to its setting point, resulting in failure of the tool to operate properly.

Retrievable well packers adapted to be anchored in packed-off condition in a well casing against movement in both longitudinal directions have the further disadvantage of being relatively long, and costly to produce. If hydraulically actuated, they may have been restrictions through them which prevents other equipment from being lowered through the packer, or which prevents the free passage of fluent materials through the packer. Moreover, in accomplishing setting of the well packer in the well casing, or its release therefrom, undesirable manipulations of the tubular string, to which the well packer is secured, are essential.

Accordingly, an object of the present invention is to provide a well packer, particularly of the retrievable type, capable of being anchored in a well casing against movement in both longitudinal directions, at least partly by the application of hydraulic pressure within the packer, in which any such pressure that might develop in the packer as a result of it being lowered through the fluid in the well casing is prevented from expanding the packer parts into engagement with the well casing. As a result, hydraulically actuated slips, and the like, are not dulled, or otherwise damaged, during lowering of the tool to its setting point.

Another object of the invention is to provide a retrievable well packer capable of being anchored in a well casing against movement in both longitudinal directions by upper and lower sets of slips, in which the upper sets of slips is expanded hydraulically into anchoring engagement with the well casing, and in which hydraulic pressure in the packer is prevented from expanding such upper slips during lowering or other longitudinal movement of the packer through the fluid in the well casing.

A further object of the invention is to provide a retrievable well packer capable of being lowered in a well casing on a tubular string and anchored to the casing against movement in both longitudinal directions, which requires a minimum of manipulation of the tubular string in effecting its setting in the well casing.

An additional object of the invention is to provide a retrievable well packer capable of being lowered in a well casing on a tubular string and anchored to the casing in packed-off condition against downward movement by a simple manipulation of the tubular string, anchoring against upward movement occurring automatically in response to fluid pressure in the tubular string and well packer, without the need for the main body or mandrel of the well packer partaking of any substantial movement.

Yet another object of the invention is to provide a retrievable well packer to be lowered in a well bore on a tubular string and having a lower set of downwardly holding slips adapted to be expanded into anchoring engagement with the well casing by downward movement of a lower wedge expander and an upper set of upwardly holding slips adapted to be expanded into anchoring engagement with a well casing by upward movement of an upper wedge expander, both sets of slips being releasable from the well casing by taking a simple straight line pull on the tubular string.

Still a further object of the invention is to provide a retrievable well packer adapted to be anchored in packed-off condition in a well casing against movement in both longitudinal directions, the well packer being relatively short and compact, and comparatively economical to manufacture.

Another object of the invention is to provide a retrievable well packer adapted to be anchored in packed-off condition in a well casing against movement in both longitudinal directions, the well packer having a large longitudinal bore therethrough to permit unimpeded passage of fluent materials and objects through the tool.

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:

FIGURES 1 and 1*a* together constitute a combined side elevational and longitudinal sectional view through an apparatus embodying the invention disposed in a well casing, the parts of the apparatus being in retracted position, FIG. 1*a* constituting a lower continuation of FIG. 1;

FIGS. 2 and 2*a* together constitute a quarter longitudinal sectional view corresponding to FIGS. 1 and 1*a*, respectively, on an enlarged scale, illustrating the apparatus anchored in packed-off condition against downward movement in the well casing, FIG. 2*a* constituting a lower continuation of FIG. 2;

FIGS. 3 and 3*a* are views similar to FIGS. 2 and 2*a*, illustrating the well packer anchored in packed-off condition against longitudinal movement in both an upward and downward direction within the well casing, FIG. 3*a* constituting a lower continuation of FIG. 3;

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

FIG. 5 is an enlarged cross-section through the well packer taken along the line 5—5 on FIG. 2a;

FIG. 6 is an enlarged fragmentary longitudinal section through a latch portion of the apparatus;

FIG. 7 is an enlarged cross-section taken along the line 7—7 on FIG. 1;

FIG. 8 is an enlarged cross-section taken along the line 8—8 on FIG. 1;

FIG. 9 is an enlarged cross-section taken along the line 9—9 on FIG. 1*a*;

FIG. 10 is a cross-section taken along the line 10—10 on FIG. 2*a*.

The apparatus A disclosed in the drawings is adapted to be anchored in packed-off condition in a well casing B against movement in both an upward and a downward direction, to withstand pressure imposed on the tool A from a position below its setting point in the well casing, as well as from a position above its setting point in the well casing. The apparatus is lowered in the well casing by means of a tubular string C, such as a string of tubing or drill pipe, extending to the top of the well bore. After having been set in the well bore and the desired operation or operations performed therewithin, the tool A is readily released merely by taking an upward strain on the tubing string C and can be withdrawn from the well casing, or may be moved in the well casing to another location, where it is again to be anchored in packed-off condition.

As specifically shown, the well tool A includes a tubular mandrel or body **10**, preferably having a straight-through or uninterrupted passage **11** therethrough, the inside diameter of which is preferably no smaller than the inside diameter through the tubular string C. The lower end of the mandrel may be constituted as a threaded pin **12** for threaded attachment to lower tubing **13** or a lower tool. The upper end of the body or mandrel **10** may also be constituted as a threaded pin **14** threadedly secured to an upper body member **15**, such as a coupling, which is, in turn, threadedly attached to the lower end of the tubular running-in string C. For the purpose of preventing sand and other material dropping down around the apparatus A, a rubber sand baffle **16** may be disposed around the body coupling **15**, its lower end resting upon an outwardly directed flange **17** and its upper end being adapted to be engaged by the split, contractible snap ring **18** disposed in a peripheral groove **19** in the body coupling. The baffle **16** has a flexible wiper portion **20** adapted to slidably engage the wall of the well casing B as the apparatus is moved longitudinally within the latter.

The lower portion of the tool is adapted to anchor it in packed-off condition against downward movement in the well casing B. Essentially, such lower portion is a set down type of well packer. It includes a lower set of circumferentially spaced slips **21** having external wickers or teeth **22** facing in a downward direction, to resist downward movement of the tool in the well casing B when engaged therewith. The slips **21** are received in longitudinal slots **23** in a lower expander **24**, the slips having inner expander surfaces **25**, tapering in a downward and inward direction, engaging companion tapered surfaces **26** in the lower expander forming the bottom portion of the slots **23**. The slips **21** are slidably splined to the lower expander **24**, as by having opposed tongues **27** extending outwardly from the sides of each slip which are received within companion grooves **28** in the expander in the sides of each slot **23**, the tongues **27** and grooves **28** being inclined in a downward and inward direction. Thus, downward movement of the lower expander **24** with respect to the lower slips **21** will expand them outwardly into engagement with the well casing B, the expander **24** and slips **21** serving to anchor the body **10** against downward movement in the well casing B, whereas relative upward movement of the lower expander **24** with respect to the slips **21** will cause the sides of the grooves **28** to engage the tongues **27** and pull the slips inwardly to their initial retracted position.

The lower slips **21** are movable jointly in longitudinal directions by slidably coupling them to a slip ring portion **29** of the drag body **30** of a drag device **31** which encircles the body **10** of the tool. The lower portions of the slips **21** are constituted as heads **32** slidable in radial slots **33** in the slip ring portion **29**, the heads having outwardly directed tongues **34** slidably mounted in companion side grooves **35** in the slip ring portion. The lower slip tongues **34** and slip ring grooves **35** are preferably inclined slightly in a downward and outward direction, which will facilitate movement of the slips **21** toward and from engagement with the wall of the well casing B.

Movement of the slips **21** in the well casing is resisted by the drag device **31**, which includes the aforementioned body **30** that has circumferentially spaced longitudinal slots **36** therein in which radially movable drag blocks **37** are slidably received, these drag blocks being urged outwardly into frictional engagement with the wall of the well casing B by helical compression springs **38** disposed in sockets **39** in each drag block and engaging the base of the drag block body grooves **36**. Outward movement of the drag blocks **37** under the influence of the springs **38**, as when the tool is out of the well casing, is limited by engagement of the upper and lower terminal portions **40** of each drag block with an upper flange **41** depending from the slip ring portion **29** and by the upper end **42** of a clutch housing **43** threadedly secured on the lower portion of the drag body **30**, the lower portion of the clutch housing **43** having an inwardly directed flange **44**.

The slips **21** are expanded outwardly against the well casing B whenever the body or mandrel **10** of the tool is permitted to lower relative to the drag body **30**, such lowering movement being transferred through parts to be described hereinbelow to the lower expander. The lowering movement of the body **10** relative to the drag body **30** and slips **21** is prevented by a control mechanism **45**, of which the clutch housing **43** forms a part.

The clutch mechanism includes a plurality of clutch or ratchet teeth **46** formed on the periphery of the body or mandrel **10** of the tool, these teeth facing in a downward direction and being engageable with companion upwardly facing clutch teeth **47** on a dog or clutch element **48** disposed in a radial slot **49** provided in a sleeve or ring **50** disposed within the clutch housing **43**. The sleeve or ring **50** is prevented from turning with respect to the clutch housing **43** and the drag body **30** by a longitudinal pin **51** extending into a bore **52** in the drag body **30** and into an aligned bore **53** in the clutch sleeve.

The dog **48** is urged inwardly, so that its teeth **47** mesh with the body teeth **46**, by a helical compression spring **54** bearing against the dog **48**, with its outer end bearing against a finger or spring seat **55** that may be integral with the clutch sleeve **50**. When the dog **48** is engaged with the body ratchet or clutch teeth **46**, a space **56** exists between the outer end of the dog and the spring seat **55** to permit the dog to be shifted in a lateral outward direction to disengage the ratchet or clutch teeth **46**, **47** from one another. Such disengagement occurs under the action of a cam member in the form of a key **57** disposed in a longitudinal keyway **58** in the body **10**, this key having an outer portion **59** movable within an arcuate cavity or recess **60** in the clutch sleeve **50**. The mandrel or body **10** is adapted to turn the key **57** with it relative to the clutch sleeve **50** and the clutch dog **48** between a position in which the outer key portion engages one stop shoulder **61** at the end of the arcuate cavity **60**, wherein the dog **48** can be shifted by the spring **54** into engagement with the ratchet teeth **46**, and a second position in which the key **57** will engage the tapered end **62** of the dog and cam the latter outwardly to disengage its teeth **47** from the body teeth **46**, the key coming to rest against another stop shoulder **63** in the sleeve at the end of the arcuate recess or cavity **60** fully across the dog **48** to hold the latter out of clutching engagement with the body teeth **46**. As disclosed in the drawings (FIGS. 4 and 5), by way of example, the body or mandrel **10** must rotate the key **57** about 270 degrees from its position of engagement against one stop **61** to its position of engagement against the other stop **63**. Thus, if the key engages one of the stops **61**, so that the clutch dog **48** can be coupled to the body **10** of the tool, then rotation of the mandrel **10** within the drag

device 31 and clutch housing sleeve 50 of about 270 degrees is required for the key 57 to engage and cam the dog 48 out of its clutching relation to the body 10 of the tool, and to hold the dog in such disengaged position. The body 10 of the tool is rotated in a right-hand direction, to shift the dog 48 from clutching engagement with the body teeth 46, and is rotated in a left-hand direction to enable the dog to reengage the body clutch teeth. Such relative movement can occur since the drag device 31 is resisting or preventing rotation of the clutch mechanism 45 surrounding the body of the tool.

Although the dog 48 must be cammed by the key 57 out of clutching engagement with the body 10 of the tool, in order to lower the body 10 relative to the clutch member 43 surrounding it, the body 10 can be shifted upwardly relatively to the clutch member 43 surrounding it merely by taking an upward pull thereon, in view of the one-way or ratcheting action of the body teeth 46 upon the companion teeth 47 of the clutch dog 48.

With the clutch dog 48 engaged, downward movement of the body 10 of the tool will carry the drag device 31 and the lower slips 21 downwardly with it. Such downward movement is also transferred to the lower expander 24 through a segmental retaining or pulling sleeve 65 disposed within the slips 21, the lower end of the sleeve being movable within an annular space 66 between the body or mandrel 10 and the upper portion of the drag body 30, the lower part of the sleeve having an outwardly directed flange 67 adapted to engage a downwardly facing shoulder 68 on the slip ring portion 29 of the apparatus. The upper portion of the retaining sleeve 65 is disposed within the lower portion of the expander 24 having an outwardly directed flange 69 disposed within an internal groove 70 in the lower expander. Thus, it is evident that downward movement of the drag body 30 will exert a pull through the retaining sleeve 65 on the lower expander 24, pulling the latter downwardly with it.

In the absence of the retaining or pulling sleeve 65, the slips 21, when disposed in their innermost position, would also exert a downward pull on the lower expander 24 through the inclined tongue 27 and groove 28 interconnection.

The upper portion 24*a* of the lower expander 24 is threadedly secured to a lower abutment 71 which is adapted to effect expansion of a packing structure 72 into sealing engagement with the wall of the well casing B. This packing structure includes an inner compression or thrust sleeve 73 slidable along the body 10 of the tool, the lower portion of this sleeve being adapted to shift within an annular space 74 between the upper part 24*a* of the lower expander and the body 10 of the tool. The lower abutment 71 has an inwardly directed flange 75 engageable with a split, snap ring 76 disposed in a groove 77 in the lower portion of the thrust or compression sleeve such that downward movement of the lower expander 24 will be transferred through the flange 75 and snap ring 76 to the thrust sleeve 73, tending to move the latter downwardly with it. The upper end of the thrust sleeve 73 is integral with an upper abutment or flange 78 of the thrust sleeve extending laterally in an outward direction. When this upper abutment 78 is moved relatively toward the lower abutment 71, the packing structure 72 therebetween, and surrounding the thrust sleeve 73, is foreshortened and compressed outwardly into sealing engagement with the wall of the well casing B, as well as with the thrust sleeve 73 itself.

As specifically shown in the drawings, the packing structure 72 includes a packing sleeve 79 of rubber or rubber-like material surrounding the compression sleeve 73, the lower end of the packing sleeve engaging an expander member 80 having a cam surface 81 engaging a companion surface 82 on a lower split, expanding gauge ring 83 contacting the lower abutment 71. In a similar fashion, the upper end of the packing sleeve 79 engages an upper expander 84 having a tapered cam surface 85 engaging a companion surface 86 on an upper split, expanding gauge ring 87 contacting the upper abutment 78, or a separate abutment gauge ring 78*a* encompassing the latter and secured thereto by one or more screws 88. The outer ends of the upper and lower gauge ring expander members 80, 84 are initially spaced from their companion abutments 71, 78 such that initial movement of the upper abutment 78, 78*a* toward the lower abutment 71 will not only foreshorten the rubber packing sleeve 79 and expand it outwardly against the well casing B, but will also shift the expanders 80, 84 along their respective split gauge rings 83, 87 to urge the latter against the wall of the well casing B and bridge the annular spaces 89 between the abutments 71, 78*a* and the wall of the well casing, preventing the packing sleeve 79 from being extruded into or through such annular spaces.

As assurance that fluid will not leak between the packing structure 72 and the compression or thrust sleeve 73, the ring expander members 80, 84 may have side seal rings 90, such as rubber or rubber-like O rings, disposed in their internal grooves 91 and slidably sealing against the periphery of the thrust sleeve 73. Similarly, as assurance that fluid leakage cannot occur between the thrust sleeve member 73 and the body 10 of the tool, a side seal ring 192, such as a rubber or rubber-like O ring, may be disposed in an internal groove 193 in the upper abutment or flange 78 which is slidably and sealingly engageable with the periphery of the packer body 10.

The upper abutment 78, 78*a* is movable toward the lower abutment 71 by moving the body 10 of the tool downwardly, to effect expansion of the packing sleeve 79 into engagement with the wall of the well casing B, downward movement of the upper abutment 78, 78*a* also being transmittable through the packing structure 72 to the lower abutment 71 and the lower expander 24, for the purpose of expanding the lower slips 21 into anchoring engagement with the well casing. The downward movement of the body 10 to the upper abutment 78, 78*a* is transmitted through a lost motion device including an upper retainer member 92 which may be made in segments, such as three segments, spaced 120 degrees apart. The lower portion 93 of these segments is disposed in an elongate circular groove 94 formed in the exterior of the mandrel 10, such lower portions preferably being about 120 degrees in arcuate extent so as to collectively fill the groove 94 around its entire circumference. Extending upwardly from the lower portions or flanges 93 of the retaining member are their arm portions 95, the inner surfaces 96 of which are engageable with the periphery of the body 10 above the circular groove 94. The upper portions 97 of the arms are disposed in the annular space 98 between the body 10 above the groove 94 and the coupling skirt portion 99 of an upper hydraulic cylinder 100 constituting part of the upper anchoring portion of the apparatus, to be described hereinbelow. To facilitate insertion of the arms 95 between the body 10 of the tool and the coupling skirt 99, the upper ends of the arms 95 may have their inner portions 101 tapered in an upward and inward direction, so that the arms may be placed into the space 98 between the body of the tool and the coupling skirt 99 and the lower portions 93 then swung inwardly into the circular body groove 94, placing outer fingers 102 at the upper ends of the arms above an inwardly directed flange 103 at the lower end of the coupling skirt 99.

The upper retaining member 92 is secured to the upper abutment 78 by a two-piece tie ring 104 having an upper flange 105 received within an external groove 106 in the upper retaining member 92 and also having a lower internal flange 107 received within a groove 108 in the upper abutment 78. The tie ring 104 is held in place by an upwardly extending portion 109 of the upper gauge ring 78*a*.

When the lower control mechanism or clutch 45 is engaged, the relative downward movement between the body 10, the packing construction 72, lower expander 24 and lower slips 21 cannot occur, so that all of the parts are movable through the well casing B as a unit. However, when the clutch 45 is released, as by turning the tubular string C and the body 10 connected thereto to the right, the key 57 is rotated into engagement with the dog 48, camming the latter radially outward from engagement with the clutch teeth 46 and holding it in such position. The body 10 of the tool can now be lowered, but in view of the release of the dog element 48 therefrom, such lowering action will not carry the outer clutch members 45, drag device 31, slips 21, pulling sleeve 65, lower expander 24, and thrust sleeve 73 downwardly with it, as well as the packing structure 72 surrounding the thrust sleeve. The drag device 31 resists downward movement of such outer parts, the body 10 moving downwardly until the downwardly facing body shoulder 111 defining the upper end of the circular groove 94 engages the inwardly directed flange or lower portion 93 of the upper retaining member 92. Following such engagement, the retaining member 92, upper abutment 78, 78*a*, and compression sleeve 73 are shifted downwardly with the body 10, this downward movement being transferred through the packing structure 72 to the lower abutment 71 and the lower expander 24. The drag device 31 is resisting downward movement of the lower slips 21, so that the lower expander 24 and the pulling sleeve 65 connected thereto are shifted downwardly within the lower slips 21, the latter being urged radially outward into anchoring engagement with the wall of the well casing B.

After the slips 21 have engaged the wall of the well casing, downward movement of the lower expander 24 and lower abutment 71 cannot occur to any further extent. Accordingly, a continuation of the downward movement of the packer body 10 will shift the upper abutment 78, 78*a* toward the lower abutment, foreshortening the packing sleeve 79 and expanding it outwardly into sealing engagement with the wall of the well casing B. If a large degree of force is imposed on the packing structure 72, the split, expanding gauge rings 87, 83, which inherently tend to contract, will be urged along their respective expanders 84, 80 and outwardly into contact with the wall of the well casing B, forming a bridge or anti-extrusion device preventing the rubber material from being squeezed through the annular clearance spaces 89 surrounding the upper and lower abutments 78*a*, 71 (FIGS. 2, 2*a*).

The apparatus is now anchored in packed-off condition against downward movement in the well casing. It also includes an upper portion which will anchor the apparatus against upward movement in the well casing. Such anchoring occurs hydraulically and without the necessity for longitudinally moving the body 10 of the tool, as in an upward direction.

The upper or anchor portion of the apparatus includes a plurality of circumferentially spaced slips 115 disposed around the body 10 of the tool, the slips being shiftable between retracted and expanded positions and of partaking of joint longitudinal movement. Thus, the upper portion 116 of each slip is slidable in a slot 117 extending through the lower portion of a slip retainer ring 118 slidable on the body or mandrel 10, the slips each having oppositely directed tongues 119 adapted to be received within companion grooves 120 in the sides of the slot. Preferably, the tongues and grooves 119, 120 are inclined to a small extent in an upward and outward direction to facilitate anchoring of the slips 115 against the well casing B, and also their retraction therefrom. The lower portions of the slips have external wickers or teeth 121 which face in an upward direction to engage and embed themselves in the wall of the well casing.

The inner surfaces 122 of the slips are tapered in an upward and inward direction, coacting with companion tapered surfaces 123 on an upper expander 124 slidably mounted on the body or mandrel 10 of the tool. The slips 115 and expander 124 are slidably splined to one another, such that relative upward movement of the expander 124 within the slips 115 will effect expansion of the slips into anchoring engagement with the well casing, whereas relative downward movement of the expander with respect to the slips will effect positive retraction of the slips from the well casing. Such connection is afforded by means of oppositely directed tongues 125 on the inner portion of each slip slidable in companion grooves 126 in the upper expander. It is evident that the tongues 125 and the grooves 126 are inclined in an upward and inward direction to the same extent as the coengaging expander surfaces 122, 123.

The slip ring 118 is movable upwardly on the body 10 of the tool to the extent limited by its engagement with the lower end 127 of the body coupling. Its downward movement relative to the body 10 is determined by its engagement with an upwardly facing body shoulder 128. When the slip ring 118 engages the body coupling 115, it is spaced above the body shoulder 128 (FIG. 3) so that the body or mandrel 10 of the tool can partake of some longitudinal movement in an upward direction relative to the slip ring 118 and the upper slips 115 themselves.

The slip ring 118 and, consequently, the slips 115, on the one hand, and the expander 124, on the other hand, are normally urged in directions away from each other to tend to retain and place the slips 115 in their retracted position by spring means acting between the slip retainer ring 118 and the expander 124. As disclosed, longitudinally extending, circumferentially spaced helical compression springs 130 are located circumferentially between the slips 115, the upper ends of the springs being disposed within sockets 131 in the upper slip retainer ring 118 and bearing against the upper portions of the sockets. The springs 130 are telescoped over longitudinal centering pins 132 secured to the expander 124, with the lower ends of the springs bearing against the upper end of the expander. It is evident that the springs 130 tend to shift the upper slip retainer ring 118 and upper slips 115 in an upward direction relative to the expander 124, such that the inclined tongue and groove connection 125, 126 between the slips and expander tends to return the slips 115 to, and hold them in, a retracted position. However, when the expander 124 is shifted upwardly relative to the slips 115, the latter are urged in a radial outward direction to place their wickers 121 in anchoring engagement with the wall of the well casing B.

Depending from the upper expander 124 is a cylinder sleeve portion 133 of the hydraulic cylinder 100, which is spaced from the mandrel 10 of the tool to provide an annular cylinder space 134 therebetween in which a hydraulically actuatable latch or coupling sleeve 135 is disposed. Actually, the expander 124 may be considered as constituting an annular cylinder head. As specifically shown, this head 124 is integral with the depending cylinder skirt 133, although it is evident that, if desired, the head and skirt could be made separate from one another and suitably secured together, as by welding or screw threading.

The latch or coupling sleeve 135 includes an annular piston portion 136 slidable along the periphery of the body 10 and also along the lower inner wall 137 of the cylinder sleeve 133. The piston portion 136 is always disposed below one or a plurality of fluid inlet ports 138 establishing communication between the central passage 11 through the body 10 and the annular cylinder space 134 between the body and cylinder above the piston. Leakage of fluid in an upward direction from the cylinder space 134 is prevented by a suitable side seal 139, such as a rubber or rubber-like O ring, disposed

in an internal groove 139*a* in the cylinder head or expander 124 and slidably sealing against the periphery of the body 10. Leakage of fluid in a downward direction from the annular cylinder space 134 is prevented by an inner side seal ring 140, such as a rubber or rubber-like O ring, disposed within an internal groove 141 in the piston 136 and slidably sealing against the periphery of the body 10 below its ports 138. Leakage of fluid between the periphery of the piston 136 and the adjacent cylinder wall 137 is prevented by a suitable side seal ring 142, such as a rubber or rubber-like O ring, disposed in a ring groove 143 in the piston and slidably sealing against the cylinder wall.

When fluid under pressure differential enters the cylinder space 134 from the interior of the body and through the ports 138, such pressure tends to shift the cylinder 100 and expander 124 in an upward direction, at first shifting the slip retainer ring 118 into engagement with the lower end 127 of the coupling, which functions as a stop, the expander then moving upwardly along and behind the slips 115 to expand them radially into anchoring engagement with the wall of the well casing B. However, it is desired to prevent such upward movement of the expander 124 and its effecting outward expansion of the slips 115, until the lower slips 21 have been anchored against the well casing B and the packing structure 72 sealed off against the wall of the well casing. Upward movement of the upper expander 124 is prevented by the upper retaining member 92, the fingers 102 of which engage the inwardly directed flange 103 of the coupling skirt 99 integral with the upper cylinder 100 and the upper expander (FIG. 1), thereby preventing the upper expander 124 from moving up along the body 10 and with respect to the upper slips 115, for the purpose of shifting the latter outwardly into engagement with the wall of the well casing.

It is also desired for the body or mandrel 10 to be directly coupled to the upper expander 124 after the slips 115 have been expanded into anchoring engagement with the wall of the well casing B, in order that hydraulic forces acting on the body 10 from below the apparatus will be transmitted directly from the body 10 to the expander 124, and through the upper slips 115 to the wall of the well casing.

The direct transmission of upward thrust is accomplished in the present instance by forming the upper portion of the latch or coupling sleeve 135 of upwardly extending arms 150 which are produced by longitudinal slots 151 opening through the upper end of the sleeve and extending downwardly to the region of the annular piston 136. These arms 150 terminate in inwardly directed thrust heads 152 having inner, lower cam surfaces 153 tapering in an upward and inward direction, and coacting with companion tapered surfaces 154 on an expander and lock portion 155 integral with the body 10. After the cylinder 100 and upper expander 124 have been shifted upwardly hydraulically for the purpose of expanding the slips 115 into anchoring engagement with the well casing, the pressure in the cylinder is acting on the piston 136, urging the coupling sleeve 135 downwardly, the coengaging thrust head and expander surfaces 153, 154 overcoming the elasticity or resiliency of the spring arms 150 and shifting them laterally outward to the extent determined by engagement of longitudinally extending teeth 156 on the arms with companion teeth 157 formed in the inner wall of the upper portion of the cylinder sleeve 133. When such teeth 156, 157 coengage, as a result of outward expansion of the spring-like arms 150 and thrust heads 152, the expander surfaces 153, 154 are still engaged and the body 10 and cylinder sleeve 133, as well as the upper expander 124 integral with or secured to the latter, are directly coupled to one another, any upwardly directed forces on the body 10 being transmitted through the body, expander 155 and thrust heads 152 to the cylinder sleeve 133 and upper expander 124, the latter being wedged behind the slips 115 to transmit such forces through the latter to the well casing B, or corresponding well conduit (FIG. 3).

When the pressure differential within the cylinder 100 is relieved, the hydraulic force acting downwardly on the annular piston 136 is also relieved, which permits the arms 150 and their thrust heads 152 to inherently return to their retracted positions, such as disclosed in FIGS. 1 and 2.

For the purpose of facilitating assembly of the coupling sleeve 135 on the body, with its thrust heads 152 disposed between the expander and lock surface 154 and the body flange 158 thereabove, the expander and lock portion 155 is provided with slots 159 having a circumferential or arcuate extent corresponding to the circumferential extent of each arm 150 and head 152. Between the body slots 159 are the circumferentially spaced expander and lock portions 155, which correspond in arcuate extent with the slots or spaces 151 between the arms. It is to be noted that the interrupted expander and lock portion 155 of the body has a substantially larger external diameter than the body portion therebelow. In assembling the latch or coupling sleeve 135 on the body, the latter is inserted over the lower portion of the body and is moved upwardly therealong to the expander and lock portion 155. When it reaches such portion, the arms 150 and thrust heads 152 are aligned with the slots 159 therein, the thrust heads 152 being inserted through the slots 159 until they are disposed between the expander surface 154 and the flange 158 thereabove. The coupling sleeve 135 is then turned with respect to the body 10, to place the thrust heads 152 in alignment with the expander and lock elements 155, the heads then being disposed above these latter elements. The latch or coupling sleeve 135 is retained properly aligned or oriented with respect to the expander and lock elements 155 by means of an orienting screw 160 threaded into the body between a pair of adjacent thrust head portions 155. This screw will prevent substantial angular shifting of the thrust sleeve 135 on the body and will insure the proper engagement between the thrust head surfaces 153 and the expander and lock surfaces 154.

It is to be noted that upward movement of the latch or coupling sleeve 135 along the body is limited by engagement of the heads 152 with the external flange 158 on the body disposed immediately above the heads. Downward movement of the upper expander 124 along the body 10 and the latch or coupling sleeve 135 is limited by engagement of a downwardly facing shoulder 161 with the upper end 162 of the annular piston 136. The full retraction of the upper slips 115 against the body or mandrel 10 of the tool will also limit downward movement of the upper expander 124 and cylinder 100 along the body 10, by virtue of the inclined tongue and groove interconnection 125, 126 between the slips 115 and the expander 124.

In the use of the apparatus illustrated in the drawings, the parts are initially disposed in the condition shown in FIGS. 1 and 1*a*, in which the lower clutch 45 is engaged, the cam or key device 57 being disposed against one of the stops 61 at the end of the arcuate cavity 60 in the clutch sleeve 50. Both the upper and lower slips 115, 21 and the packing structure 72 are in their retracted positions. The apparatus is lowered in the well casing B toward the desired setting point therewithin. During such lowering on the tubular string C, the drag device 31 is coupled by the clutch 45 to the body 10 of the tool, these parts moving downwardly together. This downward motion is transferred directly to the lower expander 24 through the segmental pulling sleeve 65, and directly from the lower expander through the interengaging lower abutment 71 and snap ring 76 to the thrust sleeve 73 and upper abutment 78, by-passing the packing

structure 72. From the upper abutment, the pulling action is transferred through the two-piece tie ring 104 to the upper retaining device 92, which is then disposed in the lower end of the circular groove 94. The fingers 102 of this retaining device are pulling directly upon the flange 103 of the hydraulic cylinder 100, in order to pull the upper expander 124 in a downward direction and hold it in its downward position in which the upper slips 115 are in their fully retracted position.

Because of the direct pulling action imposed by the body 10 on the upper expander 124, any hydraulic pressure that might be developed within the body of the tool and the annular cylinder space 134 is prevented from shifting the cylinder 100 and upper expander 124 in an upward direction, to expand the slips 115 outwardly, since the upper expander is then, in effect, tied directly to the body 10 of the tool. Accordingly, assurance is had that the upper slips 115 will be retained in their fully retracted position, preventing their wickers or teeth 121 from engaging or sliding upon the casing wall B during lowering of the tool therein, which would dull them and possibly prevent their becoming anchored to the casing wall when desired.

When the location in the well casing B is reached at which the tool is to be anchored in packed-off condition, it is merely necessary to turn the tubing string C and the body or mandrel 10 of the tool to the right about 270 degrees, which will move the key or cam 57 against the dog 48, shifting it out of clutching engagement with the body teeth 46 and holding it in such outwardly engaged position. Assurance is had that the dog will be held in its outwardly engaged position, since the cam or key is disposed in engagement with the other stop shoulder 63 defining the other end of the clutch sleeve cavity 60. Such relative rotation between the body 10 and key 57, on the one hand, and the clutch dog 48, on the other hand, can occur since the drag device 31 is preventing rotation of the outer clutch members 45.

The apparatus A can now be anchored in packed-off condition against downward movement in the well casing merely by lowering the tubing string C and the mandrel 10 secured thereto. Such lowering action is permitted by virtue of the longitudinal keyway 58 which allows the mandrel or body 10 to slide downwardly along the key 57. During such downward movement, the upper anchor portion 115—162 of the tool will shift downwardly with the body 10, the upper body coupling 15 engaging the upper slip ring 118, shifting it and the slips 115 downwardly, the downward force being transferred through the springs 130 to the expander 124 and moving the latter and the cylinder 100 in a downward direction with respect to the upper retaining member 92, until the body shoulder 111 defining the upper end of the circular groove 94 engages the inwardly directed lower flange portion 93 of the upper retaining member 92. At this time, it is to be noted that the inwardly directed flange 103 of the cylinder coupling skirt 99 is spaced substantially below the retainer fingers 102 (FIG. 2). The body 10 of the tool and the whole upper anchor portion is then lowered, the drag device 31 preventing downward movement of the slips 21. Such lowering motion is transferred through the upper retaining member flange 93 to the upper abutment 78, 78*a*, and through the packing structure 72 to the lower abutment 71 and lower expander 24, the latter being shifted downwardly within the slips 21 and expanding the latter radially outwardly until their wickers 22 become embedded in the well casing B, thus precluding further downward movement of the lower expander 24 and of the lower abutment 71. A continuation of the downward movement of the body 10 will move the upper abutment toward the lower abutment 78, 78*a*, expanding the packing structure 72 into sealing engagement with the wall of the well casing, in the manner described above. The apparatus A is now anchored in packed-off condition in the well casing B against downward movement therewithin, the parts occupying the relative positions illustrated in FIGS. 2 and 2*a*.

The desired operation can now be commenced in the well bore. If fluid or fluent materials under pressure are to be pumped through the apparatus, such as cement slurry that is to be forced into the well bore below the set position of the apparatus, such fluent materials are introduced into the tubular string C, being pumped downwardly therethrough. The fluid pressure developed in the mandrel or body 10 of the tool will be imposed through the ports 138 upon the liquid in the cylinder 100, urging the cylinder and upper expander 124 attached thereto upwardly of the tool, the upper slips 115 and upper slip ring 118 at first being shifted upwardly until the slip ring 118 engages the lower end 127 of the body coupling 15, leaving a space 15*a* between the upper body shoulder 128 and the lower shoulder 118*a* of the upper slip ring. Continued upward movement of the expander 124 under the influence of the hydraulic pressure within the cylinder will overcome the force of the springs 130, the expander moving upwardly along the body 10 and the slips 115 to shift the latter outwardly into anchoring engagement with the wall of the well casing B.

After the upper expander 124 has moved upwardly along the body and slips to the fullest extent, any increase in pressure within the mandrel or body 10 and cylinder 100 will urge the piston 136 and the latch or coupling sleeve 135 in its entirety in a downward direction, the thrust heads 152 moving down along the expander and lock portion 155 and being cammed outwardly to bring the teeth 156 on the arms and heads into full meshing engagement with the internal teeth 157 in the cylinder sleeve 133, the parts then occupying the relative positions shown in FIGS. 3 and 3*a*.

Any tendency for the body 10 to move upwardly will then be transferred directly through its expander and lock portion 155 to the thrust heads 152, and from the latter through the coengaging teeth 156, 157 to the expander 124, the expander being urged upwardly behind the slips 115 to wedge them more firmly into anchoring engagement with the wall of the well casing. To enable the teeth 121 to penetrate to a greater extent into the wall of the well casing, the body 10 and expander 124 will move upward slightly relative to the slips 115, and such slight upward movement is permitted by the space 15*a* that exists between the upper body shoulder 128 and the lower portion 118*a* of the upper slip ring 118.

It is, accordingly, apparent that anchoring of the well packer in packed-off condition against downward movement in the well casing has been effected as a result of releasing the lower coupling or control mechanism 45 and merely lowering the body 10 of the tool. Upward anchoring of the apparatus against the well casing occurs without any manipulation of the tubing string or body 10 of the apparatus being necessary, since the hydraulic pressure within the tool will automatically shift the upper slips 115 into anchoring engagement with the well casing, the body of the tool then being coupled directly to the upper expander 124 through the expander and lock portions 155, 152 of the body and the coupling sleeve 135 and the teeth 156, 157. The tool is capable of remaining anchored in packed-off condition in the well casing, with substantial pressures being imposed upon the tool tending to shift it upwardly in the well casing. It is also capable of anchoring the tool in packed-off condition against downward movement, as by providing a pressure differential in the annulus between the tubing string C and the well casing B above the apparatus. Such downward pressure will act through the packing structure 72 to wedge the lower expander 24 more firmly in the lower slips 21 and also hold the packing structure 72 sealed off against the wall of the well casing.

In the event it is desired to release the apparatus A

from the well casing B, the internal pressure therewithin, as well as the pressure therebelow, is released. When the pressure differential within the tool drops below a force equivalent to that exerted by the helical springs 130, the latter can shift the expander 124 and cylinder 100 downwardly relative to the slips 115 and the body 10 of the tool, the teeth 157 on the cylinder bearing against the teeth 156 on the arms 150 and thrust heads 152 and camming the latter inwardly, so that the cylinder can, in effect, ratchet downwardly along the coupling sleeve 135 until the expander 124 has returned to its initial position, pulling the upper slips 115 inwardly by virtue of their tongue and groove interconnection 125, 126.

An upward pull can now be taken on the tubular string C and the mandrel 10 of the tool, the mandrel moving upwardly, its shoulder 128 engaging the upper slip ring 118 to pull the latter upwardly and the flange 158 engaging the lower end of the expander 124 to move it and the cylinder 100 upwardly, until the lower body shoulder 180, defining the lower end of the circular groove 94, engages the lower end of the upper retaining member 92. Such upward movement can occur, since the body ratchet teeth 46 merely ratchet freely through the clutch dog 48 in an upward direction, even if the cam or key 57 does not retain the clutch dog 48 out of clutching engagement with the body teeth 46. The upward movement is transferred from the upper retaining member 92 through the tie ring 104 to the upper abutment 78 and the compression or thrust sleeve 73, raising the upper abutment 78 relative to the lower abutment 71 to permit the packing structure 72 to return to its retracted position. The snap ring 76 secured on the lower end of the compression or thrust sleeve 73 then engages the lower abutment 71 and pulls it and the lower expander 24 upwardly relative to the lower slips 21, the latter being shifted away from the well casing and returned to their retracted position because of the inclined tongue and groove interconnection 27, 28. Upward movement of the lower expander 24 relative to the drag device 31 can occur until the lower flange 67 of the pulling sleeve 65 again engages the slip ring portion 29 of the drag device, whereupon the entire drag device 31 and clutch device 45 is moved upwardly with the body 10 of the tool. The entire apparatus can then be elevated in the well casing, and removed entirely therefrom, if desired.

In the event the apparatus is to be lowered in the well casing from its prior setting point, the tubing string C and body 10 of the tool are rotated to the left, to be assured that the cam and key 57 has been removed from the clutch dog 48 and has been again placed in engagement with the stop 61 at the end of the cavity 60. Accordingly, the clutch 45 will be engaged and downward movement of the body 10 of the tool can occur, to pull all of the mechanism surrounding it, and which is in retracted position, down the casing with it without effecting setting of any of the parts, and also preventing inadvertent fluid or hydraulic expansion of the upper slips 115 against the well casing.

In the event that the upper slips 115 are not retracted merely by relieving the pressure in the tool and in the cylinder 100, such retraction will occur in any event merely as a result of taking an upward pull on the tubular string C and the body 10 of the tool. It is to be noted that the angle R that the tapered surfaces 154, 153 on the expander 155 and thrust heads 152 makes to the axis of the apparatus is substantially greater than the angle S that the surfaces of the coengaging teeth 156, 157 make to the axis of the apparatus (see FIG. 6, particularly). By way of example, the surfaces 154, 153 on the expander and thrust heads may make an angle R of about 30 degrees to the vertical, whereas the tooth surfaces may make an angle S of about 20 degrees to the vertical. Accordingly, following relieving of the pressure differential in the apparatus and with the slips 115 in anchored position against the well casing, such as disclosed in FIGS. 3 and 3*a*, an upward strain may be taken on the tubular string C and the body or mandrel 10 of the tool. Such upward pull is transmitted through the expander 155 to the thrust heads 152, and from the latter through the coengaging teeth 156, 157 to the cylinder 100 and expander 124, the force passing from the expander 124 through the slips 115 to the well casing. Inasmuch as the angle of inclination S of the tooth surfaces to the axis of the tool is substantially less than the angle R of the expander and thrust head surfaces to the axis of the tool, a much greater lateral force component is being exerted between the cylinder teeth 157 and arm and thrust head teeth 156, tending to shift the arms and thrust heads inwardly, than is being exerted between the expander 155 and thrust heads 152, tending to shift the thrust heads and arms outwardly. The result of the relative angular relationship between the parts is that the taking of a sufficient upward pull on the tubular string C and the body 10 will cause the coengaging teeth 156, 157 to pinch or cam the arms 150 and thrust heads 152 inwardly out of engagement with the cylinder teeth 157, allowing the body 10 of the tool and the arms 150 and heads 152 to move upwardly relative to the expander 124, slips 115 and slip ring 118. This upward movement will occur until the upper body shoulder 128 engages the upper slip retainer ring 118, after which a continuation of the upward pull will cause the body 10 to move the slip retainer ring 118 and the upper slips 115 coupled thereto upwardly relative to the expander 124, effecting a retraction of the slips with respect to the expander, in view of the inclined slidable tongue and groove interconnection 125, 126 therebetween. Actually, it may only be necessary for the shoulder 128 to engage the slip retainer ring 118 and move the slips 115 a slight distance to disengage them from the well casing, after which the springs 130 become effective to shift the expander 124 downwardly relative to the slips 115 and the body 10 of the tool back to its initial position, such as disclosed in FIGS. 1 and 1*a*, in which the parts of the tool are again releasably retained in their retracted positions.

Even in the absence of the helical compression springs 130 between the upper slip retainer ring 118 and the upper expander 124, the upper slips 115 will be shifted back to their retracted positions as a result of taking an upward pull on the tubing string C and the body 10 of the tool. Upon release of the coupling sleeve 135 from the hydraulic cylinder 100 and the upper expander 124, the upper body shoulder 128 will engage the upper slip ring 118 and will shift the slips 115 upwardly relative to the expander 124 sufficiently to release the slips from the casing, after which the expander 124 will drop downwardly along the body 10 to the extent limited by engagement of its shoulder 161 with the upper end 162 of the piston 136. In the event that the cylinder and upper expander do not drop downwardly, as has just been described, then a continuation of the upward movement of the body 10 will carry the slips 115 and expander 124 upwardly with it until the inwardly directed flange 103 on the cylinder and coupling skirt 99 engages the fingers 102 of the upper retaining member 92. Such engagement, followed by continued upward movement of the body 10, will result in the upper expander 124 being incapable of moving up with the body at this time, the slips 115 then being pulled upwardly relative to the upper expander and back to their retracted position. A continuation of the upward movement on the body will then cause the lower body shoulder 180 defining the circular groove 94 to engage the upper retaining member 92 and exert an upward pull on the thrust sleeve 73 and the lower expander 24, to effect retraction of the packing structure 72 and the lower slips 21 from the well casing, allowing the apparatus to be removed from the well bore.

The inventor claims:

1. In apparatus to be disposed within and anchored to

a well conduit: a body; first initially retracted anchor means carried by and movable relative to said body and expandible outwardly into engagement with the well conduit in response to downward movement of said body relative to said first initially retracted slip means to prevent downward movement of said body within the well conduit; second initially retracted slip means carried by said body; expander means movable longitudinally along said body and second initially retracted slip means for expanding said second initially retracted slip means outwardly into engagement with the well conduit to prevent upward movement of said body within the well conduit; means interconnecting said first initially retracted anchor means and expander means to prevent said expander means from expanding said second initially retracted slip means until said first initially retracted anchor means has been expanded into engagement with the well conduit; and means releasably coupling said body to said first initially retracted anchor means to prevent downward movement of said body relative to said first initially retracted anchor means.

2. In apparatus to be disposed within and anchored to a well conduit: a body; first initially retracted anchor means carried by and movable relative to said body and expandible outwardly into engagement with the well conduit in response to longitudinal movement of said body to prevent movement of said body within the well conduit in one longitudinal direction; second initially retracted slip means carried by said body; hydraulically operable means for expanding said second initially retracted slip means into engagement with the well conduit to prevent movement of said body within the well conduit in the opposite longitudinal direction; and means interconnecting said first anchor means and said hydraulically operable means to prevent said hydraulically operable means from expanding said second slip means until said first anchor means has been expanded into engagement with the well conduit.

3. In apparatus to be disposed within and anchored to a well conduit: a body; first initially retracted anchor means carried by said body; means for expanding said first anchor means outwardly into engagement with the well conduit to prevent movement of said body within the well conduit in one longitudinal direction; second initially retracted slip means carried by said body; hydraulically operable means for expanding said second slip means into engagement with the well conduit to prevent movement of said body within the well conduit in the opposite longitudinal direction; and means interconnecting said first anchor means and said hydraulically operable means to prevent said hydraulically operable means from expanding said second slip means until said first anchor means has been expanded into engagement with the well conduit.

4. In apparatus to be disposed within and anchored to a well conduit: a body; first initially retracted anchor means carried by said body; means for expanding said first anchor means outwardly into engagement with the well conduit to prevent downward movement of said body therewithin; second initially retracted slip means carried by said body; hydraulically operable means for expanding said second slip means into engagement with the well conduit to prevent upward movement of said body therewithin; and means interconnecting said first anchor means and said hydraulically operable means to prevent said hydraulically operable means from expanding said second slip means until said first anchor means has been expanded into engagement with the well conduit.

5. In apparatus to be disposed within and anchored to a well conduit: a body; first initially retracted anchor means carried by and movable relative to said body and expandible outwardly into engagement with the well conduit in response to downward movement of said body to prevent downward movement of said body within the well conduit; second initially retracted slip means carried by said body; hydraulically operable means for expanding said second slip means into engagement with the well conduit to prevent upward movement of said body therewithin; and means interconnecting said first anchor means and said hydraulically operable means to prevent said hydraulically operable means from expanding said second slip means until said body has moved downwardly to expand said first anchor means into engagement with the well conduit.

6. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted lower slips surrounding said body and engageable with the well conduit to hold the body against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means releasably coupling said body to said drag means for movement together; lower expander means on said body coacting with said slips to expand them into engagement with the well conduit; normally retracted packing means on said body above and engageable with said expander means; abutment means operatively connected to said body and movable downwardly by said body to expand said slips and packing means outwardly against the well conduit after release of said coupling means; normally retracted upper slips surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; hydraulically operable upper expander means movable upwardly on said body and coacting with said upper slips to expand said upper slips against the well conduit; and releasable means interconnecting said abutment means and upper expander means to prevent said upper expander means from moving upwardly on said body.

7. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted lower slips surrounding said body and engageable with the well conduit to hold the body against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means for movement together releasably coupling said body to said drag means; lower expander means on said body coacting with said slips to expand them into engagement with the well conduit; normally retracted packing means on said body above and engageable with said expander means; abutment means operatively connected to said body and movable downwardly by said body to expand said slips and packing means outwardly against the well conduit after release of said coupling means; thrust means for transmitting downward movement of said lower expander means to said abutment means; normally retracted upper slips surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; hydraulically operable upper expander means movable upwardly on said body and coacting with said upper slips to expand said upper slips against the well conduit; and releasable thrust means for transmitting downward movement of said abutment means to said upper expander means to prevent upward movement of said upper expander means relative to said body.

8. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted lower slips surrounding said body and engageable with the well conduit to hold the body against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means releasably coupling said body to said drag means for movement together; lower expander means on said body coacting with said slips to expand them into engagement with the well conduit; normally retracted packing means on said body above and engageable with said expander means; abutment means operatively connected to said body and movable downwardly by said body to expand said slips and packing means outwardly against the well conduit after release of said coupling means; a thrust sleeve

secured to said abutment means and extending through said packing means; means on said lower expander means engageable with said sleeve to transmit downward movement of said lower expander means to said abutment means; normally retracted upper slips surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; hydraulically operable upper expander means movable upwardly on said body and coacting with said upper slips to expand said upper slips against the well conduit; and releasable thrust means for transmitting downward movement of said abutment means to said upper expander means to prevent upward movement of said upper expander means relative to said body.

9. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted lower slips surrounding said body and engageable with the well conduit to hold the body against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means releasably coupling said body to said drag means for movement together; lower expander means on said body coacting with said slips to expand them into engagement with the well conduit; normally retracted packing means on said body above and engageable with said expander means; abutment means operatively connected to said body and movable downwardly by said body to expand said slips and packing means outwardly against the well conduit after release of said coupling means; a thrust sleeve extending through said packing means to transmit downward movement of said lower expander means for movement together to said abutment means; normally retracted upper slips surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; hydraulically operable upper expander means movable upwardly on said body and coacting with said upper slips to expand said upper slips against the well conduit; and releasable thrust means for transmitting downward movement of said abutment means to said upper expander means to prevent upward movement of said upper expander means relative to said body.

10. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted lower slips surrounding said body and engageable with the well conduit to hold the body against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means releasably coupling said body to said drag means for movement together; lower expander means on said body coacting with said slips to expand them into engagement with the well conduit; normally retracted packing means on said body above and engageable with said expander means; abutment means operatively connected to said body and movable downwardly by said body to expand said slips and packing means outwardly against the well conduit after release of said coupling means; normally retracted upper slips surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; hydraulically operable upper expander means movable upwardly on said body and coacting with said upper slips to expand said upper slips against the well conduit; releasable means interconnecting said abutment means and upper expander means to prevent said upper expander means from moving upwardly on said body; and a lost motion connection between said body and abutment means, whereby release of said coupling means permits downward movement of said body and upper expander means relative to said abutment means to release said interconnecting means from said upper expander means to permit upward movement of said upper expander means along said body to expand said upper slips.

11. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted lower slips surrounding said body and engageable with the well conduit to hold the body against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means releasably coupling said body to said drag means for movement together; lower expander means on said body coacting with said slips to expand them into engagement with the well conduit; normally retracted packing means on said body above and engageable with said expander means; abutment means operatively connected to said body and movable downwardly by said body to expand said slips and packing means outwardly against the well conduit after release of said coupling means; normally retracted upper slips surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; hydraulically operable upper expander means movable upwardly on said body and coacting with said upper slips to expand said upper slips against the well conduit; releasable means interconnecting said abutment means and upper expander means to prevent said upper expander means from moving upwardly on said body; and means for transmitting upward force on said body directly from said body to said upper expander means and upper slips.

12. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted slip means surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; hydraulically operable expander means movable upwardly on said body and coacting with said slip means to expand said slip means against the well conduit; and releasable means on said body disconnectably secured to said body and engageable with said hydraulically operable expander means to prevent upward movement of said hydraulically operable expander means on said body to expand said slip means; said preventing means including a lost motion connection connected with said body and expander means to permit downward movement of said body and expander means relative to said preventing means, after disconnection of said preventing means from said body, to release said preventing means from said expander means and permit its movement upwardly along said body to expand said slip means.

13. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted slip means surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; hydraulically operable expander means movable upwardly on said body and coacting with said slip means to expand said slip means against the well conduit; and releasable means disconnectably secured to said body for preventing upward movement of said hydraulically operable expander means on said body to expand said slip means; said preventing means including a lost motion connection permitting downward movement of said body and expander means relative to said preventing means, after disconnection of said preventing means from said body, to release said preventing means from said expander means and permit its movement upwardly along said body to expand said slip means.

14. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted slip means surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; hydraulically operable expander means movable upwardly on said body and coacting with said slip means to expand said slip means against the well conduit; releasable means on said body disconnectably secured to said body and engageable with said hydraulically operable expander means to prevent upward movement of said hydraulically operable expander means on said body to expand said slip means; said preventing means including a lost motion connection connected with said body

and expander means to permit downward movement of said body and expander means relative to said preventing means, after disconnection of said preventing means from said body, to release said preventing means from said expander means and permit its movement upwardly along said body to expand said slip means; and means for transmitting upward force on said body directly from said body to said expander means and slips.

15. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted slip means surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; hydraulically operable expander means movable upwardly on said body and coacting with said slip means to expand said slip means against the well conduit; releasable mean disconnectably secured to said body for preventing upward movement of said hydraulically operable expander means on said body to expand said slip means; said preventing means including a lost motion connection permitting downward movement of said body and expander means relative to said preventing means, after disconnection of said preventing means from said body, to release said preventing means from said expander means and permit its movement upwardly along said body to expand said slip means; and means for transmitting upward force on said body directly from said body to said expander means and slip means.

16. In apparatus to be disposed within and anchored to a well conduit: body means; normally retracted slip instrumentalities carried by said body means and adapted to engage the well conduit to anchor the body means against upward movement therewithin; hydraulically operable expander means movable upwardly along said body means and adapted to coact with said slip instrumentalities to expand and hold said slip instrumentalities against the well conduit; means for transmitting longitudinal force directly from said body means to said expander means including a coupling member, first coengageable cam means on said body means and coupling member tending to urge said coupling member laterally outwardly in response to relative longitudinal movement between said body means and coupling member, second coengageable cam means on said coupling member and expander means tending to urge said coupling member laterally inwardly in response to relative longitudinal movement between said expander means and coupling member, one of said cam means exerting a greater lateral force than said other cam means to release said coupling member from one of said body means and expander means in response to a longitudinal force imposed on said one of said body means and expander means; and releasable means on said body means disconnectably secured to said body means and engageable with said hydraulically operable expander means to prevent upward movement of said hydraulically operable expander means on said body means to expand said slip instrumentalities; said preventing means including a lost motion connection connected with said body means and expander means to permit downward movement of said body means and expander means relative to said preventing means, after disconnection of said preventing means from said body means, to release said preventing means from said expander means and permit its movement upwardly along said body means to expand said slip instrumentalities.

17. In apparatus to be disposed within and anchored to a well conduit: body means; normally retracted slip instrumentalities carried by said body means and adapted to engage the well conduit to anchor the body means against upward movement therewithin; hydraulically operable expander means movable upwardly along said body means and adapted to coact with said slip instrumentalities to expand and hold said slip instrumentalities against the well conduit; means for transmitting longitudinal force directly from said body means to said expander means including a coupling member, first coengageable cam means on said body means and coupling member tending to urge said coupling member laterally outwardly in response to relative longitudinal movement between said body means and coupling member, second coengageable cam means on said coupling member and expander means tending to urge said coupling member laterally inwardly in response to relative longitudinal movement between said expander means and coupling member, one of said cam means exerting a greater lateral force than said other cam means to release said coupling member from one of said body means and expander means in response to a longitudinal force imposed on said one of said body means and expander means; normally retracted slips surrounding said body and adapted to engage the well conduit to anchor the body means against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means releasably coupling said body means to said drag means; lower expander means on said body means coacting with said slips to expand them into engagement with the well conduit; normally retracted packing means on said body means engageable with said lower expander means; abutment means operatively connected to said body means and movable downwardly by said body means to expand said slips and packing means outwardly against the well conduit upon release of said coupling means; and releasable means interconnecting said abutment means and hydraulically operable expander means to prevent said hydraulically operable expander means from moving upwardly on said body means.

18. In apparatus to be disposed within and anchored to a well conduit: body means; normally retracted slip instrumentalities carried by said body means and adapted to engage the well conduit to anchor the body means against upward movement therewithin; hydraulically operable expander means movable upwardly along said body means and adapted to coact with said slip instrumentalities to expand and hold said slip instrumentalities against the well conduit; means for transmitting longitudinal force directly from said body means to said expander means including a coupling member, first coengageable cam means on said body means and coupling member tending to urge said coupling member laterally outwardly in response to relative longitudinal movement between said body means and coupling member, second coengageable cam means on said coupling member and expander means tending to urge said coupling member laterally inwardly in response to relative longitudinal movement between said expander means and coupling member, one of said cam means exerting a greater lateral force than said other cam means to release said coupling member from one of said body means and expander means in response to a longitudinal force imposed on said one of said body means and expander means; normally retracted slips surrounding said body and adapted to engage the well conduit to anchor the body means against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means releasably coupling said body means to said drag means; lower expander means on said body means coacting with said slips to expand them into engagement with the well conduit; normally retracted packing means on said body means engageable with said lower expander means; abutment means operatively connected to said body means and movable downwardly by said body means to expand said slips and packing means outwardly against the well conduit upon release of said coupling means; a thrust sleeve extending through said packing means to transmit downward movement of said lower expander means to said abutment means; and releasable thrust means for transmitting downward movement of said abutment means to said hydraulically operable expander means to prevent upward movement of said hydraulically operable expander means relative to said body.

19. In apparatus to be disposed within and anchored

to a well conduit: body means; normally retracted slip instrumentalities carried by said body means and adapted to engage the well conduit to anchor the body means against upward movement therewithin; hydraulically operable expander means movable upwardly along said body means and adapted to coact with said slip instrumentalities to expand and hold said slip instrumentalities against the well conduit; means for transmitting longitudinal force directly from said body means to said expander means including a coupling member, first coengageable cam means on said body means and coupling member tending to urge said coupling member laterally outwardly in response to relative longitudinal movement between said body means and coupling member, second coengageable cam means on said coupling member and expander means tending to urge said coupling member laterally inwardly in response to relative longitudinal movement between said expander means and coupling member, one of said cam means exerting a greater lateral force than said other cam means to release said coupling member from one of said body means and expander means in response to a longitudinal force imposed on said one of said body means and expander means; normally retracted slips surrounding said body and adapted to engage the well conduit to anchor the body means against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means releasably coupling said body means to said drag means; lower expander means on said body means coacting with said slips to expand them into engagement with the well conduit; normally retracted packing means on said body means engageable with said lower expander means; abutment means operatively connected to said body means and movable downwardly by said body means to expand said slips and packing means outwardly against the well conduit upon release of said coupling means; releasable means interconnecting said abutment means and hydraulically operable expander means to prevent said hydraulically operable expander means from moving upwardly on said body means; and a lost motion connection between said body means and abutment means, whereby release of said coupling means permits downward movement of said body means and hydraulically operable expander means relative to said abutment means to release said interconnecting means from said hydraulically operable expander means to permit upward movement of said hydraulically operable expander means along said body means to expand said slip instrumentalities.

20. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted lower slips surrounding said body and engageable with the well conduit to hold the body against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means releasably coupling said body to said drag means; lower expander means on said body adapted to coact with said slips to expand them into engagement with the well conduit; normally retracted packing means on said body above and engageable with said expander means; abutment means operatively connected to said body and movable downwardly by said body to expand said slips and packing means outwardly against the well conduit upon release of said coupling means; normally retracted upper slips surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; upper expander means movable relatively upwardly on said body and coacting with said upper slips to expand said upper slips against the well conduit; and releasable means interconnecting said abutment means and upper expander means to prevent said upper expander means from moving relatively upwardly on said body during downward movement of said apparatus in the well conduit.

21. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted lower slips surrounding said body and engageable with the well conduit to hold the body against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means releasably coupling said body to said drag means; lower expander means on said body adapted to coact with said slips to expand them into engagement with the well conduit; normally retracted packing means on said body above and engageable with said expander means; abutment means operatively connected to said body and movable downwardly by said body to expand said slips and packing means outwardly against the well conduit upon release of said coupling means; normally retracted upper slips surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; upper expander means movable relatively upwardly on said body and coacting with said upper slips to expand said upper slips against the well conduit; releasable means interconnecting said abutment means and upper expander means to prevent said upper expander means from moving relatively upwardly on said body during downward movement of said apparatus in the well conduit; and means providing a lost motion connection between said body and abutment means to permit said body to move downwardly relative to said abutment means before said body moves said abutment means downwardly to expand said lower slips and packing means.

22. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted lower slips surrounding said body and engageable with the well conduit to hold the body against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means releasably coupling said body to said drag means; lower expander means on said body adapted to coact with said slips to expand them into engagement with the well conduit; normally retracted packing means on said body above and engageable with said expander means; abutment means operatively connected to said body and movable downwardly by said body to expand said slips and packing means outwardly against the well conduit upon release of said coupling means; thrust means for transmitting downward movement of said lower expander means to said abutment means; normally retracted upper slips surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; upper expander means movable relatively upwardly on said body and coacting with said upper slips to expand said upper slips against the well conduit; and releasable thrust means for transmitting downward movement of said abutment means to said upper expander means to prevent upward movement of said upper expander means relative to said body.

23. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted lower slips surrounding said body and engageable with the well conduit to hold the body against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means releasably coupling said body to said drag means; lower expander means on said body adapted to coact with said slips to expand them into engagement with the well conduit: normally retracted packing means on said body above and engageable with said expander means; abutment means operatively connected to said body and movable downwardly by said body to expand said slips and packing means outwardly against the well conduit upon release of said coupling means; thrust means for transmitting downward movement of said lower expander means to said abutment means; normally retracted upper slips surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; upper expander means movable relatively upwardly on said body and coacting with said upper slips to expand said upper slips against the well conduit; releasable thrust means for

transmitting downward movement of said abutment means to said upper expander means to prevent upward movement of said upper expander means relative to said body; and means providing a lost motion connection between said body and abutment means to permit said body to move downwardly relative to said abutment means before said body moves said abutment means downwardly to expand said lower slips and packing means.

24. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted lower slips surrounding said body and engageable with the well conduit to hold the body against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means releasably coupling said body to said drag means; lower expander means on said body adapted to coact with said slips to expand them into engagement with the well conduit; normally retracted packing means on said body above and engageable with said expander means; abutment means operatively connected to said body and movable downwardly by said body to expand said slips and packing means outwardly against the well conduit upon release of said coupling means; a thrust sleeve secured to said abutment means and extending through said packing means; means on said lower expander means engageable with said sleeve to transmit downward movement of said lower expander means to said abutment means; normally retracted upper slips surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; upper expander means movable relatively upwardly on said body and coacting with said upper slips to expand said upper slips against the well conduit; and releasable thrust means for transmitting downward movement of said abutment means to said upper expander means to prevent upward movement of said upper expander means relative to said body.

25. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted lower slips surrounding said body and engageable with the well conduit to hold the body against downward movement therewithin; drag means frictionally engageable with the well conduit and connected to said slips; means releasably coupling said body to said drag means; lower expander means on said body adapted to coact with said slips to expand them into engagement with the well conduit; normally retracted packing means on said body above and engageable with said expander means; abutment means operatively connected to said body and movable downwardly by said body to expand said slips and packing means outwardly against the well conduit upon release of said coupling means; normally retracted upper slips surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; upper expander means movable relatively upwardly on said body and coacting with said upper slips to expand said upper slips against the well conduit; releasable means interconnecting said abutment means and upper expander means to prevent said upper expander means from moving upwardly on said body; and a lost motion connection between said body and abutment means, whereby release of said coupling means permits downward movement of said body and upper expander means relative to said abutment means to release said interconnecting means from said upper expander means to permit upward movement of said upper expander means along said body to expand said upper slips.

26. In apparatus to be disposed within and anchored to a well conduit: a body; normally retracted slip means surrounding said body and engageable with the well conduit to hold the body against upward movement therewithin; expander means movable relatively upwardly on said body and coacting with said slip means to expand said slip means against the well conduit; and releasable means disconnectably secured to said body for preventing upward movement of said expander means on said body to expand said slip means; said preventing means including a lost motion connection permitting downward movement of said body and expander means relative to said preventing means, after disconnection of said preventing means from said body, to release said preventing means from said expander means and permit movement of said expander means relatively upwardly along said body to expand said slip means.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,013,610 December 19, 1961

Martin B. Conrad

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 15, line 5, for "slip" read -- anchor --.

Signed and sealed this 22nd day of May 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents