March 24, 1970 D. E. YOUNG 3,502,144

WELL PACKER APPARATUS

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Fig. 1A

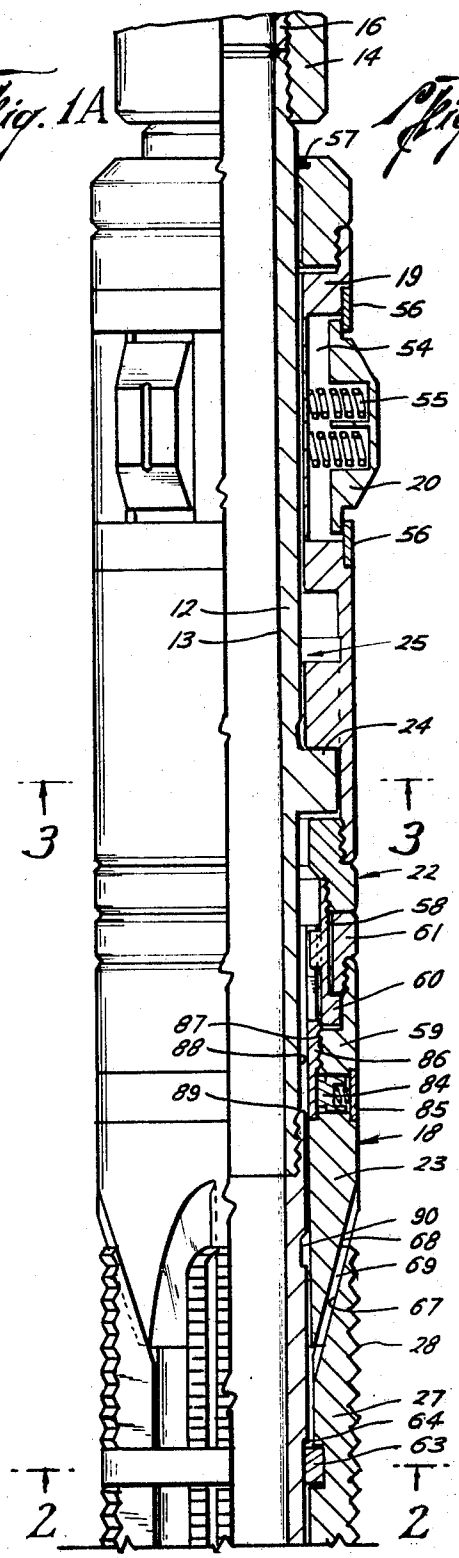
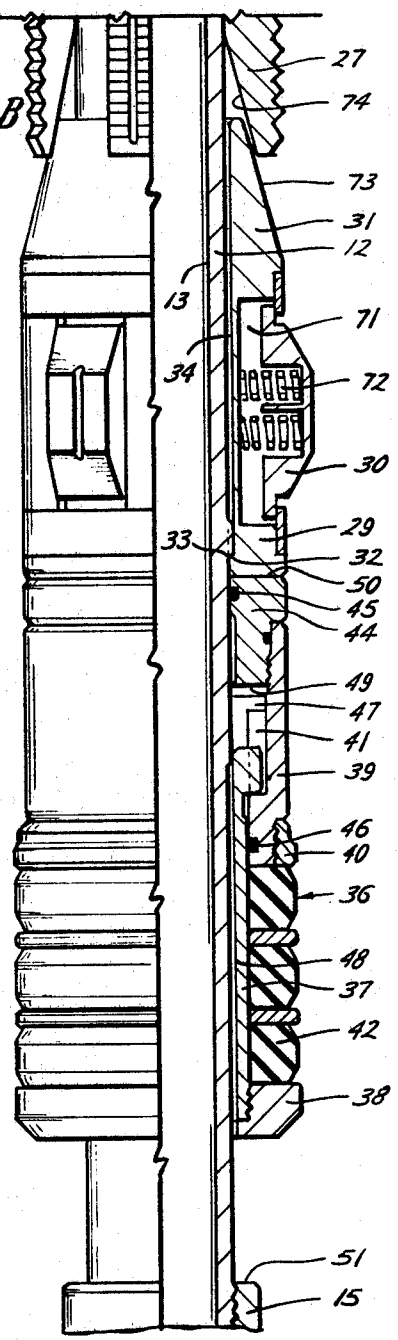


Fig. 1B



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WELL PACKER APPARATUS

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Fig. 2

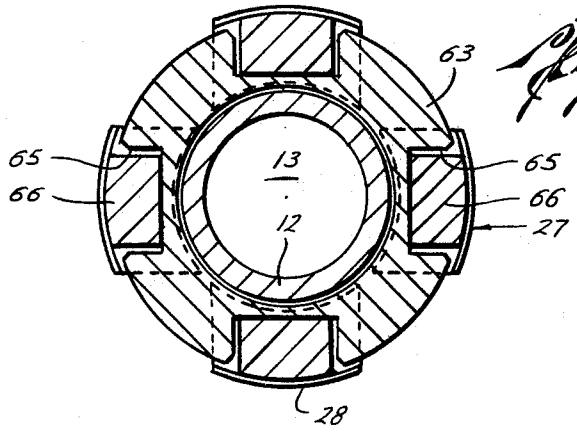


Fig. 3

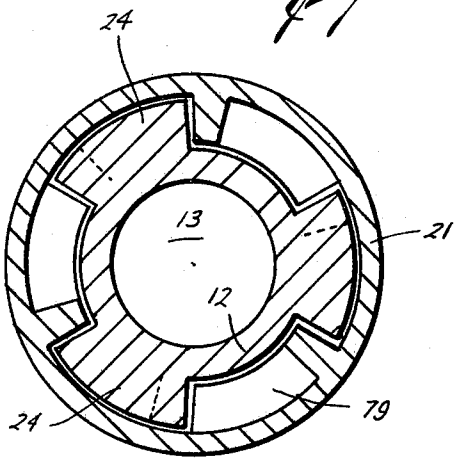
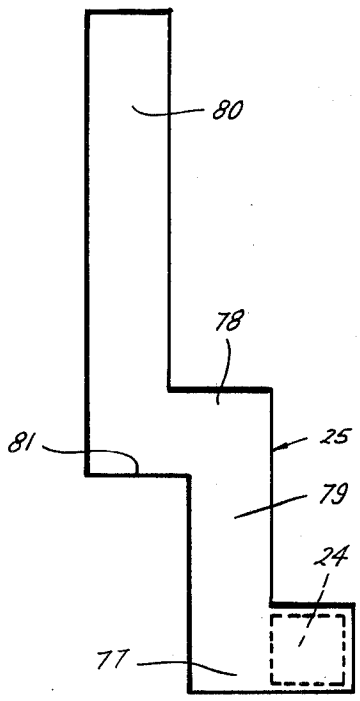


Fig. 4



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WELL PACKER APPARATUS

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Fig. 5A

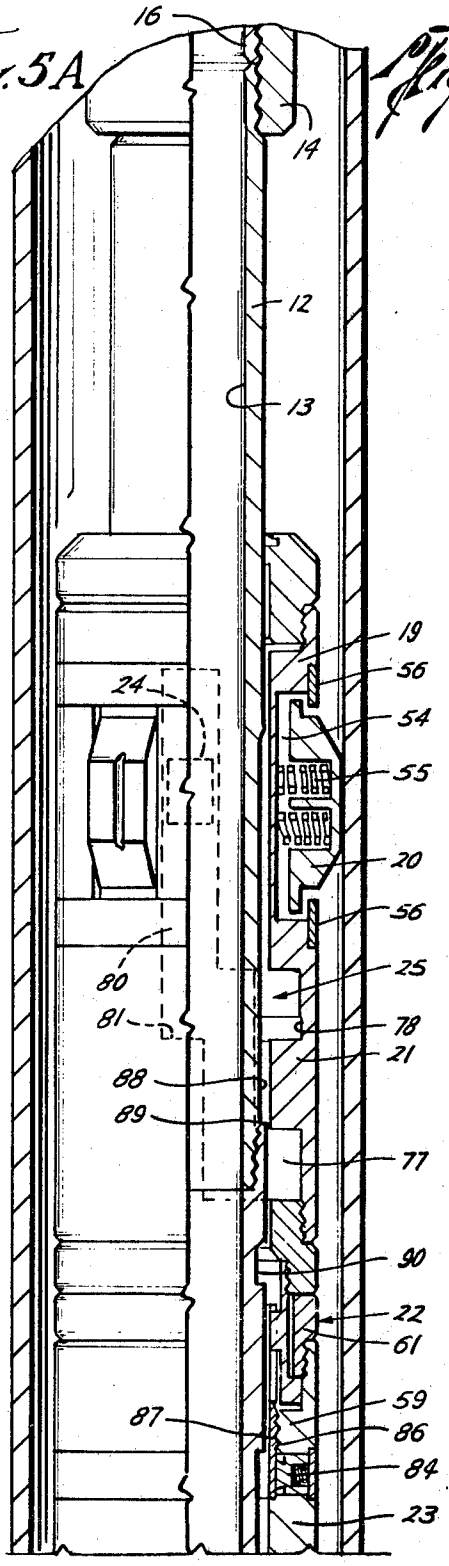
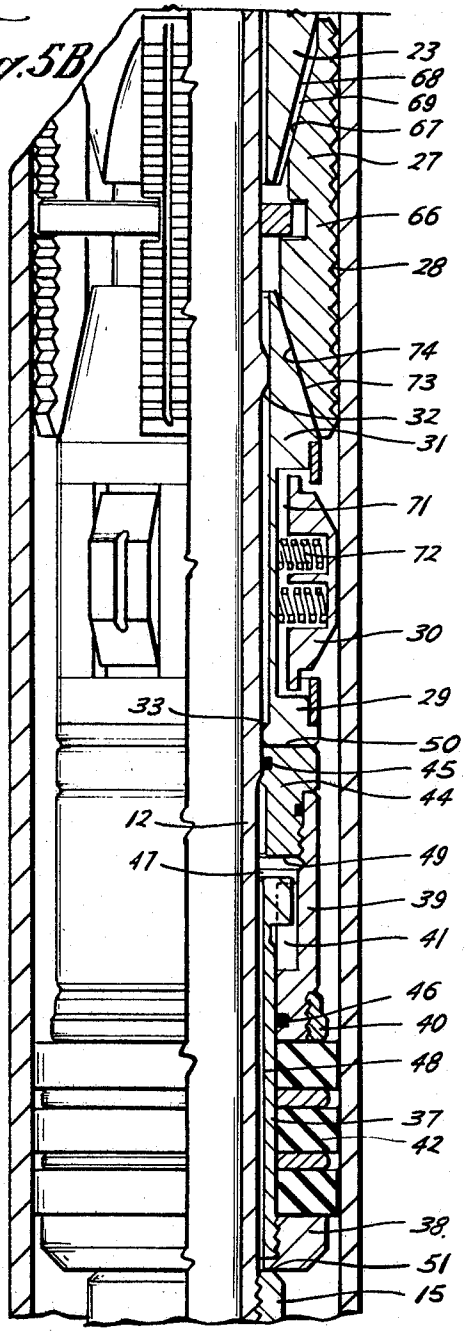


Fig. 5B



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WELL PACKER APPARATUS

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Fig. 7

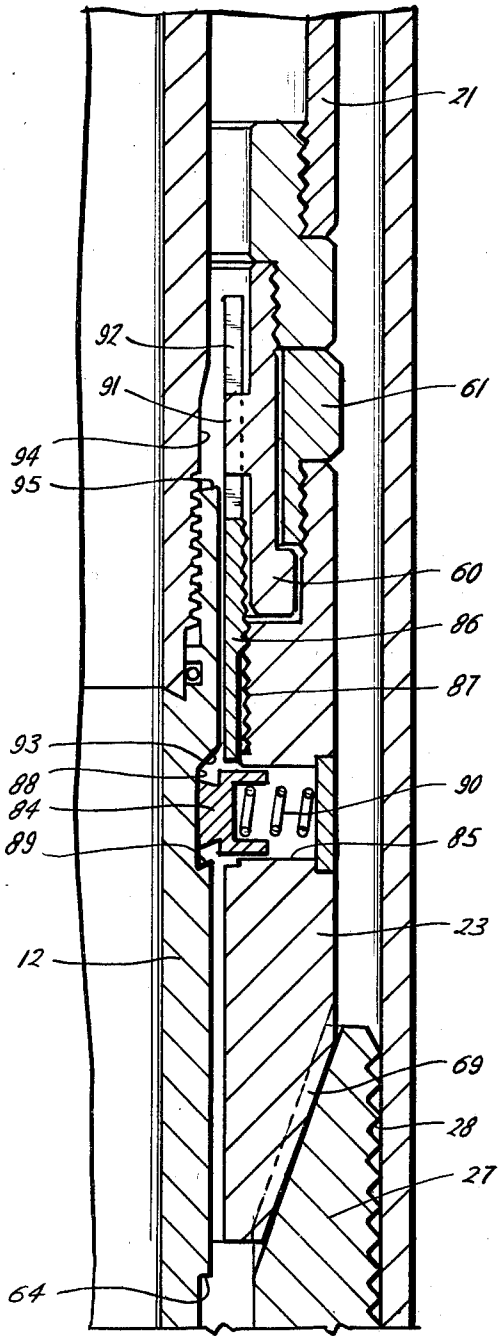
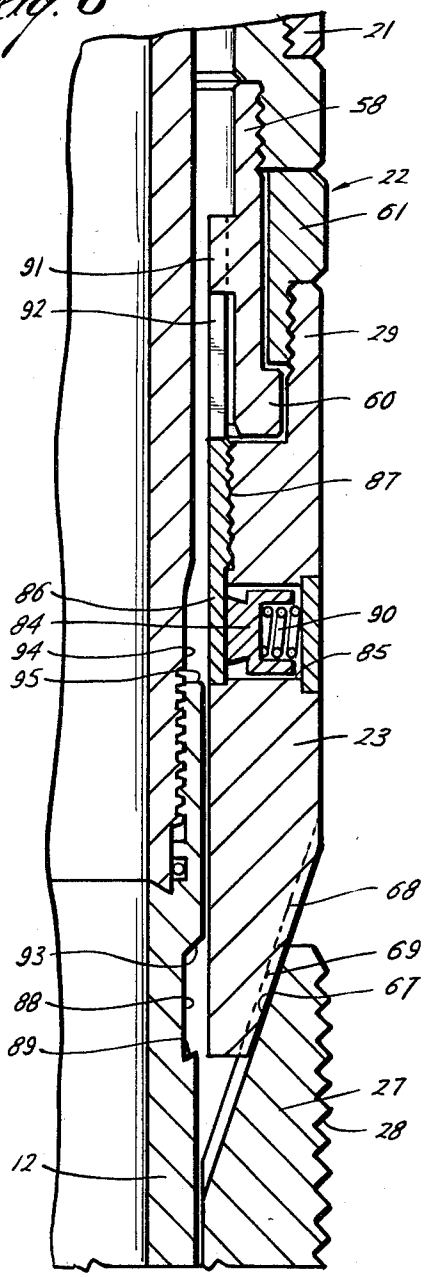


Fig. 6



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United States Patent Office 3,502,144 Patented Mar. 24, 1970

3,502,144

WELL PACKER APPARATUS

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Filed Apr. 22, 1968, Ser. No. 722,911
Int. Cl. E21b 23/06
U.S. Cl. 166—216 4 Claims

ABSTRACT OF THE DISCLOSURE

A retrievable well packer apparatus including a body member having upper and lower expander means slidably mounted thereon for movement toward and away from each other, normally retracted slip means between said expander members and slidably coupled to said body member and one of said expander means and expandable by said expander members into anchoring engagement with a well bore wall, packing means for sealing off a well bore in response to movement of said body member relative to slip and expander means in one longitudinal direction, and disarming means for preventing expansion of said slip means including laterally movable means which is normally retained in inoperative position and which can be operated by manipulation of said body member to prevent expansion of said slip means by said expander members.

This invention relates generally to well packers used in well bores, and more specifically to an apparatus for disarming a well packer to prevent inadvertently setting the packer as it is being retrieved to the surface after use.

Retrievable well packers commonly used for isolating bore zones are generally lowered into the well bore on a running-in string of tubing or drill pipe. The packer has slips which can be operated to anchor the tool at a preselected depth, as well as packing which seals off the annulus between the string and the surrounding well conduit wall. When it is desired to retrieve the tool, the slip and packing can be released.

It is highly undesirable for the slips or the packing to be accidentally operated while the tool is being moved through the conduit because this may result in damage to the tool or to the conduit or both. Particularly when retrieving the tool, such premature operation may also result in damage to the running-in string which is being pulled in tension at the surface. In any event, the present invention provides a new and improved apparatus for disarming a retrievable well packer so that it is not possible to accidentally operate the slips or the packing during longitudinal movement in a well conduit, thereby eliminating the foregoing problem from the art.

SUMMARY OF THE INVENTION

Generally speaking, an apparatus in accordance with the concepts of the present invention includes a body member which is adapted to be secured to a running-in string and to be moved by the string in a well bore. The body member carries normally retracted slip means which can be shifted outwardly into gripping contact with a well bore wall, and expander means which is movable longitudinally on the body member and relative to the slip means for shifting the slip means outwardly. First means on the body member and expander means is selectively operable in response to manipulation of the body member relative to the expander means for preventing or permitting relative longitudinal movement between the body member and the expander means, and second means on the body member and the expander means is also selectively operable in response to manipulation of the body member relative to the expander means to positively

lock the expander means to the body member. The first means is utilized in conventional manner to enable setting and releasing of the slip means and the packing means, whereas the second means is utilized to prevent operation of the first means, whereby the slip means or the packing means cannot be set.

The novel features of the present invention are particularly set forth in the appended claims. One preferred embodiment of the present invention is illustrated in the accompanying drawings in which:

FIGURES 1A and 1B are longitudinal sectional views, with portions in side elevation, of a well packer in accordance with this invention, FIGURE 1B forming a lower continuation of FIGURE 1A;

FIGURE 2 is a cross-section on line 2—2 of FIGURE 1A;

FIGURE 3 is a cross-section on line 3—3 of FIGURE 1A;

FIGURE 4 is a schematic plan view of a slot configuration which is used to enable selective control over relative movement between parts;

FIGURES 5A and 5B are views similar to FIGURES 1A and 1B except with the packer set in a well conduit;

FIGURE 6 is a fragmentary exploded view of the disarming structure of the present invention in its normally inactive position of parts; and

FIGURE 7 is a view similar to FIGURE 6 but with the disarming structure operated.

Referring initially to FIGURES 1A and 1B, an apparatus which illustrates the principles of the present invention includes a tubular body member or mandrel **12** having a central passage **13** through which fluid can flow. Threaded collars **14** and **15** can be provided at the upper and lower ends of the mandrel **12**, the upper collar **14** being coupled to a running-in string of tubing or drill pipe **16** which extends to the earth's surface. The mandrel **12** carries an anchoring structure **18** which includes a tubular cage **19** and drag elements **20**, the cage **19** being secured to a tubular sleeve **21** which is coupled by a swivel connection **22** to an upper expander member **23**. One or more lug elements **24** extend outwardly from the mandrel **12** and engage within a slot system **25** formed on the interior of the sleeve **21**, the lugs and slot system cooperating to provide control over relative longitudinal movement between the mandrel and the anchoring structure as will be more fully described.

Circumferentially spaced slip elements **27** are slidably coupled to the expander member **23** and are mounted on the mandrel **12** for both longitudinal and lateral movement relative to the mandrel. The slip elements **27** have peripheral wickers or teeth **28** which can bite into and grip the well casing in order to prevent movement in either direction in a well casing.

A lower tubular cage **29** carries drag elements **30** and is secured to a lower expander member **31**. The cage and expander members **29** and **31** are slidable upwardly relative to the mandrel **12** to a position where respective shoulders **32** and **33** on the cage and the mandrel engage to limit relative movement. A bore **34** in the cage and expander member is, however, sized to permit unlimited upward relative movement of the mandrel **12** within the cage and expander member.

A packing structure **36** is slidably carried by the mandrel **12** and includes an inner sleeve **37** having a lower abutment **38**, and an outer sleeve **39** having an upper abutment **40**. The respective sleeves **37** and **39** are slidable along each other and can have a spline connection **41** to prevent relative rotation. One or more conventional elastomeric packing rings **42** are mounted around the inner sleeve **37** between the upper and lower abutments **40** and **38**, the rings being expandable into sealing engagement with a well casing wall by movement of the abut-

ments 40 and 38 relatively toward each other. The outer sleeve 39 has an inwardly extending annular piston section 44 which is sealed against an outer peripheral surface of the mandrel 12 by an O-ring seal 45 or the like. Moreover, an O-ring seal 46 prevents fluid leakage between the inner end outer sleeves 37 and 39, whereby a variable volume chamber 47 is formed between the outer sleeve 39 and the mandrel 12. This chamber 47 is communicated with the well annulus below the packing rings 42 by a suitable passage which can conveniently be formed by an annular space 48 between the mandrel 12 and the inner sleeve 37. Consequently, fluid pressure below the packing rings 42 can act on the lower face 49 of the piston section 44, while fluid pressure above the packing rings can act on the upper face 50 of the piston section. With this arrangement, once the packing rings 42 are expanded into sealing engagement with a well casing wall, high pressure in the well annulus above the packing rings can act on the piston section 44 to impose compressive force on the packing rings for purposes which will become more apparent hereafter. Upward movement of the packing assembly 36 along the mandrel 12 is limited by engagement of the piston section 44 with the lower cage 29, and upward movement of the mandrel 12 within the packing assembly is limited by a transverse surface 51, which may be conveniently provided by the collar 15.

Turning now to a more detailed consideration of various other structural features of the present invention, the upper tubular cage 19 has a plurality of circumferentially spaced, radially directed recesses 54 which receive drag blocks 20. The drag blocks 20 can be urged outwardly by coil springs 55 or the like into frictional engagement with a well casing, and outward movement of the blocks can be limited by bands 56. A seal barrier 57 prevents debris in the well bore from getting in between the cage and the mandrel. The swivel connection 22 can be suitably formed by flanged sleeves 58 and 59 which are threadedly secured to the extension sleeve 21 and the upper expander member 23, respectively. The sleeves 58 and 59 have coengaging annular portions 60 and 61 to provide a rotational coupling.

The slip elements 27 are mounted on a ring member 63 which is relatively slidable on the mandrel 12 below an annular stop shoulder 64. The ring member 63 can be an integral piece as shown in cross-section in FIGURE 2, or can be formed in segments secured together by threaded studs. In any event, the ring member 63 has circumferentially spaced, axially disposed recesses 65, each of which receives a central portion 66 of a respective slip element 27 to provide a lateral guide therefor. As previously noted, the ring member 63 can slide downwardly relative to the mandrel 12, however upward movement is limited by the downwardly facing stop shoulder 64 on the mandrel.

The slip elements 27 have upper inner inclined surfaces 67 cooperable with the outer inclined surfaces 68 on the expander member 23 whereby longitudinal movement of the elements relative to the expander member will cause lateral shifting thereof. A "dove-tail" flange and groove connection 69 slidably couples each slip element 27 to the upper expander member 23 so that the slip elements are retracted by upward movement of the expander member 23 relative to the slip elements.

The lower drag cage 29 has recesses 71 receiving drag blocks 30 which are urged outwardly by coil springs 72. Outer inclined surfaces 73 on the expander member 31 are engageable with inner inclined surfaces 74 on the slip elements 27 for wedging the elements outwardly. However, there is no sliding connection between the lower expander member 31 and the slip elements 27.

The slot system 25 which cooperates with the mandrel lugs 24 may best be understood by considering FIGURES 3 and 4. As shown in FIGURE 3, there can be three lugs 24 circumferentially spaced about the mandrel 12, each of which engages in a slot configuration formed interiorly of the sleeve extension 21 and shown somewhat schematically in FIGURE 4. Each slot configuration is longitudinally stepped and includes lower and upper transverse channels 77 and 78 connected by a short vertical channel 79. An elongated vertical channel 80 connects with the upper transverse channel 78. In the running-in condition of parts shown in FIGURES 1A and 1B, the lugs 24 are positioned in the lower transverse channels 77 to prevent relative movement of the upper expander member 23 along the mandrel 12. However, it will be appreciated that by applying right-hand torque to the mandrel 12 while lifting the mandrel upwardly, the lugs 24 can be moved into the elongated vertical channels 80 to permit a substantial amount of relative movement between the upper expander member 23 and the mandrel. Moreover, the transverse form of the upper channels 78 provides transverse surfaces or shoulders 81 which can be engaged by the lugs 24 in response to downward movement of the mandrel 12, whereby downward force on the mandrel can be applied to the upper expander member 23 for reasons which will be subsequently pointed out. Of course, it will be understood that more or less than three lugs 24 can be on the mandrel 12, in which case the slot system 25 will include a like number of slot configurations in which the lugs engage.

In operation of the structure thus far described, it will be apparent that the assembled tool can be connected to the lower end of the pipe string 16 and pushed downwardly along the well casing to setting depth as additional joints of the pipe string are added in end-to-end relation. The lower drag blocks 30 slide along the well casing wall and the coengaged shoulders 32 and 33 on the mandrel and lower cage maintain the lower expander member 31 in spaced relation to the slip elements 27. The upper drag blocks 20 are also sliding along the casing wall as the downward motion of the mandrel 12 is being transmitted to the anchor assembly 18 by engagement of the lugs 24 with the lower transverse channels 77. The slip elements 27 are being held in retracted positions by their sliding connections 69 with the upper expander member 23, together with engagement of the mounting ring 63 underneath the mandrel shoulder 64. Of course, the packing rings 42 are in their inherently retracted positions so that well fluids can pass between the rings and the well casing wall.

When it is desired to set the packer, right-hand torque coupled with an upward strain on the pipe string 16 will position the lugs 24 within the elongated vertical channels 80 as previously described, the drag blocks 20 functioning to prevent movement of the upper cage member 19 and the upper expander member 23. As the mandrel 12 is pulled upwardly, the lower mandrel shoulder 51 engages the lower end of the inner sleeve 37 to elevate the packing assembly 36 as well as the lower drag assembly 29 and the lower expander member 31 toward the slip elements 27. This results in outward shifting of the slip elements 27 until their teeth 28 bite into and grip the well casing wall. Then the lower expander member 31 and the outer sleeve 39 of the packing assembly 36 cannot move any further upwardly, whereby continued upward movement of the mandrel 12 telescopes the inner sleeve 37 within the outer sleeve 39 and effects compression and lateral expansion of the packing rings 42 until their outer peripheries seal against the well casing wall. A predetermined amount of upward strain is maintained in the pipe string 16 at the earth's surface in order to maintain the tool in set condition as shown in FIGURES 5A and 5B.

It should be specifically noted at this point that both of the expander members 23 and 31 are engaging the slip elements 27. This engaged relationship will be maintained during the operation of the packer and until it is desired to release the tool for retrieval from the well. With the slip elements 27 set and the packing 42 expanded, the well bore below the tool can be pressurized

as desired and the slip elements will prevent upward movement while the packing rings seal off the well annulus.

Should a sufficiently high pressure exist in the annulus above the packer, the packing assembly **36** and the mandrel **12** can shift downwardly to a limited extent in the casing, such limited shifting being accompanied by stretching of the pipe string **16**. However, the slip elements **27** remain in anchoring positions and engaged by both expander members **23** and **31**. Downward movement of the mandrel **12** will bring the lugs **24** against the shoulder surfaces **81**, whereupon downward force on the mandrel is imposed by the upper expander member **23** on the slip elements **27** which prevent further downward movement.

During this movement, the packing rings **42** merely slide downwardly along the casing in expanded condition and remain sealed against the well casing wall This will occur because the lower fluid pressures are acting on the lower face **49** of the piston section **44** while the high pressures are acting on the upper face **50**, the pressure differential acting on the area A as downward force which is applied to the upper end of the packing rings **42** by the upper abutment **40**. It will be remembered that upward strain is still being exerted on the pipe string **16** so that compressive force is being applied to the lower end of the packing rings **42** by the lower abutment **33**. Accordingly, since compressive force is being exerted on both ends of the packing rings, the rings will not retract but can slide downwardly along the casing wall in expanded and sealing condition. The actual extent of downward shifting of the mandrel **12** and packing assembly **36** is actually quite short compared to prior art devices of this general type, and may be only two or three inches. This feature provides a significant advantage over such prior tools, particularly when the packer is set at shallow depths and the length of the pipe string is consequently short.

If the pressure in the annulus is reduced, tension is still being held in the pipe string **16** and the string can contract and shift the packing assembly **36** and the mandrel **12** back upwardly to their original position with the upper and lower expander members **23** and **31** cooperating with the slip elements **27** to prevent further upward movement. In fact, as long as tension is held on the pipe string, the packing assembly **36** and the mandrel **12** can shift to and fro and it will be appreciated that the well bore remains sealed off to prevent any fluid movement past the tool. The slip elements **27** remain anchored against the well casing wall and remain supported in anchoring position by both the upper and lower expander members **23** and **31**.

To unset the tool, pressures above and below the packer are equalized by operation of a suitable bypass valve (not shown) as upward strain on the pipe string **16** is relieved and as the mandrel **12** is moved downwardly by lowering the pipe string. This relieves the compressive force on the packing assembly **36** and the packing rings **42** will inherently retract. The mandrel shoulder **32** will engage the cage shoulder **33** to push the lower expander member **31** out from behind the slip elements **27**. The lugs **24** are manipulated back into the lower transverse channels **77** of the slot system **25** to lock the upper expander member **23** and the drag assembly **19** in their upper positions on the mandrel **12**. Then an upward pull on the pipe string **16** will lift the upper expander member **23** and cause the slip elements **27** to shift inwardly along the inclined surfaces **68** of the expander member **23** to their retracted positions, whereupon the tool is free to be moved upwardly or downwardly within the casing.

It is sometimes desirable to be able to "safety" the tool during removal of same from the well. In other words, some operators may desire to completely disarm the tool immediately before retrieving it so that it is impossible to again set the slips and the packing in the well bore. A structure for accomplishing this end is shown in detail in FIGURE 6. An inwardly biased latch lug **84** is received in a radial bore **85** in the wall of the expander member **23**, the lug being urged inwardly by a coil spring **90** or the like. The latch lug **84** is normally retained outwardly and in inoperative position by a retaining sleeve **86** which is threaded at **87** to the expander member **23** and slidably and corotatively coupled to the flanged sleeve **58** on the cage extension sleeve **21** by one or more projections **91** which engage in elongated slots **92** in the retaining sleeve **86**. By rotation of the extension sleeve **21** relative to the expander member **23**, the retainer sleeve **86** can be fed upwardly by the threads **87** to a position clear of the latch lug **84**, whereupon the lug can spring inwardly against the mandrel **12** and into a detent groove or recess **88** formed above a shoulder **89** on the mandrel. When this occurs, it is impossible to again manipulate the mandrel lugs **24** within the slot system **25** in a manner to enable setting the slips and packing because the mandrel **12** cannot be moved upwardly relative to the slips **27**. If desired, the mandrel **12** can be lowered and an inclined surface **93** will cause the lug **84** to ride out of the groove **88**. When the mandrel **12** has been lowered until the lugs **24** are in the lower slot channels **77**, the upper detent groove **94** will be positioned adjacent the lug **84** so that the lug can engage above a shoulder **95** to prevent setting of the slips and packing during retrieval from the well. Thus it will be appreciated that the disarming feature of the present invention can be operated in two longitudinal positions of the mandrel **12** relative to the upper expander member **23**.

To operate the disarming mechanism, the mandrel **12** is first manipulated to place the mandrel lugs **24** in the long vertical channels **80**, and then the pipe string **16** is moved downwardly to set the slip elements **27** against the casing wall. With a small amount of pipe weight being applied, the slip elements cannot be rotated within the casing, and the upper expander member **23** cannot rotate due to the "dove-tail" connection **69** between the slip elements and the expander member. Accordingly, sufficient torque can be applied to the pipe string **16** to rotate the upper drag elements **20** within the casing and relative to the expander member **23**, such relative rotation being permitted by the swivel connection **22**. Although the upper drag elements are sufficiently resistive to movement to enable setting and unsetting the tool as previously described, the elements can be forced by torque applied thereto by the mandrel lugs **24** against the sides of the channels **80** to slide around the inner periphery of the casing. Such relative rotation causes the retaining sleeve **86** to feed upwardly until the latch lug **84** is released and engaged in the groove **88** as shown in FIGURE 7. Then the mandrel **12** can be lowered and manipulated to place the lugs **24** back within the transverse channels **77**, and where the mandrel recess **94** is located adjacent the latch lug, allowing the lug to snap into the recess and above the shoulder **95**. Now it is impossible to elevate the mandrel **12** relative to the upper expander member **23** or the slip elements **27**. Accordingly, the tool cannot again be set on this trip into the well and the operator can pull the tool from the well as fast as he desires without fear that the tool will, by some fortuitous circumstance, accidentally hang up and set in the casing.

It will be appreciated that the entire tool shown in the drawings could be inverted or turned upside down and then run ino a well bore, in which case the tool could be set in compression by pipe weight if desired. Also, the rotational directions for setting and unsetting movement applied to the pipe string at the surface are a function of the slot system **25**, which can be arranged for right-hand or left-hand torque as desired.

It will be apparent that the present invention provides a new and improved retrievable well packer which can be disarmed so that it is impossible to set the slips and packing during retrieval from a well bore. Since certain

changes or modifications may be made in the present invention without departing from the inventive concepts, it is the aim of the appended claims to cover all such changes and modifications falling within the true spirit and scope of the present invention.

I claim:

1. In a well tool having a body member and normally retracted slip means which can be shifted into gripping contact with a well conduit by expander means mounted on said body member for movement relative to said slip means, first means including lug and channel means on said body member and expander means for controlling relative longitudinal movement between said expander means and said slip means to enable shifting of said slip means by said expander means; and second selectively operable means for preventing operation of said first means to selectively prevent shifting of said slip means by said expander means.

2. Apparatus for permitting or preventing relative movement between parts of a well tool adapted to be anchored in a well bore, comprising: a body member carrying normally retracted slip means which can be expanded outwardly, and expander means for expanding said normally retracted slip means outwardly; laterally movable means including lug means on said expander means engageable in recess means on said body member in spaced longitudinal relative positions of said body member and said expander means to prevent expansion of said slip means by said expander member; means for retaining said lug means in an inoperative position; and means responsive to manipulation of said body member for disabling said retaining means to permit engagement of said lug means in said recess means.

3. The apparatus of claim 2 wherein said retaining means includes a sleeve member longitudinally movable on said expander means between a position of engagement with said lug and a position of disengagement from said lug, said disabling means including thread means responsive to rotation of said sleeve member relative to said expander means to move said sleeve member between said positions.

4. Apparatus for use in a well bore comprising: a body member; normally retracted means which can be expanded outwardly into anchoring engagement with a well conduit wall; expander means for expanding said normally retracted means; friction drag means on said body member coengageable with the well conduit wall; rotative coupling means between said drag means and said expander means to permit relative rotation therebetween; normally restrained lock means on said expander means movable into locking engagement with said body member; means for restraining said lock means from engaging said body member; and means responsive to rotation of said drag means by said body member relative to said expander means for disabling said restraining means to enable said locking means to engage said body member and lock said expander means to said body member.

References Cited

UNITED STATES PATENTS

2,671,513	3/1954	Clark	166—237
2,906,347	9/1959	Baker	166—140 X
2,988,149	6/1961	Conrad	166—237
3,054,452	9/1962	Clark et al.	166—237 X

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U.S. Cl. X.R.

166—237