Jan. 2, 1968 D. V. CHENOWETH 3,361,207

RETRIEVABLE SUBSURFACE WELL TOOLS

Filed Sept. 4, 1964 7 Sheets-Sheet 1

FIG. 1a.

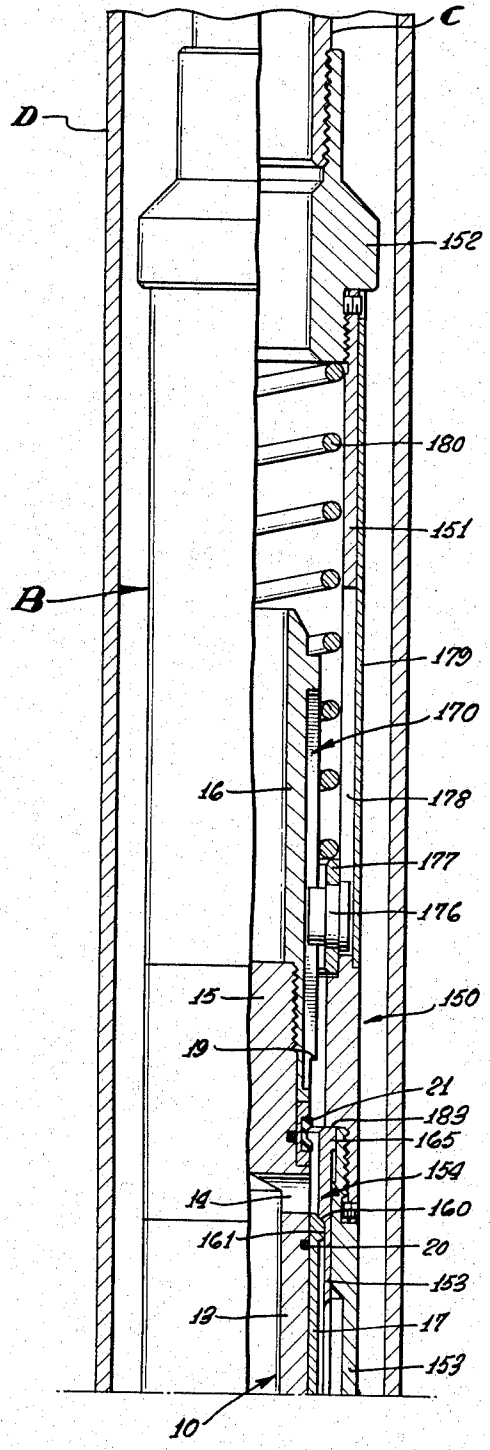
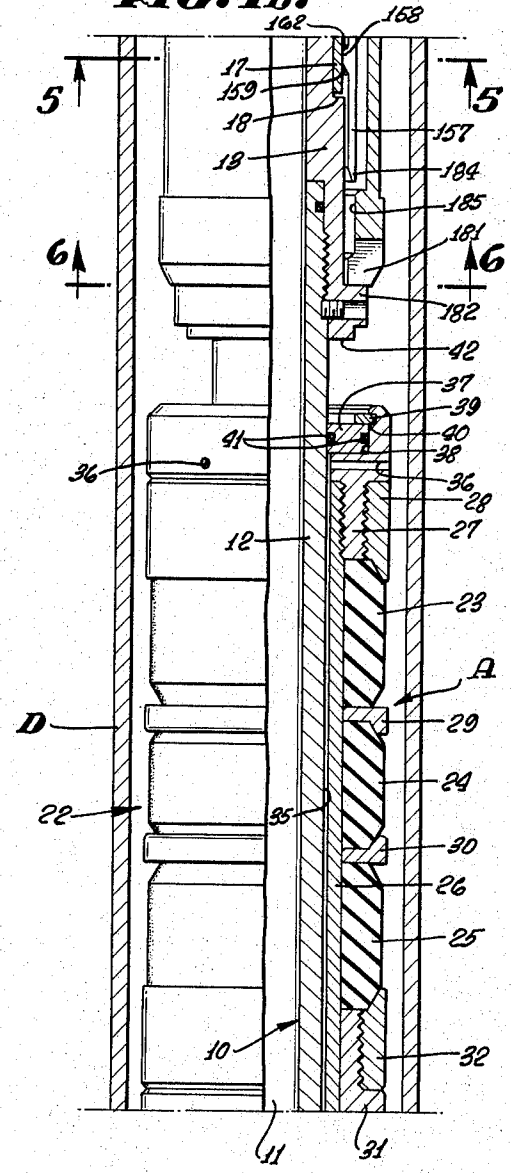


FIG. 1b.



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Jan. 2, 1968 D. V. CHENOWETH 3,361,207

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Filed Sept. 4, 1964 7 Sheets-Sheet 2

FIG. 1c.

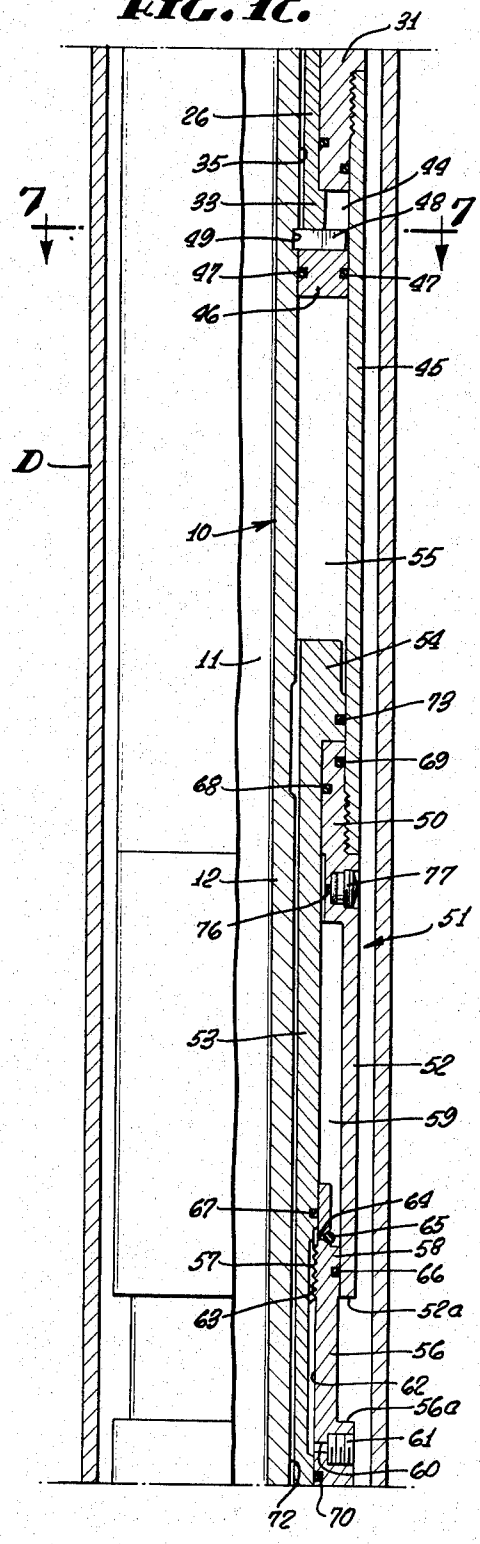
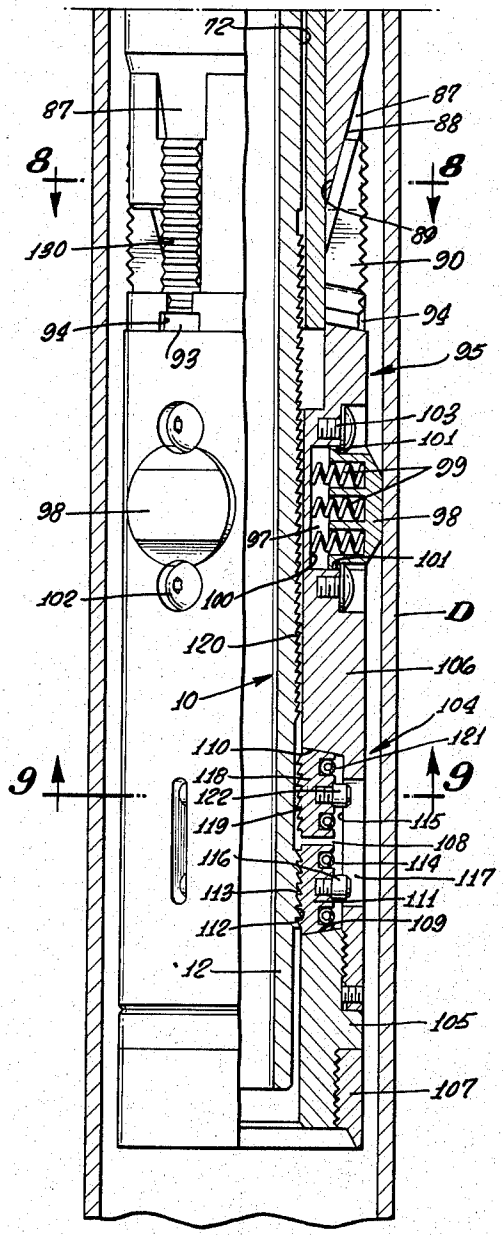


FIG. 1d.



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RETRIEVABLE SUBSURFACE WELL TOOLS

Filed Sept. 4, 1964 7 Sheets-Sheet 3

FIG. 2a.

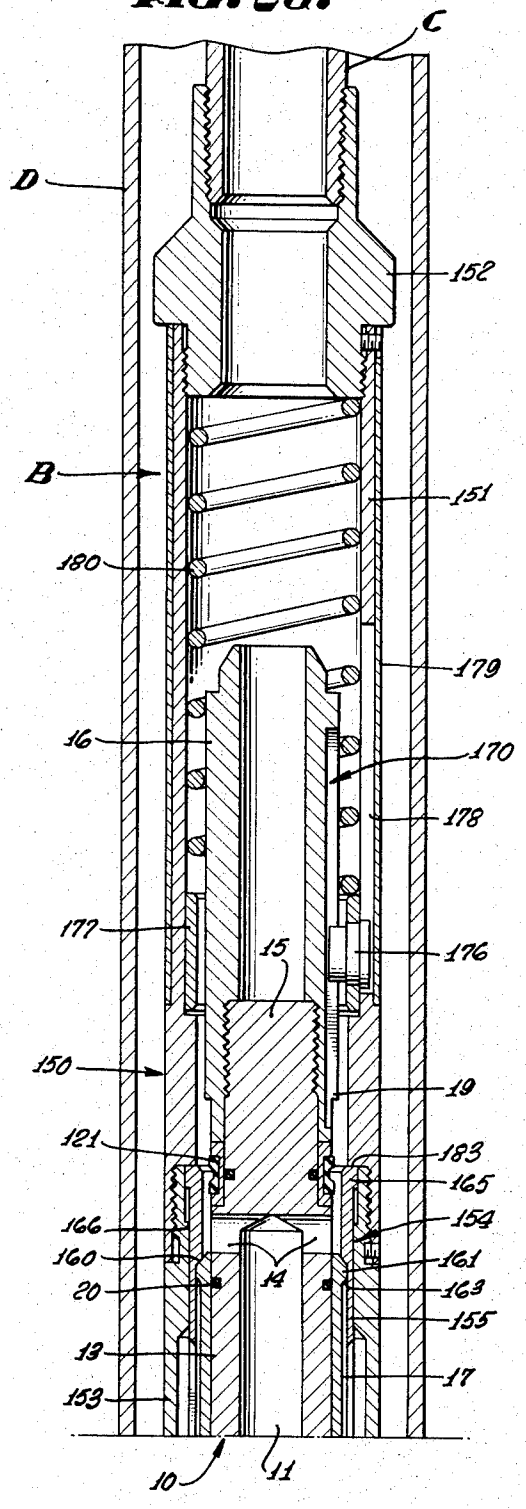
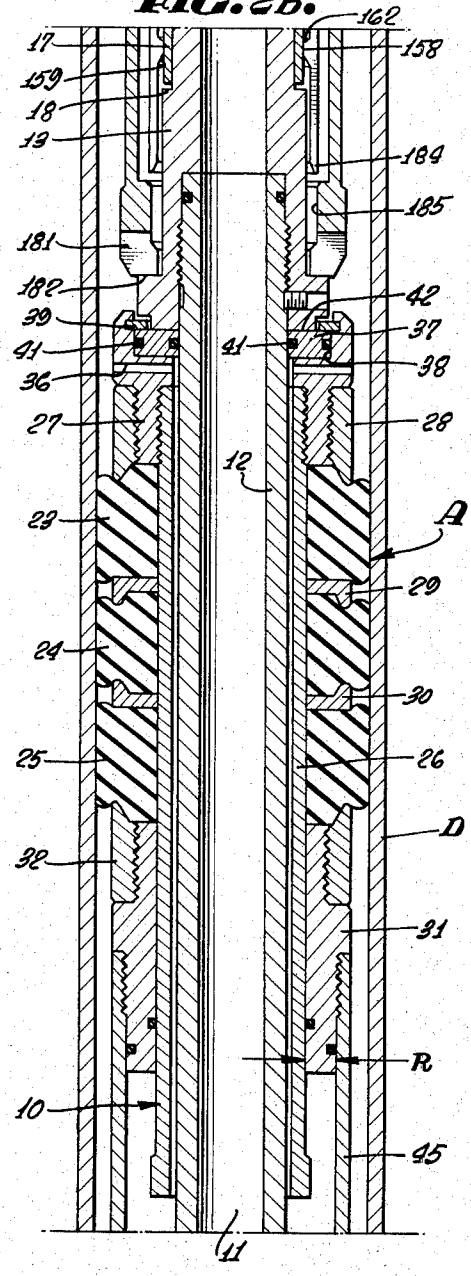


FIG. 2b.



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Filed Sept. 4, 1964 7 Sheets-Sheet 4

FIG. 2c.

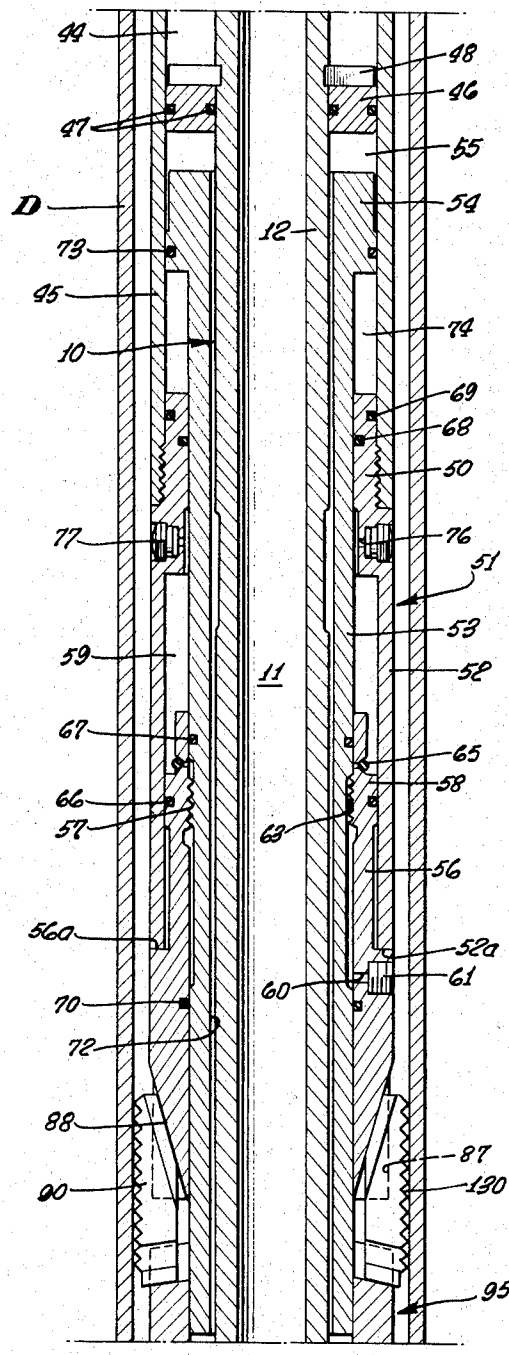
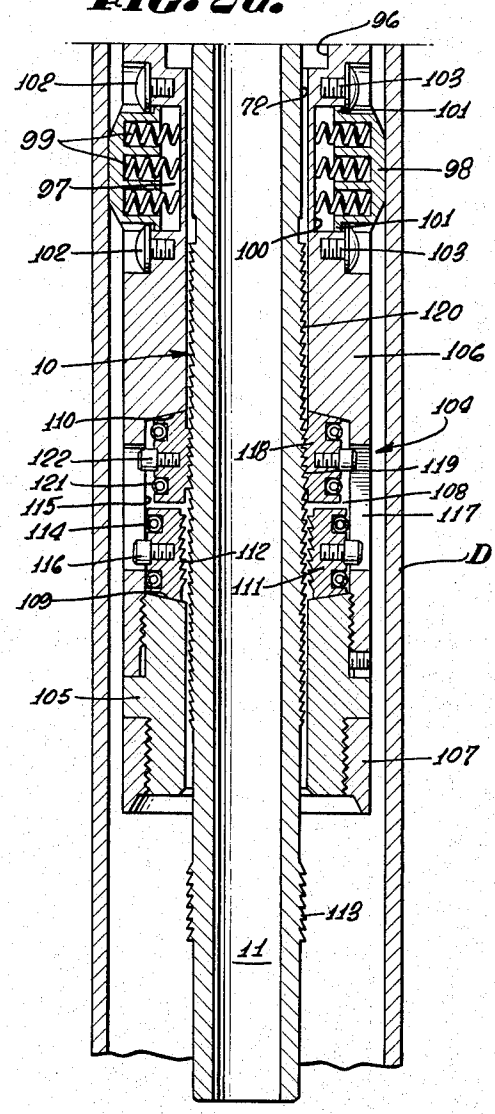


FIG. 2d.



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Jan. 2, 1968 D. V. CHENOWETH 3,361,207

RETRIEVABLE SUBSURFACE WELL TOOLS

Filed Sept. 4, 1964 7 Sheets-Sheet 5

FIG. 3a.

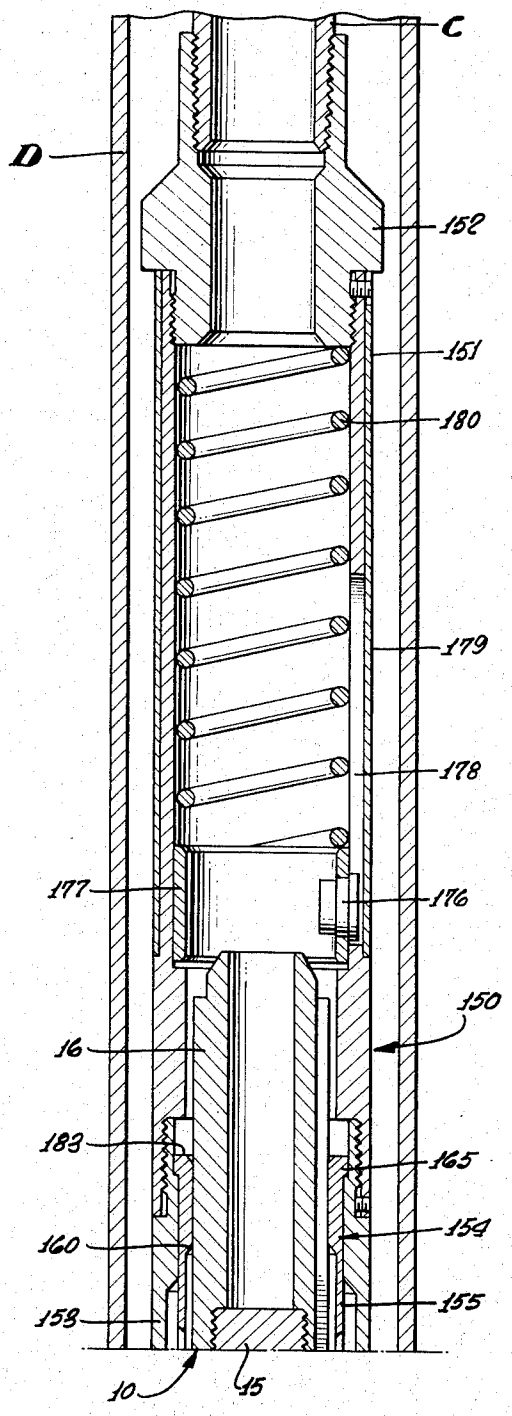
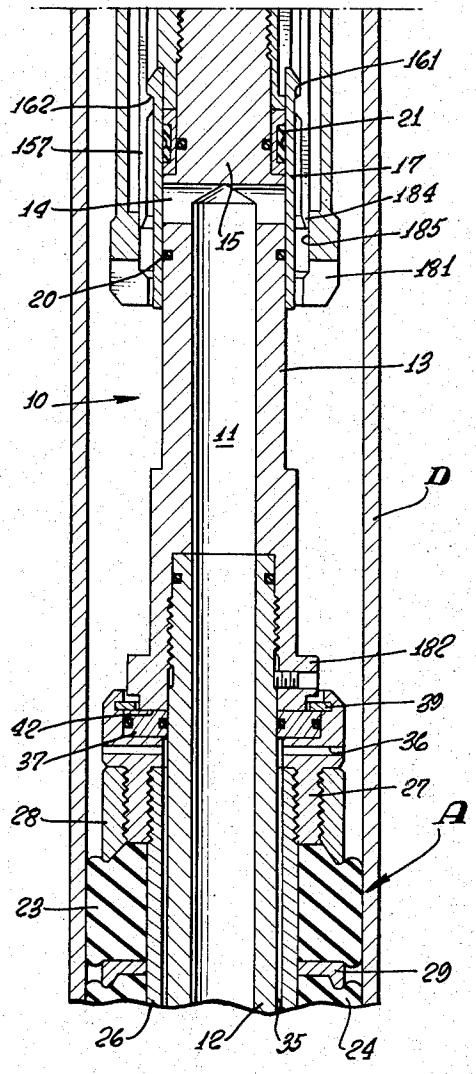


FIG. 3b.



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RETRIEVABLE SUBSURFACE WELL TOOLS

Filed Sept. 4, 1964 7 Sheets-Sheet 6

FIG. 4.

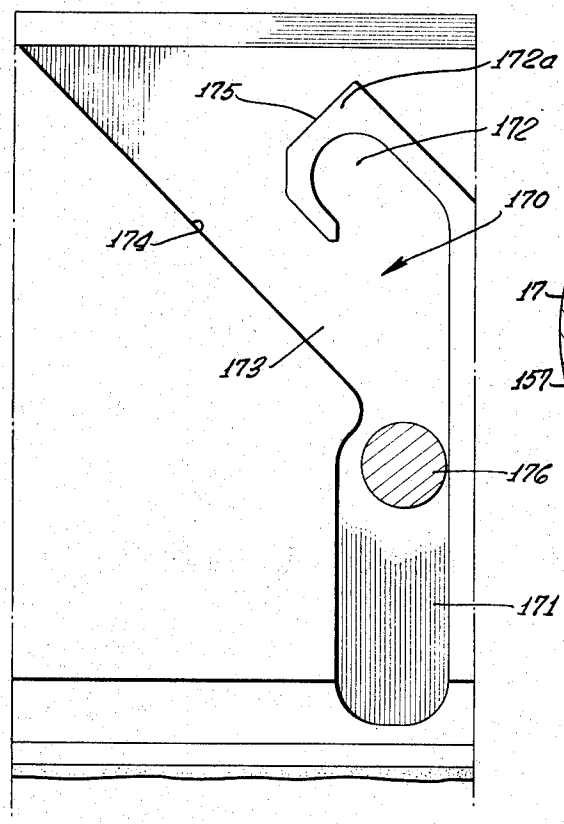


FIG. 5.

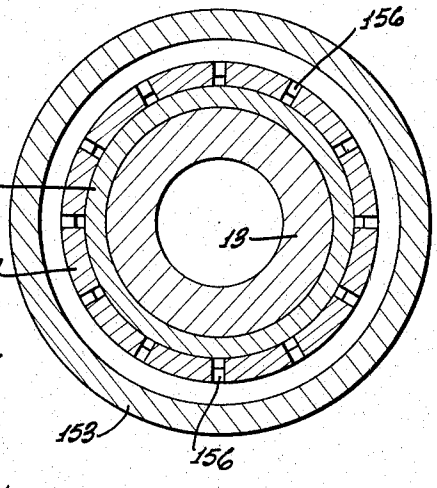


FIG. 6.

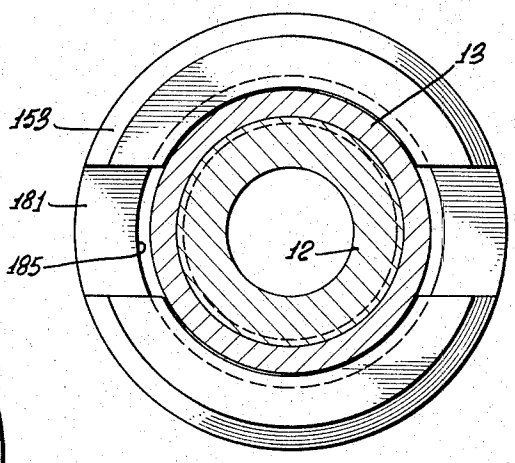
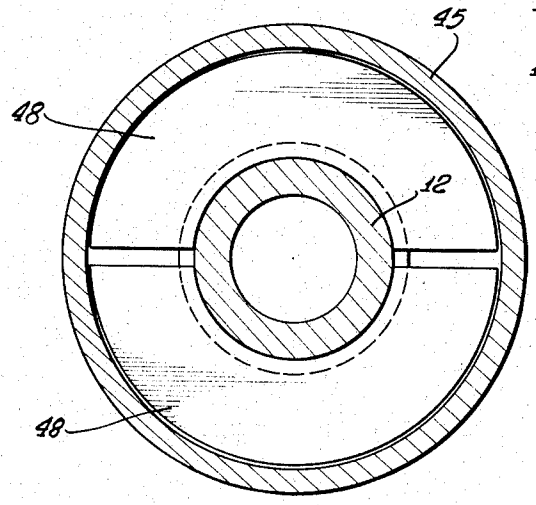


FIG. 7.



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Jan. 2, 1968 D. V. CHENOWETH 3,361,207

RETRIEVABLE SUBSURFACE WELL TOOLS

Filed Sept. 4, 1964 7 Sheets-Sheet 7

FIG. 10.

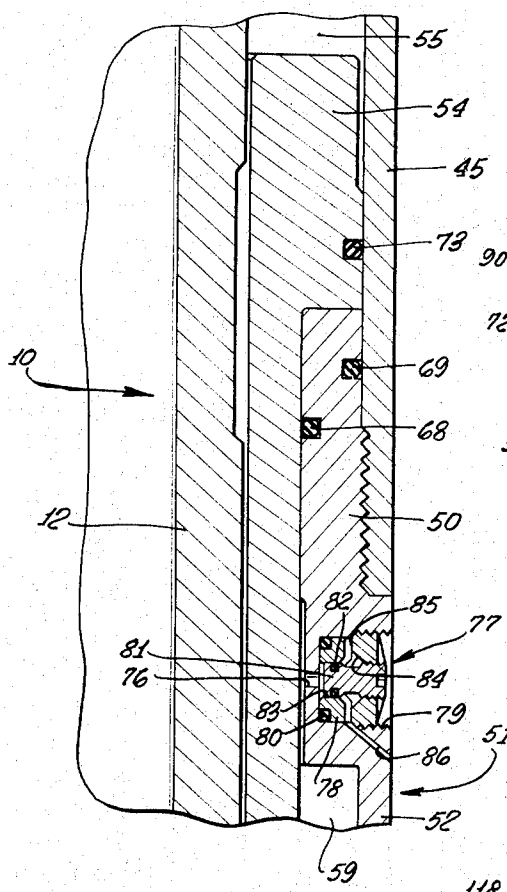


FIG. 8.

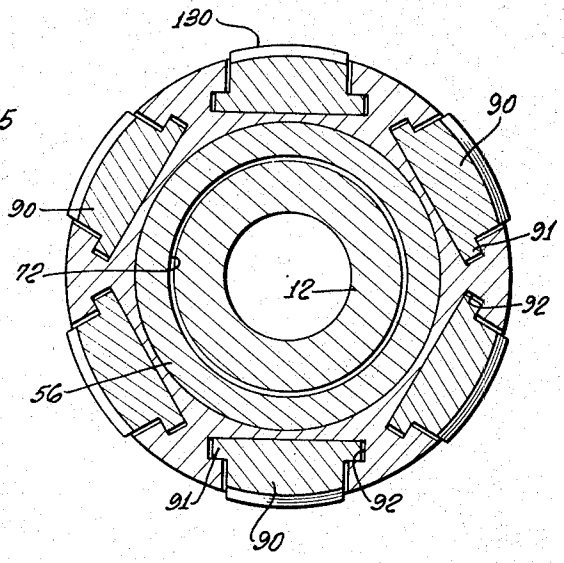


FIG. 9.

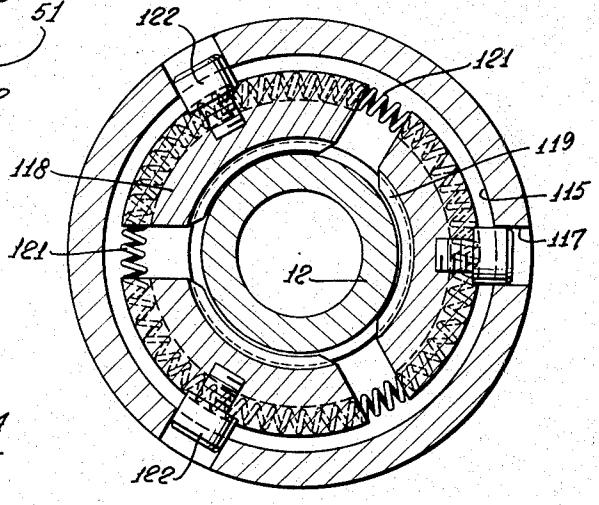
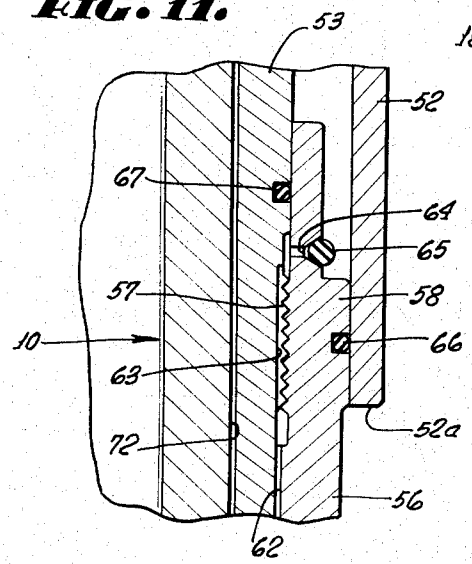


FIG. 11.



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United States Patent Office 3,361,207 Patented Jan. 2, 1968

1

3,361,207

RETRIEVABLE SUBSURFACE WELL TOOLS

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Filed Sept. 4, 1964, Ser. No. 394,402
23 Claims. (Cl. 166—120)

The present invention relates to subsurface well bore apparatus, and more particularly to tools, such as anchors, well packers and bridge plugs, adapted to be set in well bores.

An object of the invention is to provide an improved retrievabe subsurface well bore apparatus, such as a well packer (including a well packer capable of functioning as a bridge plug), having a normally retracted packing structure to facilitate lowering and elevating of the apparatus in the well bore, the apparatus being capable of being set in the well bore and of holding pressure in both longitudinal directions without the assistance of a tubing string or other force applying device.

Another object of the invention is to provide a retrievable subsurface well bore apparatus capable of being anchored in the well bore against movement in both longitudinal directions, and in which it is unnecessary for any parts to move in connection with change in the direction in which the apparatus is to be anchored to withstand fluid pressures acting thereagainst.

A further object of the invention is to provide retrievable subsurface well bore apparatus capable of being anchored in a well bore against movement in both longitudinal directions and of being locked mechanically in its anchored position to prevent subsequent relative movement of the anchoring parts until their retraction is desired for the purpose of releasing the well apparatus from the well bore.

An additional object of the invention is to provide improved retrievable subsurface apparatus capable of being anchored in a well casing against movement in both longitudinal directions in which the apparatus can be easily released from the well casing whenever desired. In a more limited sense, the apparatus includes a reverse or downwardly tapering expander and companion slips in which pressure differential from above the apparatus, as well as from below the apparatus, tend to hold the expander in downward wedging relation to the slips, so that bleeding off of the pressure differential and elevation of the expander effects an easy release and retraction of the slips from the well casing.

Yet another object of the invention is to provide an improved well packer embodying a packing structure adapted to seal against a well casing, in which the well packer embodies a mechanism for retaining a setting or pack-off force on the apparatus despite loss of packing material around the apparatus due to its extrusion or cold flowing, and the like.

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.

2

Referring to the drawings:

FIGURES 1*a*, 1*b*, 1*c* and 1*d* together constitute a combined side elevational view and longitudinal section through a well apparatus embodying the invention disposed in the well casing with the parts in their relative positions for lowering the apparatus in the well casing, FIGURES 1*b*, 1*c* and 1*d* constituting lower continuations of FIGS. 1*a*, 1*b* and 1*c*, respectively;

FIGS. 2*a*, 2*b*, 2*c* and 2*d* are longitudinal sections corresponding to FIGS. 1*a* to 1*d* disclosing the well packer anchored in packed-off condition within the well casing, FIGS. 2*b*, 2*c* and 2*d* constituting lower continuations of FIGS. 2*a*, 2*b* and 2*c*, respectively;

FIGS. 3*a* and 3*b* together constitute a longitudinal section through the upper portion of the apparatus illustrated in FIGS. 2*a* and 2*b* disclosing the release of the running-in and retrieving tool from the well packer or bridge plug therebelow, FIG. 3*b* being a lower continuation of FIG. 3*a*;

FIG. 4 is a diagrammatic view of the lock pin and slot arrangement for releasably securing the running-in and retrieving tool to the well packer or bridge plug;

FIG. 5 is a cross-section on an enlarged scale taken along the line 5—5 on FIG. 1*b*;

FIG. 6 is a cross-section on an enlarged scale taken along the line 6—6 on FIG. 1*b*;

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

FIG. 8 is a cross-section on an enlarged scale taken along line 8—8 on FIG. 1*d*;

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

FIG. 10 is an elarged fragmentary longitudinal section through the gas pressure bleeder portion of the apparatus;

FIG. 11 is a fragmentary enlarged longitudinal section through the gas pressure inlet portion of the apparatus.

The invention is illustrated in the drawings as being embodied in a well packer A, such as a bridge plug, adapted to be connected to a running-in and retrieving tool B, which is, in turn, attached to a tubular string C, by means of which the combination of apparatus is lowered in a well casing D to a desired setting point. The running-in and retrieving tool B is also used in connection with release of the well packer from the well casing and its shifting to another location therein, or its complete removal through the casing to the top of the well bore.

The specific well packer A illustrated includes a mandrel or body **10** having a longitudinal passage **11** therein open at its lower end. The mandrel includes an elongate lower section **12**, the upper end of which is threadedly secured to an upper section **13** having side ports **14** therethrough establishing communication between the central passage and the exterior of the mandrel or body **10**. The upper pin end **15** of the upper body section is threadedly secured to a control head **16**, there being a sleeve valve **17** slidable longitudinally along the upper body mandrel section **13** from a lower position, in which the ports **14** are opened, to an upper position across the ports. The lower position is determined by engagement of the lower end of the sleeve valve **17** with an upwardly facing body shoulder **18**, its upper position being determined by engagement of its upper end with a downwardly facing shoulder **19** on the control head. When in its upper position closing the ports **14**, leakage of fluid between the sleeve valve and the mandrel or body **10** is prevented by opposed seal members **20**, **21** mounted on the body sec-

tion 13 which slidably and sealingly engage the inner surface of the sleeve valve 17.

An upper packing structure 22 surrounds the body, which is adapted to seal against the wall of the well casing D. As specifically disclosed, a plurality of packing sleeves 23, 24, 25 of pliant, elastic material, such as rubber or rubber-like material, encompasses an elongate sleeve 26 surrounding the body 10, the upper end of the uppermost packing sleeve or element 23 engaging an upper abutment 27 threadedly secured to the sleeve 26, there being a gage ring 28 threaded on the upper abutment in engagement with the upper packing element 23 to minimize the extent of extrusion of the rubber packing material through the annular clearance space between the gage ring 28 and the wall of the well casing D. The upper packing element 23 contacts a spacer ring 29 which, in turn, is engaged by the upper end of the intermediate packing element 24 that engages a lower spacer ring 30, the latter contacting the upper end of the lower packing element 25 which engages a lower abutment 31 having a lower gage ring 32 threadedly secured thereto. The lower gage ring will also tend to minimize the extent of extrusion or cold flowing of the lower packing sleeve 25 through the annular clearance space between the gage ring and the wall of the well casing D, as a result of shortening and compression of the lower packing sleeve and its expansion against the wall of the well casing, as described hereinbelow.

The lower end of the packing structure sleeve 26 has an external flange 33 adapted to engage the lower end of the lower abutment 31, which will limit the extent of separating movement between the upper and lower abutments 27, 31, as shown in FIGS. 1*b* and 1*c*, in which the packing elements 23, 24, 25 are retracted. However, the upper abutment 27 can move toward the lower abutment 31 for the purpose of exerting an axial force on the packing elements to effect their shortening and lateral outward expansion and compression against the wall of the well casing D, and also against the periphery of the packing structure sleeve 26.

The packing structure sleeve 26 is spaced laterally from the periphery of the mandrel or body 10, providing an annular passage or space 35 therebetween through which fluid under pressure can pass, the upper end of this passage communicating with upper ports 36 extending through the upper abutment 27 to its exterior. The upper end of the passage 35 is closed by a bearing ring 37 disposed within a counterbore 38 in the upper abutment and held therein by a split snap retaining ring 39 located in a groove 40 in the upper abutment and overlying the bearing ring. The bearing ring has inner and outer seals 41 sealing against the periphery of the lower body section 12 and also against the wall of the counterbore 38 to prevent passage of fluid therebetween. This bearing ring is adapted to be engaged by a lower pilot portion 42 on the upper body section 13 when the apparatus is to be set, to facilitate rotation of the body 10 relative to the packing structure 22 and the remainder of the apparatus surrounding the main body or mandrel of the tool, in the manner described hereinbelow.

The lower end of the annular fluid passage 35 opens into a pressure chamber 44 below the lower abutment 31. This pressure chamber is defined by the lower abutment 31, an upper cylinder sleeve 45 threadedly attached thereto and depending therefrom in lateral spaced relation to the body 10 of the tool, and an annular piston 46 which is slidable longitudinally along both the periphery of the body and the inner wall of the upper cylinder sleeve. This piston has inner and outer seal rings 47 sealingly engaging the periphery of the body and the inner wall of the cylinder sleeve, respectively. Its upward movement relative to the body 10 is limited by its engagement with a two-piece stop ring 48 disposed in a peripheral groove 49 in the body and extending substantially to the wall of the cylinder sleeve 45. This stop ring is also engageable with the lower end of the packing structure sleeve 26 when the apparatus is to be retracted or released from the well casing, following its setting thereagainst.

The lower portion of the upper cylinder sleeve 45 is threadedly secured to the upper cylinder head 50 of a cylinder 51 having a cylinder sleeve 52 depending therefrom. The upper cylinder sleeve 45, head 50, and lower cylinder sleeve 52 encompass a connector sleeve 53, the upper head 54 of which is disposed in an annular chamber 55 defined between the upper cylinder sleeve 45 and body 10 of the tool, and which head 54 is also disposed between the cylinder head 50 and the annular piston 46. The connector sleeve 53 extends within a reverse cone or expander 56 to which it is suitably secured, as by means of a threaded connection 57, the upper portion of the reverse cone or expander being constituted as an annular piston 58 disposed within and adapted to slide relatively along the wall of the lower cylinder sleeve 52. The spaced relation between the lower cylinder sleeve 52 and the connector sleeve 53 provides an annular chamber 59 adapted to contain a gas under pressure, such as compressed air or nitrogen. This gas can be introduced into the chamber through an inlet port 60 closed by a filler plug 61 threadedly secured within the expander member 56. The gas can pass from the inlet port 60 through an annular passage 62 between the connector sleeve 53 and the expander 56, and through a longitudinal slot 63 cut through the externally threaded portion of the connector sleeve (FIG. 11) to an inlet port 64 extending through the expander member above its piston 58. A one-way or check valve surrounds the port, being disclosed in the form of an elastic O-ring 65 embracing the exterior of the expander above the piston 58 and closing inwardly to prevent gas from having retrograde movement through the inlet port 64. However, it permits gas under pressure to flow through the inlet port 64 into the chamber 59.

Leakage of gas from the chamber 59 is prevented by a suitable side seal ring 66 on the piston sealingly engaging the wall of the lower cylinder sleeve 52, by a seal ring 67 carried by the connector sleeve 53 and engaging the upper portion of the expander 56, and by an inner seal ring 68 on the cylinder head 50 slidably and sealingly engaging the periphery of the connector sleeve 53. A thread seal ring 69 is also mounted on the cylinder head 50, engaging the upper cylinder sleeve 45 to prevent fluid leakage through the threaded connection between the head and upper cylinder sleeve. Leakage of fluid from the injection or inlet port 60 in a downward direction between the connector sleeve and expander is prevented by a suitable seal ring 70 mounted on the expander 56 and engaging the periphery of the connector sleeve 53 below its inlet port.

The connector sleeve 53 is relatively slidable with respect to the cylinder 51 and is laterally spaced from the mandrel or body 10 to provide an annular passage 72 therebetween which will allow fluid pressure from below the apparatus to pass through such annular passage into the chamber 55 above the connector head 54. Such fluid under pressure cannot escape upwardly out of the chamber because of the annular piston 46, and it cannot escape downwardly between the upper cylinder sleeve and the connector head because of the provision of a suitable seal ring 73 on the connector head which slidably and sealingly engages the wall of the upper cylinder sleeve 45. The connector head 54 and the cylinder head 50 are disclosed in FIG. 1*c* as being in engagement with one another. However, when the tool is set, the cylinder head moves downwardly away from the connector head, as disclosed in FIG. 2*c*, the annular chamber or space 74 between the two heads always containing air at a pressure no greater than atmospheric, and actually much less than atmospheric, since air is trapped between the head 50, 54 when the tool is assembled at the top of the well bore. The increase in volume of the chamber 74 as the cylinder head 50 moves downwardly away from the connector

head 54 will result in the air expanding and having a lesser pressure than atmospheric.

A suitable gas at a desired pressure is ejected into the compressed air or other gas chamber 59 through the inlet port 60 and through the check valve controlled port 64 in the upper portion of the expander 56. Such gas under pressure remains trapped in the chamber, but may be bled therefrom when desired in the event the tool is to be dismantled at the top of the well bore. Thus, a bleeder port 76 is provided in the cylinder head that communicates with the upper end of the chamber 59 which is normally closed by a bleeder plug 77 threaded into the cylinder head 50. Such bleeder plug can assume any desired form, the one disclosed more specifically in FIG. 10 being a safety device to prevent the pressure in the chamber from blowing the plug outwardly after it has been unthreaded from the head. As shown in FIG. 10, the bleeder plug includes an outer member 78 threaded into a radial bore 79 in the cylinder head and having a suitable side seal ring 80 sealing against the wall of the bore. An inner plug 81 is threaded within the outer plug and carries a suitable seal ring 82 sealing against the wall of the inner plug passage 83. As disclosed in FIG. 10, the entire plug construction 77 is in a position closing the bleeder port 76. When the gas under pressure is to be vented or bled from the chamber 59 with the tool located at the top of the well bore, the inner bleeder plug member 81 is first threaded outwardly, its inner head engaging a companion shoulder 84 on the outer threaded plug member 78, with the head disposed outwardly of lateral bleeder ports 85 in the outer member to allow the compressed gas to flow through the bleeder port 76 and through the radial ports 85 into a passage 86 leading to the atmosphere. The inner plug 81 can be rotated and threaded inwardly again to close the bleeder port 76, i.e., being replaced in the position illustrated in FIG. 10.

The expander 56 has a plurality of longitudinal slots 87, the base 88 of each slot tapering in a downward and inward direction and being engageable with a companion tapered inner surface 89 on a slip 90 received within the slot. Each slip has opposed inclined side tongues 91 slidable within companion side grooves 92 in the expander (FIG. 8), the tongues and grooves being parallel to the tapered surfaces 88, 89 of the expander and slip. The slips 90 are mounted for joint longitudinal movement, but are capable of partaking of generally radial inward and outward movement, by providing lower inverted T-heads 93 on each of them which are receivable within companion T-shaped slots 94 in the upper end of a combined slip, drag block, and control unit housing 95. The lower end of the connector sleeve 53 is capable of downward movement within an upper counterbore 96 within such housing. The housing 95 has a plurality of circumferentially spaced generally radial cavities 97 therein, each receiving a drag block 98 which is urged outwardly into frictional engagement with the wall of the well casing D by a plurality of helical compression springs 99 engaging the housing portion forming the base 100 of the cavity and also engaging the drag block itself. The radial outward movement of each drag block is limited by engagement of upper and lower shoulders 101 thereon with the heads 102 of upper and lower stop screws 103 threadedly secured to the housing on opposite sides of the cavity and overlying the shoulders.

The lower portion of the housing 95 forms part of a control unit 104 that determines the retention of the packer parts in retracted position, their release to allow the packer to be anchored in packed-off condition in the well casing, the retention of the packer or bridge plug in its packed-off and anchored condition, and its release from such condition in the well casing and relocation of its parts in their initial condition. Such housing includes a lower housing section 105 threadedly secured to the lower portion of the main housing section 106 thereabove, there being a suitable gage ring 107 threaded on the lower end of the lower housing section for insuring that the entire tool can be moved downwardly in the well casing D to the desired setting point, and to prevent any portions of the apparatus from becoming stuck in the well casing.

The housing sections together provide a circumferential internal groove 108, the lower side 109 of the groove tapering to a slight extent in a downward and inward direction, the upper side 110 of the groove tapering upwardly to a slight extent and in an inward direction. Disposed within the groove are upper and lower clutch or lock structures. The lower lock structure includes a plurality of clutch segments or elements 111 having internal ratchet teeth 112 constituted by right-hand buttress threads adapted to mesh with companion right-hand buttress or ratchet threads 113 on the lower portion of the body or mandrel 10. The segments 111 are urged in an inward direction, to hold the buttress threads 112 meshing with the body threads 113, by a plurality of encircling helical tension springs 114. The segments can move radially outward so that their teeth 112 are free from engagement with the lower buttress threads 113 on the body, since there is adequate lateral clearance between the outer surfaces of the clutch segments and the outer base portion 115 of the groove 108 in which they are located. Rotation of the segments 111 is prevented by a guide screw 116 threadedly secured to each of them and slidably received within a longitudinally extending slot 117 in the housing 95. The buttress threads 112, 113 face in the direction shown in the drawings so that the mandrel or body 10 can ratchet upwardly through the segments 111, but cannot be moved downwardly, except as a result of rotating the body 10 relative to the segments, rotation of the segments being prevented or resisted by the frictional engagement of the drag blocks 98 against the wall of the well casing D. The right-hand buttress thread connection 112, 113 is preferably a multiple pitch thread so that only a comparatively small number of turns of the body 10 within the segments is required to effect full downward unthreading of the body from the segments, whereupon the body 10 is free to continue its downward movement without rotation.

The control unit 104 of the mechanism also includes upper clutch segments or elements 118 having downwardly facing ratchet teeth 119 in the form of multiple pitch buttress threads which are preferably left-hand threads, and which are adapted to engage companion buttress left-hand threads 120 extending longitudinally along the body 10 thereabove. Encompassing helical springs 121 engage the segments 118 and urge them inwardly, the segments being adapted to be shifted radially outwardly upon downward movement of the body 10 and the left-hand buttress threads 120 therealong. Once the left-hand buttress threads 120 are engaged with the internal threads 119, the body 10 cannot move upwardly relative to the segments unless the body is rotated in a right-hand direction. Such rotation will not effect rotation of the segments 118 since the latter are prevented from turning by guide screws 122 attached to the segments and received within the longitudinal slots 117, the guide screws allowing radial inward and outward shifting of the segments, but preventing their rotation in view of the resistance to rotation afforded by the drag blocks 98.

The left-hand threads 119, 120 are also preferably multiple pitch threads, so that upon rotation of the body 10 a lesser number of body turns is required to effect upward unthreading of the body from the upper set of clutch segments 118, as described hereinbelow.

The apparatus is adapted to be anchored in the well casing against movement in both directions, despite the fact that only a single set of slips 90 and a single reverse cone or expander 56 is provided. To facilitate anchoring of the slips in the casing against longitudinal movement in both directions, their external wickers or teeth 130 are formed in a neutral position, that is, they face neither up-

wardly nor downwardly, but will be embedded in the casing D to resist movement longitudinally therealong as the result of being subjected to pressure and other forces from below the tool, as well as pressure and other forces from above the tool.

In the use and operation of the packer portion of the apparatus so far described, its parts are arranged in the relative positions illustrated in FIGS. 1*a* to 1*d*, in which the lower right-hand buttress threads 112, 113 are fully meshed, the slips 90 being in their retracted position, as well as the packing structure 22. At this time, the lower end 42 of the upper body section 13 is spaced above the bearing ring 37. The well packer A is lowered in the well casing D, as through use of the running-in and retrieving tool B, or, if desired, the tubing string could be connected directly to the packer body 10. The downward force imposed on the body 10 is transmitted directly to the housing 95, because of the meshing of the right-hand body threads 113 with the companion threads 112 of the lower clutch segments 111, the segments tending to shift and remain inwardly by virtue of the engagement of the lower inclined surfaces of the segments with the companion inclined side 109 of the groove 108 in which they are located. In view of the coupling of the body 10 to the housing 95 through the lower set of segments 111, as the body is moved downwardly, the body 95 is carried with it, the drag blocks 98 sliding along the wall of the well casing. The slips 90 are in their inward position, as disclosed in FIG. 1*d*, and the downward pull exerted thereon by the housing 95 is transmitted through their tongue and groove interconnections 91, 92 to the expander 56, shifting the latter downwardly and carrying the connector sleeve 53 connected thereto with it. The connector head 54 of the connector sleeve engages the cylinder head 50 to pull the cylinder 51 downwardly with it.

It is to be noted at this time that the lower end 52*a* of the lower cylinder sleeve 52 is longitudinally spaced from a shoulder 56*a* on the expander therebelow. The downward movement of the cylinder sleeve 45 is transferred to the lower abutment 31, which engages the flange 33 of the packing structure sleeve 26 to pull such sleeve downwardly and the upper abutment 27 downwardly with it. At this time the upper and lower abutments 27, 31 cannot move relatively toward each other, particularly since the lower end of the packing structure sleeve 26 is engaging the stop ring 48 secured to the body 10.

Prior to lowering of the well packer A in the well casing D, the pressure chamber 59 will have been filled with a suitable gas, such as air, to the desired pressure, which, for example, may be of the order of 1200 p.s.i. Such gas under pressure actually functions as a spring tending to hold the cylinder 51 in an upward position relative to the connector sleeve 53.

It is further to be noted that during lowering of the apparatus in the well casing, the upper segments 118 are disposed between the right and left-hand body threads 113, 120, being in an ineffective position, insofar as clutching action with respect to the body or mandrel is concerned.

When the location in the well casing D is reached at which it is desired to anchor the packer or bridge plug in packed-off condition, the tubing string C is rotated to the right to rotate the body 10 of the tool in the same direction. The drag blocks 98 resist and prevent rotation of the housing 95, so that right-hand rotation of the body causes its right-hand threads 113 to feed downwardly along the lower clutch or lock segments 111, until the right-hand threads 113 completely unthread from the segment threads 112. Such downward unthreading releases the body 10 from the housing 95 and permits the tubing string C to be lowered and correspondingly lower the body, the lower end 42 of the upper mandrel or body section 13 engaging the bearing ring 37, which will then move the packing structure 22 as a unit, and the upper cylinder sleeve 45, downwardly, the downward movement of the latter being transferred through the cylinder head 50 and through the compressed gas in the chamber 59 to the expander 56, the latter shifting downwardly within the slips 90, which are prevented from moving downwardly by virtue of the resistance offered by the drag blocks 98 against the wall of the well casing.

The expander 56 moves down within the slips 90 to expand the latter outwardly into firm engagement with the casing, after which the expander is prevented from moving downwardly to any further extent. A continued straight-line downward movement of the tubing C and mandrel 10 will then effect a shifting of the packing structure 22 and the upper cylinder sleeve 45 downwardly as a unit, the cylinder 51 moving along the connector sleeve 53 until the lower end 52*a* of the cylinder engages the expander shoulder 56*a*, the pressure of the gas in the cylinder 59 being increased in view of the decrease in its volume. The downward thrust of the packing structure 22 and the cylinder sleeves 45, 52 is then transmitted directly from the end 52*a* of the lower cylinder sleeve to the expander 56 and from the expander through the slips 90 and its wickers 130 to the well casing D.

An increase in downward force imposed on the tubing string C and body 10 then effects a shifting of the upper abutment 27 towards the lower abutment 31, since the expander prevents the latter from moving downwardly any further, the upper abument moving toward the lower abutment to shorten the packing elements 23, 24, 25 and expand them outwardly into anchored engagement with the wall of the well casing (FIGS. 2*a* to 2*d*). During downward movement of the body 10, after the right-hand buttress threads 113 have become unthreaded and released from the clutch segments 111, the left-hand threads 120 can ratchet downwardly freely through the upper clutch segments 118. However, the body 10 cannot move upwardly relative to the housing 95 since the coengagement between the external and internal ratchet threads 120, 119 on the body and upper segments prevents such movement. An upward force imposed on the upper segments 118 causes them to be urged inwardly to remain in full mesh with the left-hand threads 120 because of the inclined surface on the upper segments engaging the companion upper side 110 of the housing groove 108. Accordingly, the body 10 of the tool can move downwardly relatively to the housing 95, but it cannot move upwardly, retaining the slips 90 and packing structure 22 in an outward expanded condition.

During the downward shifting of the cylinder 51 along the connector sleeve 53, to bring the lower end 52*a* of the cylinder sleeve 52 into engagement with the shoulder 56*a*, the cylinder head 50 is moved away from the connector sleeve head 54, as disclosed in FIGS. 2*c*, the gas under pressure in the chamber 59 constantly tending to urge the cylinder 51 upwardly and the lower abutment 31 toward the upper abutment 27 to retain the packing elements 23, 24, 25 sealed off against the wall of the well casing D, as well as against the packing sleeve 26. Thus, in the event of extrusion of packing material, after the well packer or plug A has been set in the well casing, the gas under pressure functions as a spring to retain a substantial packed-off force on the packing elements and thereby insure against leakage of the well packer.

The parts are now in the position illustrated in FIGS. 2*a* to 2*d*. Pressure from above the well packer can enter the chamber 44 between the lower abutment 31 and the annular piston 46 by passing through the ports 36 in the upper abutment into the annular passage 35 and around the lower end of the sleeve 26 into the chamber. Thus, this chamber 44 will always have fluid under pressure in it corresponding to the fluid pressure above the packer externally of the tubing string C. On the other hand, pressure in the well casing below the set packer can pass into the chamber 55 between the annular piston 46 and the connector head 54, such fluid under pressure passing

upwardly through the annular space 72 between the connector sleeve 53 and body 10 into such chamber.

The parts are so proportioned and arranged that pressure from below the tool tends to force the expander 56 downwardly to hold it wedged within its companion slips 90. Pressure from above the tool is also exerting a force to hold the expander in wedging relation within the slips to retain them anchored in the wall of the well casing. As disclosed in FIGS. 2*a* to 2*d*, a predominance of a pressure differential above the well packer acts downwardly on the packing structure 27, such force being transmitted through the lower abutment 31 and cylinder structure 51 directly to the expander 56, because of the abutting of the end 52*a* of the lower cylinder sleeve with the expander shoulder 56*a*. Thus, the pressure from above assists in holding the slips 90 anchored against the well casing and in retaining the packing elements 23, 24, 25 compressed in sealing relation against the wall of the well casing D.

Following anchoring in packed-off condition of the well packer in the casing, if a pressure differential is present below the well packer A, such pressure can pass through the passage 72 between the connector sleeve and body into the chamber 55 above the connector head 54. The pressure is acting upwardly on the annular piston 46 which engages the stop ring 48 connected to the body 10. However, the body cannot move upwardly because of the locking relation between the left-hand buttress threads 120 and the upper clutch segments 118, such upward force being transmitted through the housing 95 to the slips 90, which are wedged outwardly by the expander 56. The pressure in the chamber 55 is also acting in a downward direction over the cross-sectional area of the connector head 54, and the predominant fluid pressure below the tool is also being exerted against the lowermost packing element 25 which has an internal pressure equal to the predominant fluid pressure, such internal pressure being exerted in a downward direction over the abutment 31 and its gage ring 32. The lower annular area R of the lower abutment 31 is subject to the lesser fluid pressure that might exist above the packing structure 22, since such fluid pressure enters the chamber 44 above the annular piston 46 through the ports 36 and the annular passage 72. Because of the air in the atmospheric chamber 74 between the connector head 54 and the cylinder head 50, and the various elements on which the lower pressure is acting, it can be demonstrated that there is a resultant area R over which the pressure from below the well tool is acting in a downward direction on the expander 56, which area is quite substantial. Thus, the fluid pressure from below the apparatus is urging the reverse cone or expander 56 downwardly to retain it in wedged relation behind the slips 90, holding their teeth 130 anchored against the wall of the well casing.

It is, therefore, apparent that despite the presence of only a single set of slips 90 and a single companion expander 56, the well packer apparatus A will remain anchored in packed-off condition whether the pressure is exerted on the apparatus from below its packing structure 22 or above its packing structure. The left-hand thread and upper segment clutch mechanism 120, 119, 118 will hold and lock in the packer parts in the positions illustrated in FIGS. 2*a* to 2*d*, relative upward movement of the body 10, which is necessary to retraction of the well packer parts from the well casing, being prevented. As a result, even if no down weight is imposed on the apparatus A through the tubular string C, or for that matter, if there is no upward force on the apparatus, it will remain anchored in packed-off condition.

When the well packer is to be released from the well casing, the pressure above and below the said packer is equalized, as in the manner described hereinbelow. The tubular string C and the body 10 are then rotated several turns to the right while the tubing string and body move upwardly, the packer body 10 threading upwardly with respect to the upper segmental nut or clutch elements 118. Despite the fact that the left-hand threads 120 are disposed within the right-hand threaded lower clutch elements 111, the latter cannot mesh therewith and are merely held in the outward position disclosed in FIG. 2*d*. The upward threading of the body 10 elevates the lower portion 42 of the upper section 13 from the bearing member 37, which will remove the downward setting force on the upper abutment 27, the packing elements 23, 24, 25 retracting inherently from the well casing and shifting the abutment 27 upwardly. Even if such shifting does not occur, the stop ring 48 secured to the body will engage the lower end of the packing structure sleeve 26 to shift it and the upper abutment upwardly relative to the lower abutment 31, this upward movement continuing until the sleeve flange 33 engages the lower end of the lower abutment 31, which will then effect an elevation of the upper cylinder sleeve 45 and of the cylinder 51 therebelow with respect to the connector sleeve 53, until the cylinder head 50 engages the connector head 54. Continued upward movement of the body 10 will move the connector sleeve and expander 56 upwardly, the expander shifting in an upward direction with respect to the slips 90 whose upward movement is resisted and prevented by the frictional engagement of the drag blocks 98 against the well casing. Because of the tongue and groove interconnection 91, 92 between the expander and the slips, the latter, as a result of moving relatively downwardly of the expander, are shifted radially inwardly to their retracted position.

Upon complete upward unthreading of the left-hand body threads 120 from the upper clutch segments 118, the body 10 is free to be shifted upwardly without rotation, the right-hand buttress threads 113 then ratcheting upwardly through the lower segmented nut 111 and relocking the packer in its extended condition, as disclosed in FIGS. 1*a* to 1*d*. The packer apparatus A is now in its retracted position and can be shifted either downwardly or upwardly in the well casing to a new setting location, or the packer can be elevated and removed completely from the well casing, if desired.

When the apparatus is to be dismantled, the bleeder plug 77 is opened to vent the gas from the chamber 59, thereby preventing sudden expansion of the gas and possible injury to persons and property.

As disclosed in the drawing, the apparatus A is constituted as a retrievable bridge plug. It can be lowered in the well casing and can be removed therefrom by means of a running-in and retrieving tool B, which can also control the opened and closed position of the sleeve valve 17 relative to the body ports 14, which will determine whether or not the passage 11 through the body is in open or closed condition. As shown, the retrieving tool includes a housing 150 adapted to telescope over the control head 16 and upper body section 13 of the well packer or bridge plug, as well as over its sleeve valve 17. This housing consists of an upper body portion 151 threadedly secured to an upper body sub 152 which is threadedly connected to the lower end of the tubing string C that extends to the top of the well bore. The lower end of the upper housing section 151 is threadedly secured to the upper end of a lower housing section 153 which carries a latch sleeve 154 that has the purpose of shifting the valve sleeve 17 between open and closed positions. This latch sleeve includes an upper circumferentially continuous portion 155 and circumferentially spaced slots 156 (FIG. 5) that provide flexible spring-like arms 157 depending therefrom, the intermediate portions of the latch arms having inwardly directed latch fingers 158. These latch fingers have lower tapered surfaces 159 adapted to engage a companion upper tapered surface 160 on the valve sleeve 17

and to be deflected outwardly thereof so that the fingers are then disposed below an upper external flange 161 of the valve sleeve. The upper surfaces 162 of the fingers are also tapered for engagement with a companion tapered surface 163 at the lower end of the sleeve flange 161.

The latch sleeve 154 is adapted to occupy an upper position relative to the housing 150 in which it engages a housing shoulder 183, and in which the lower ends 184 of the latch arms are located above a restricted retaining bore 185 in the lower portion of the housing. At this time, the latch arms 157 can flex outwardly relatively freely within the housing so that the latch fingers 158 will readily snap over the flange 161 of the valve sleeve 17. However, when the latch sleeve 154 occupies a lower position relative to the housing 150, as determined by engagement of a latch sleeve flange 165 with an upwardly facing shoulder 166 in the housing, the lower ends 184 of the latch arms are confined within the restricted bore 185 of the lower housing portion 153, thereby preventing the lower ends 184 of the latch arms from deflecting outwardly and requiring a greater deflecting force to shift the latch fingers 158 laterally outwardly (FIG. 3*b*).

The ability of the housing 150 to move longitudinally with respect to the control head 16, upper mandrel or body section 13, and sleeve valve 17 is governed by a control lock device between the housing and the control head. Thus, the control head 16 has one or more control slots 170 therein (see FIG. 4 specifically), each slot including a lower vertical leg portion 171 that terminates in an upper hook or pocket portion 172 closed by an end wall 172*a*. Below and adjacent to the hook portion the slot portion 171 communicates with an inclined entry and withdrawal slot portion 173 defined by an inclined surface 174 extending through the upper portion of the control head. An opposed surface 175 above the hook portion 172*a* on the sleeve converges in a downward direction relative to the inclined surface 174 of the slot.

The housing carries a radial lock pin 176 for each slot 170, the inner portion of which is received within the control slot 170. This lock pin is mounted in a ring or sleeve 177 and also extends into a longitudinal slot 178 in the upper body portion 151, the pin being retained in its inward position by a retainer sleeve 179 encompassing the upper body portion enclosing its slot. A helical compression spring 180 is mounted in the housing, its upper end engaging the body sub 152 and its lower end engaging the lock pin sleeve 177 so as to yieldably urge the lock pin 176 in a downward direction.

In lowering the packer or bridge plug apparatus A in the well casing, the running-in and retrieving tool B is disposed in the position illustrated in FIG. 1*a*, in which the valve sleeve 17 is in its lower port opening position, the lock pin being disposed in the longitudinal leg 171 of the slot below the hook portion 172, the lower end 181 of the housing engaging a shoulder 182 on the upper body section 13 so as to push the body or mandrel 10 of the tool in a downward direction and, through the right-hand body and clutch segment portions 113, 111 of the apparatus, pull the parts of the apparatus surrounding the body 10 in a downward direction. The fluid in the well casing can by-pass around the well packer apparatus A and can also flow upwardly through the central passage 11, out through the ports 14 and up through the housing 150 into the tubing string C.

When the setting location in the well casing D is reached, the tubing string C is rotated to the right, such right-hand rotation being transmitted through the housing 150 to the lock pin 176, and from the latter to the control head 16, the pin engaging a side wall of the longitudinal slot 171. The control head 16, being secured to the body 10 of the tool, transmits its rotation to the latter so that its right-hand threads 113 unscrew in a downward direction from the lower clutch segments 111, whereupon an appropriate downward force can be imposed by the tubular string C on the housing 150 and on the body 10 to effect full setting of the well packer, in the manner described above, the parts being located in the positions illustrated in FIGS. 2*a* to 2*d*, inclusive.

The running-in and retrieving tool B can now be released from the well packer or bridge plug A, the latter remaining in its anchored and packed-off condition in the well casing D. The tubing string C is elevated, and during such elevation is turned to the right so that the lock pin 176 shifts from the longitudinal slot 171 into the diagonal slot 173, allowing the lock pin to move upwardly out of the control head slot 170. Immediately following such upward movement, the fingers 158 of the latch sleeve 154 engage the flange 161 on the valve sleeve 171, whereupon the housing 150 will move upwardly relative to the latch sleeve to dispose the lower ends 184 of the latch arms within the restricted bore 185 of the housing to increase the resistance to outward deflection of the latch arms. Upward movement of the tubing string and running-in and retrieving tool will now cause the fingers 158 to shift the valve sleeve 17 upwardly to the extent limited by its engagement with the downwardly facing shoulder 19 on the control head, at which time the sleeve has closed the ports 14, as disclosed in FIGS. 3*a* and 3*b*. Continued upward movement of the tubing string C and an increase of the upward force will then cause the fingers 158 to be cammed outwardly from engagement with the valve sleeve flange 161 because of the coengagement of their tapered surfaces 162, 163, freeing the latch sleeve 154 from the valve sleeve 17 and allowing the tubing string C and the retrieving device B to be elevated in the casing string D to a desired extent, or removed entirely therefrom at the top of the hole. The passage 11 through the well packer is now closed so that it functions as a bridge plug. As stated above, the bridge plug A will remain in anchored and packed-off condition, despite the imposition of fluid pressure upon it from above or below.

In the event it is desired to release and retrieve the bridge plug or well packer A from the well casing, the running-in and retrieving head B is lowered in the casing D, the housing 150 moving over the control head 16, and the lock pin 176 being directed by the converging tapered surfaces 174, 175 on the control head into the diagonal slot 173, shifting from the diagonal slot into the longitudinal slot 171. The fingers 158 will engage the upper end 160 of the valve sleeve flange 161, and the housing will shift downwardly so that the lower ends 184 of the latch arms 157 are disposed out of the restricted housing bore 185. Accordingly, a much lesser force is required to deflect the arms and their fingers outwardly, such fingers riding past the flange 161 to a position therebelow retracting inwardly. The latch sleeve 154 and housing 150 continue moving downwardly until a shoulder 190 on the latch sleeve engages the tapered surface 160 at the upper end of the valve sleeve 17, to shift the latter downwardly to its port opening position illustrated in FIG. 1*a*, the downward force being transmitted from the housing 150 to the upper end of the latch sleeve flange 165 and from the latch sleeve to the valve sleeve 17. The downward shifting of the valve sleeve is limited by engagement of the lower end 181 of the housing with the shoulder 182 on the upper mandrel or body section 13. At this time, the lock pin 176 is disposed in the longitudinal leg 171 of the control head slot.

The opening of the ports 14 allows the pressure above and below the well packer or bridge plug A to equalize whereupon the tubing string C and housing 150 are rotated to the right, the rotation being transmitted through the lock pin 176 and control head 16 to the body 10 of the tool, to thread the left-hand buttress threads 120 upwardly within the upper thread 119 of clutch segments 118 until the slips 90 and packing structure 22 have been returned to their initial position, and the right-hand body threads 113 are again relocked in the lower segments 111, as described hereinabove. The bridge plug A can now be either shifted downwardly to a new location in the well

casing, or shifted upwardly in the well casing to a new location, or, if desired, removed entirely from the latter. Upward movement of the tubing string C will move the retrieving tool housing **150** upwardly, the lock pin **176** moving into the hook portion **172** of the slot **170** at the upper end of its longitudinal portion. Such upward movement will move the latch sleeve **154** upwardly with the outer housing **150**, but the pin will be disposed in the hook portion **172**, **172***a* of the slot **170** before the fingers **158** can engage the valve sleeve flange **161**. Upward movement of the tubing string C will now carry the packer body **10** and the entire apparatus upwardly with it, the body ports **14** remaining in their open condition to facilitate elevation of the apparatus A through the fluid in the well casing D, the fluid, of course, also relatively by-passing around the exterior of the retracted bridge plug parts. As stated above, the apparatus can be removed from the well casing and the compressed gas bled from the pressure chamber **59**.

It is, accordingly, apparent that a retrievable tool, such as a well packer or bridge plug, has been provided which is capable of holding pressure in both directions without the assistance of the tubular string or other force applying means. It is unnecessary for any parts to shift relative to one another in the event that the pressure differential acting on the well packer shifts from a position above the well packer to a position therebelow, or vice versa. The parts remain locked in their holding and sealed and packed-off condition because of the ratchet locks afforded by the left-hand threads **120** in the upper segments **118**. That is to say, the upper clutch mechanism mechanically holds the tool in its set condition. Inasmuch as only a reverse cone or expander **56** is used, the tool is easy to retrieve, since the upper movement of the expander tends to retract the slips **90**. This is to be distinguished from other tools that employ both upward and downward slips and companion expanders, in which the upwardly holding slips and expanders might tend to resist release from the well casing, and may inadvertently effect setting of the upwardly holding slips during the elevation of the well tool in the well casing.

The compressed gas chamber **59** functions as a spring to retain the setting or packing force on the tool, despite loss of packing material due to extrusion, and the like. However, this feature, although capable of effectively insuring the retention of the packer apparatus in sealed-off and set condition, need not be used, in which event the lower abutment **31** would be secured directly to the expander **56**, as through the use of a suitable intervening sleeve.

I claim:

1. In a well tool adapted to be set in a well bore: a body structure; normally retracted means on said body structure; means responsive to movement of said body structure in one direction relative to said normally retracted means for expanding said normally retracted means outwardly, said expanding means including chamber means containing a gas under pressure exerting a constant force tending to retain said normally retracted means in expanded condition; first releasable clutch means acting between said body structure and normally retracted means for preventing such movement of said body structure relative to said normally retracted means; and second releasable clutch means acting between said body structure and normally retracted means for preventing movement of said body structure relative to said normally retracted means in the opposite direction to lock said normally retracted means in its outwardly expanded condition.

2. In a well tool adapted to be set in a well bore: a body structure; normally retracted means on said body structure; means for expanding said normally retracted means outwardly and including chamber means containing a gas under pressure exerting a constant force tending to retain said normally retracted means in expanded condition; first releasable clutch means acting between said body structure and normally retracted means for preventing said normally retracted means from being expanded outwardly; and second releasable clutch means acting between said body structure and normally retracted means for locking said normally retracted means in its outwardly expanded condition.

3. In a well tool adapted to be set in a well bore: a body structure; normally retracted means on said body structure; means responsive to longitudinal movement of said body structure in one direction relative to said normally retracted means for expanding said normally retracted means outwardly, said expanding means including chamber means containing a gas under pressure exerting a constant force tending to retain said normally retracted means in expanded condition; first releasable clutch means acting between said body structure and normally retracted means for preventing such longitudinal movement of said body structure relative to said normally retracted means; and second releasable clutch means acting between said body structure and normally retracted means for preventing longitudinal movement of said body structure relative to said normally retracted means in the opposite direction to lock said normally retracted means in its outwardly expanded condition.

4. In a well tool adapted to be set in a well bore: a body structure; normally retracted means on said body structure; means for expanding said normally retracted means outwardly and including chamber means containing a gas under pressure exerting a constant force tending to retain said normally retracted means in expanded condition; a clutch member slidably relatively longitudinally on said body structure and operatively connected to said normally retracted means; a first clutch element movable laterally on said clutch member into clutching engagement with said body structure for preventing said normally retracted means from being expanded outwardly; and a second clutch element movable laterally on said clutch member into clutching engagement with said body structure for locking said normally retracted means in its outward expanded condition.

5. In a well tool adapted to be set in a well bore: a body structure; normally retracted means on said body structure; means responsive to longitudinal movement of said body structure in one direction relative to said normally retracted means for expanding said normally retracted means outwardly, said expanding means including chamber means containing a gas under pressure exerting a constant force tending to retain said normally retracted means in expanded condition; a clutch member slidable relatively longitudinally on said body structure and operatively connected to said normally retracted means; a first clutch element movable laterally on said clutch member into clutching engagement with said body structure for preventing such longitudinal movement of such body structure relative to said normally retracted means; and a second clutch element movable laterally on said clutch member into clutching engagement with said body structure for preventing longitudinal movement of said body structure relative to said normally retracted means in the opposite direction to lock said normally retracted means in its outwardly expanded condition.

6. In a well tool adapted to be set in a well bore: a body structure; normally retracted means on said body structure; means for expanding said normally retracted means outwardly and including chamber means containing a gas under pressure exerting a constant force tending to retain said normally retracted means in expanded condition; said body structure having first and second threaded portions; a clutch member slidable relatively longitudinally along said threaded portions and operatively connected to said normally retracted means; a first threaded clutch element movable laterally on said clutch member and being meshable with said first threaded portion for preventing said normally retracted means from being expanded outward-

ly; a second threaded clutch element movable laterally on said clutch member into threaded mesh with said second portion for locking said normally retracted means in its outwardly expanded condition; the threads of said first portion and first element being of opposite hand from the threads of said second portion and second element.

7. In a well tool adapted to be set in a well bore: a body structure; normally retracted means on said body structure; means responsive to longitudinal movement of said body structure in one direction relative to said normally retracted means for expanding said normally retracted means outwardly, said expanding means including chamber means containing a gas under pressure exerting a constant force tending to retain said normally retracted means in expanded condition; said body structure having first and second threaded portions; a clutch member slidable relatively longitudinally along said threaded portions and operatively connected to said normally retracted means; a first threaded clutch element movable laterally on said clutch member and being meshable with said first threaded portion for preventing such longitudinal movement of said body structure relative to said normally retracted means; a second threaded clutch element movable laterally on said clutch member into threaded mesh with said second portion for preventing longitudinal movement of said body structure relative to said normally retracted means in the opposite direction to lock said normally retracted means in its outwardly expanded condition; the threads of said first portion and first element being of opposite hand from the threads of said second portion and second element.

8. In a well tool adapted to be set in a well bore: a body structure; normally retracted means on said body structure; means for expanding said normally retracted means outwardly and including chamber means containing a gas under pressure exerting a constant force tending to retain said normally retracted means in expanded condition; said body structure having first and second buttress thread portions of opposite hand; a clutch member slidable longitudinally along said threaded portions and operatively connected to said normally retracted means; a first clutch element movable laterally on said clutch member and having a buttress thread meshing with the first threaded portion to prevent said normally retracted means from being expanded outwardly; and a second clutch element movable laterally on said clutch member and having a buttress thread adapted to mesh with said second threaded portion to lock said normally retracted means in its outwardly expanded condition.

9. In a well tool adapted to be set in a well bore: a body structure; normally retracted means on said body structure; means responsive to longitudinal movement of said body structure in one direction relative to said normally retracted means for expanding said normally retracted means outwardly, said expanding means including chamber means containing a gas under pressure exerting a constant force tending to retain said normally retracted means in expanded condition; said body structure having first and second buttress thread portions of opposite hand; a clutch member slidable longitudinally along said threaded portions and operatively connected to said normally retracted means; a first clutch element movable laterally on said clutch member and having a buttress thread meshing with said first threaded portion for preventing such longitudinal movement of said body structure relative to said normally retracted means; and a second clutch element movable laterally on said clutch member and having a buttress thread adapted to mesh with said second threaded portion to prevent longitudinal movement of said body structure relative to said normally retracted means in the opposite direction to lock said normally retracted means in its outwardly expanded condition.

10. In a well tool adapted to be set in a well bore: a body structure; normally retracted means on said body structure; means responsive to downward movement of said body structure relative to said normally retracted means for expanding said normally retracted means outwardly, said expanding means including chamber means containing a gas under pressure exerting a constant force tending to retain said normally retracted means in expanded condition; first releasable means acting between said body structure and normally retracted means for preventing such downward movement of said body structure relative to said normally retracted means; and second releasable clutch means acting between said body structure and normally retracted means for preventing upward movement of said body structure relative to said normally retracted means to lock said normally retracted means in its outwardly expanded condition.

11. In a well tool adapted to be set in a well bore: a body structure; normally retracted means on said body structure; means responsive to downward movement of said body structure relative to said normally retracted means for expanding said normally retracted means outwardly, said expanding means including chamber means containing a gas under pressure exerting a constant force tending to retain said normally retracted means in expanded condition; said body structure having first and second threaded portions; a clutch member slidable longitudinally along said threaded portions and operatively connected to said normally retracted means; a first threaded clutch element movable laterally on said clutch member and being meshable with said first threaded portion for preventing downward movement of said body structure relative to said normally retracted means; a second threaded clutch element movable laterally on said clutch member into threaded mesh with said second portion for preventing upward movement of said body structure relative to said normally retracted means to lock said normally retracted means in its outwardly expanded condition; the threads of said first portion and first element being of opposite hand from the threads of said second portion and second element.

12. In a well tool adapted to be set in a well bore: a body structure; normally retracted means on said body structure; means responsive to downward movement of said body structure relative to said normally retracted means for expanding said normally retracted means outwardly, said expanding means including chamber means containing a gas under pressure exerting a constant force tending to retain said normally retracted means in expanded condition; said body structure having first and second buttress thread portions of opposite hand; a clutch member slidable along said threaded portions and operatively connected to said normally retracted means; a first clutch element movable laterally on said clutch member and having a buttress thread meshing with said first threaded portion to prevent downward movement of said body structure relative to said normally retracted means; and a second clutch element movable laterally on said clutch member and having a buttress thread adapted to mesh with said second threaded portion to prevent upward movement of said body structure relative to said normally retracted means to lock said normally retracted means in its outwardly expanded condition.

13. In a well tool adapted to be set in a well bore: a body; normally retracted packing means on said body; normally retracted slip means on said body; means responsive to longitudinal movement of said body in one direction for expanding said packing means and slip means laterally outwardly, said expanding means including chamber means containing a gas under pressure exerting a constant force tending to retain said packing means and slip means in expanded condition; first releasable clutch means acting between said body and slip means for preventing said body from effecting expansion of said slip means and packing means; and second releasable clutch means acting between said body and slip means for locking said slip means and packing means in their outwardly expanded condition.

14. In a well tool adapted to be set in a well bore: a body; normally retracted packing means on said body; normally retracted slip means on said body; means responsive to downward movement of said body for expanding said packing means and slip means laterally outwardly, said expanding means including chamber means containing a gas under pressure exerting a constant force tending to retain said packing means and slip means in expanded condition; first releasable clutch means acting between said body means and slip means to prevent said body from effecting expansion of said slip means and packing means; and second releasable clutch means acting between said body and slip means for locking said slip means and packing means in their outwardly expanded condition.

15. In a well tool adapted to be set in a well bore: a body; normally retracted packing means on said body; normally retracted slip means on said body; means responsive to downward movement of said body for expanding said packing means and slip means laterally outwardly, said expanding means including chamber means containing a gas under pressure exerting a constant force tending to retain said packing means and slip means in expanded condition; said body having first and second threaded portions; a clutch member slidable relatively longitudinally along said threaded portions and operatively connected to said slip means; a first threaded clutch element movable laterally on said clutch member and being meshable with said first threaded portion for preventing said packing means and slip means from being expanded outwardly; a second threaded clutch element movable laterally on said clutch member into threaded mesh with said second portion for preventing upward movement of said body relative to said slip means to lock said slip means and packing means in their outward expanded condition; the threads of said first portion and first element being of opposite hand from the threads of said second portion and second element.

16. In a well tool adapted to be set in a well bore: a body; normally retracted packing means on said body; normally retracted slip means on said body; means responsive to downward movement of said body for expanding said packing means and slip means laterally outwardly, said expanding means including chamber means containing a gas under pressure exerting a constant force tending to retain said packing means and slip means in expanded condition; said body having first and second buttress thread portions of opposite hand; a clutch member slidable longitudinally along said threaded portions and operatively connected to said slip means; a first clutch element movable laterally on said clutch member and having a buttress thread meshing with said first threaded portion to prevent downward movement of said body relative to said slip means and packing means to prevent said slip means and packing means from being expanded outwardly; and a second clutch element movable laterally on said clutch member and having a buttress thread adapted to mesh with said second threaded portion to prevent upward movement of said body relative to said slip means and packing means to lock said slip means and packing means in their outwardly expanded condition.

17. In a well tool adapted to be set in a well bore: a body; normally retracted packing means on said body; means for expanding said packing means laterally outwardly, comprising abutment means for exerting an expanding force on said packing means; and chamber means surrounding said body and containing a gas under pressure charged into said chamber means at the top of the well bore for exerting a continuous spring-like force on said abutment means to hold said packing means expanded outwardly.

18. In a well tool adapted to be set in a well bore: a body; normally retracted packing means on said body; an upper abutment engaging said packing means; a lower abutment engaging said packing means; means for relatively shifting said abutments toward each other to expand said packing means laterally outwardly; chamber means surrounding said body and operatively connected to one of said abutments; said chamber means containing a gas under pressure charged into said chamber means at the top of the well bore for exerting a continuous spring-like force on said chamber means and said one abutment to urge said one abutment toward the other abutment.

19. In a well tool adapted to be set in a well bore: a body; normally retracted slip means disposed around said body; expander means around said body above and engaging said slip means; means for relatively moving said expander means downwardly of said slip means to expand said slip means relatively outwardly; packing means above said expander means adapted to seal against the wall of the well bore; means providing a downwardly facing transverse surface on said expander means subject to the pressure of fluid in the well bore above said packing means; and means providing a resultant upwardly facing transverse surface on said expander means subject to the pressure of fluid in the well bore below said packing means, whereby a greater well bore pressure below said packing means and above said packing means forces said expander means downwardly within said slip means to retain said slip means expanded outwardly.

20. In a well tool adapted to be set in a well bore: a body structure; normally retracted packing means on said body structure; means responsive to movement of said body structure in one direction relative to said normally retracted packing means for expanding said normally retracted packing means outwardly, said expanding means including spring-like means exerting a constant force tending to retain said normally retracted packing means in expanded condition; first releasable clutch means acting between said body structure and normally retracted packing means for preventing such movement of said body structure relative to said normally retracted packing means; and second releasable clutch means acting between said body structure and normally retracted packing means for preventing movement of said body structure relative to said normally retracted packing means in the opposite direction to lock said normally retracted packing means in its expanded condition.

21. In a well tool adapted to be set in a well bore: a body structure; normally retracted packing means on said body structure; means for expanding said normally retracted packing means outwardly and including spring-like means exerting a constant force tending to retain said normally retracted packing means in expanded condition; first releasable clutch means acting between said body structure and normally retracted packing means for preventing said normally retracted packing means from being expanded outwardly; and second releasable clutch means acting between said body structure and normally retracted packing means for locking said normally retracted packing means in its outwardly expanded condition.

22. In a well tool adapted to be set in a well bore: a body; normally retracted means on said body; means for expanding said normally retracted means laterally outwardly, comprising abutment means for exerting an expanding force on said normally retracted means; and chamber means surrounding said body and containing a gas under pressure charged into said chamber means at the top of the well bore for exerting a continuous spring-like force on said abutment means to hold said normally retracted means expanded outwardly.

23. In a well tool adapted to be set in a well bore: a body; normally retracted means on said body; an upper abutment engaging said normally retracted means; a lower abutment engaging said normally retracted means; means for relatively shifting said abutments toward each other to expand said normally retracted means laterally outwardly; chamber means surrounding said body and operatively connected to one of said abutments; said chamber means containing a gas under pressure charged into said

chamber means at the top of the well bore for exerting a continuous spring-like force on said chamber means and said one abutment to urge said one abutment toward the other abutment.

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