The present invention relates to subsurface well packers, and more particularly to packers for performing cementing, acidizing, fracturing, testing, plugging, production, and other operations in well bores.

An object of the invention is to provide a well packer embodying a back pressure valve initially held in an open position, and which is released for movement to a closed position in response to mechanical setting of the packer in a well bore.

Another object of the invention is to provide a well packer adapted to be set in a well bore and embodying a back pressure valve capable of preventing flow of fluid through the packer in one direction, and which can be conditioned while the packer is in the well bore to prevent flow of fluid through the packer in both directions, thereby causing the packer to function as a bridge plug.

A further object of the invention is to provide an improved well packer and setting tool apparatus capable of effecting anchoring of the well packer in a well bore against movement in both directions by manipulation of a tubular string to which the setting tool and packer are attached.

An additional object of the invention is to provide well packer apparatus to be run in a well bore on a tubular string, and embodying an improved control valve for determining flow or fluid between the interior and exterior of the tubular string, the control valve being shifted from an open to a closed condition as an incident to setting of the packer in the well bore, and being retained in such closed condition.

Yet another object of the invention is to provide well packer apparatus to be run in a well bore on a tubular string and anchored in the well bore in response to manipulation of the tubular string, anchoring being prevented until a control unit is released, the control unit being automatically reengaged in the event of its inadvertent release.

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 as accompanying and forming part of the present specification.

It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

FIGURES 1 and 1a together constitute a longitudinal section through an apparatus located in a well bore, parts being disposed in their initial or retracted conditions for running of the apparatus longitudinally in the well bore or well casing contained therein, FIG. 1a constituting a lower continuation of FIG. 1;

FIGS. 2 and 2a are views similar to FIGS. 1 and 1a, respectively, with the well packer anchored in packed-off condition in the well casing and the back pressure valve released for operation, FIG. 2a constituting a lower continuation of FIG. 2;

FIG. 3 is a view similar to FIG. 2a, with the well packer converted to a bridge plug;

FIG. 4 is an enlarged section through the circulating valve and control unit portion of the apparatus on an enlarged scale, with the parts disposed in their initial position illustrated in FIG. 1;

FIG. 5 is a cross-section taken along the line 5—5 on FIG. 4;

FIG. 6 is a cross-section taken along the line 6—6 on FIG. 4;

FIG. 7 is a cross-section taken along the line 7—7 on FIG. 4;

FIG. 8 is an enlarged section taken along the line 8—8 on FIG. 1a.

The apparatus illustrated in the drawings includes a packer portion A adapted to be anchored in packed-off condition in a well casing B against movement in both longitudinal directions therewithin. The packer is set through appropriate manipulation of a setting tool or control device C releasably secured thereto which embodies a circulating valve portion D. The control device itself is attached to the lower end of a tubular string E, such as tubing or drill pipe, extending to the top of the well bore, by means of which the apparatus is lowered in the well casing to the desired setting point, is appropriately manipulated to set the packer in the well casing, to release a lower valve portion thereof, to convert the apparatus into a bridge plug, when desired, and to determine the open or closed condition of the circulating valve portion D of the apparatus.

The well packer portion A of the apparatus includes a main tubular body 10 having an upper threaded box 11, the threads of which are preferably right-hand, there being a lower body member 12, threaded onto the main portion of the body. The well packer is adapted to be anchored to the well casing B against movement in both longitudinal directions by means of a single set of segmental upright holding slips 13 surrounding the body initially held in retracted position by an inherently contractile, split ring 14 disposed in external grooves 15 in the mid-portions of the slips. The upper portions 16 of the slips have inner surfaces 17 tapering in a downward and inward direction, coating with a companion expander surface 18 on the lower portion of an upper expander 19 initially releasably secured to the body by one or more shear screws 20. The lower portions 21 of the slips are also provided with inner tapered expander surfaces 22 inclined in an upward and inward direction, coating with a companion tapered surface 23 on a lower expander 24 initially releasably secured to the packer body 10 by one or more shear screws 26. As described hereinbelow, the upper and lower expanders 19, 24 are movable relatively toward each other to expand the slips 13 outwardly into anchoring engagement with the wall of the well casing B. The upper portions of the slips have downwardly facing wickers or teeth 27 to hold the apparatus against downward movement in the well casing, whereas the lower portions of the slips have upwardly facing wickers or teeth 29 to anchor the apparatus to the well casing against upward movement therewithin.

Surrounding the packer body 10 is a packing structure 28 of any suitable form, such as a rubber or rubber-like initially or normally retracted packing sleeve, the upper end of which engages the lower end of the expander 24.

The lower end of this packing sleeve contacts a lower abutment 29 initially secured to a retainer or junk packer holder 30 that extends downwardly along the lower body member 12, to which it is initially releasably secured by one or more shear screws 31. The lower portion 32 of this housing member diverges in a downward direction so as to function as a junk packer and feeder as the apparatus is lowered through the well casing B, to prevent its premature setting. Integral with this lower portion is a spider 33 having a central upwardly extending holding or retainer sleeve or skirt 34 which initially
engages a flapper valve head 35 to hold it to one side, out of the path of fluid flowing through the apparatus. Actually, the flapper valve head 35 is retained within the annular cavity between the skirt 34 and the outer portion of the housing 30. The flapper valve 35 itself is pivotally mounted on a hinge pin 37 carried by the lower head part 38 of a clamp sleeve 39 which has external right-hand threads 40 meshing with companion internal right-hand threads 41 in the head member 12.

Initially, the clamp sleeve 39 and its head 38 are disposed in an upward position, in which the head may engage the lower end of the lower body member 12. However, as explained hereinbelow, the clamp sleeve 39 and flapper valve head 35 can be rotated relative to the lower body member 12 to effect a lowering of these parts, in order to convert the apparatus A into a bridge plug.

When the shear screws 31 are released, the housing 30 and the holding or retainer skirt 34 will shift downwardly relative to the valve head 35 until the skirt is disposed below the latter, whereupon the head 35 can swing upwardly into sealing engagement with a valve seat 42 formed at the lower end of the tubular clamp sleeve 39, thus preventing upward or back flow of fluid through the apparatus A, while permitting downward flow of fluid through the apparatus. To prevent leakage of fluid around the clamp sleeve, a suitable side seal 43 is mounted thereon for sidable sealing engagement with the inner wall 44 of the packer body 10.

For the purpose of holding the packer A anchored in packed-off condition in the well casing, a ratchet lock is provided. This lock includes a plurality of downwardly facing ratchet teeth 45 on the body 10 of the tool adapted to engage companion internal ratchet tooth 46 on a split lock sleeve 47 disposed within the upper expander 19. This lock sleeve has external cam elements 48 thereon cooperating with companion cam elements 49 in the upper expander, the coengaging cam elements tapering in a downward and inward direction thus that any tendency for the body 10 to move downwardly will force the sleeve 47 inwardly and retain the ratchet teeth 45, 46 in engagement with one another. However, the body 10 of the tool can be moved upwardly freely within the ratchet sleeve in effecting operation of the apparatus.

The well packer A is secured to the setting tool portion C of the apparatus, which includes a tubular mandrel 50 initially received within the packer body 10. This mandrel has a seal ring 51 mounted thereon in a groove 52 formed between a lower mandrel section 53, threaded on the lower end of the main mandrel portion 50, and the lower end of the mandrel body 94 of the uppermost mandrel member 60. Each dog 91 has upper and lower extensions 95 engaging the inner wall 44 of the packer body 10 to prevent leakage thereby. Surrounding the mandrel 50 is an externally threaded nut 55 meshing with the threaded box 11 of the tool, the nut being slidable splined to the mandrel 50 by means of a key 56 secured to the nut and extending into a longitudinal keyway 57 in the mandrel. With the nut 55 threaded within the box 11, upward forces and movement of the tubular mandrel 50 are conducted through an upwardly facing shoulder 58 of the mandrel to the nut 55, and from the nut to the body 10 of the tool A. The end of the mandrel 50 is threaded to a coupling 158 which, in turn, is threaded securely to an upper mandrel member 59 which also forms a portion of the circulating valve and the control unit D of the apparatus.

The upper end of this mandrel member is threaded securely to a thrust mandrel portion 60, the upper end of which is adapted to be sealed with an external sleeve valve member 62 slidably on the mandrel 59 and initially releasably located in an upper position in engagement with a mandrel stop shoulder 63 by a split inherent contractile retainer ring 64 disposed in an upper mandrel groove 65. When disposed in such groove, the sleeve 62 is located above the ports 61. However, relative downward shifting of the valve sleeve member 62 along the mandrel will dispose it fully across the ports 61 and in engagement with a lower seal ring 66 on the mandrel 59 below the ports, the sleeve carrying an upper seal ring 67 which will slidably seal against the exterior of the mandrel 59 above the ports 61, thus preventing leakage of fluid in both directions between the mandrel 59 and the sleeve valve member 62. When the sleeve valve 62 is disposed in its lowermost position, the retainer ring 64 will snap into a lower groove 68 and retain the sleeve valve in such lower or port closing position.

The lower inner corner 69 of the retainer ring 64 is tapered in an upward and inward direction, engaging a companion tapered surface 70 at the lower end of the lower lock groove 65, so that downward force imposed on the ring 64 will cam it out of this groove, enabling the sleeve 62 to slide relatively downward along the mandrel 59 to the port closing position, the ring then snapping into the lower lock groove 68 to retain the sleeve valve member in this latter position.

The well packer A is anchored in packed-off condition mechanically as a result of appropriate manipulation of the tubing string E and of the mandrel 60, 59, 50, which effects operation of the setting portion of the apparatus. The setting portion includes a plurality of circumferentially spaced setting slips 71 having upwardly facing wickers or teeth 72 and inner expander surfaces 73 tapering in an upward and inward direction. The slips are initially disposed substantially above the upper expander 19, and when the latter is moved upwardly toward the slips 71, an upper expander surface 74 on the latter, companion to the setting slip surfaces 73, will engage the latter and urge the setting slips downwardly into anchoring engagement with the well casing B.

Initially, the setting slips 71 are held in a retracted position by being releasably secured to longitudinally extending spring arms 75 through shear pins or rivets 76, the lower ends of the arms engaging upwardly facing shoulders 77 on the setting slips. The upper ends of the arms 75 are secured to a setting sleeve extension or carrier 78 by means of rivets 179, the spring arms tending inherently to shift inwardly and thereby holding the setting slips 71 inwardly against the exterior of the packer body 10. The sleeve extension 78 is threadably attached to the upper sleeve 79, the upper end of which is threadedly secured to a lower control collar 80, which also forms the lower collar of a draft assembly 81. This draft assembly includes circumferentially spaced, outwardly bowed draft springs 83 adapted to frictionally slide along the wall of the well casing B, the lower ends of the springs being secured to the lower collar 80 by an encompassing ring 83 and by screws 84. The upper ends of the springs are secured to an upper collar 85, slidable on the mandrel 60, by an encompassing ring 86 and screws 87.

The draft assembly 81 tends to resist movement of the setting sleeve 79, sleeve extension 78, setting spring arms 75, and setting slips 71 within the well casing B. Initially, relative movement between these parts and the draft assembly 81, on the one hand, and the mandrel 60, 59, 50 therein, on the other hand, is precluded by a control unit 88. This control unit releasably and threadedly secures the lower control collar 80 to the mandrel 60, 59, 50. Thus, it includes an internal left-hand buttress thread 89 in the upper portion of the lower control collar 80 which is adapted to engage companion external segmental thread portions 90 of a plurality of circumferentially spaced threaded dogs 91 that fit within radial openings 92 in slip holder 93. The dog control collar 80 is closed by an external control collar 94 and moved within a depending head 94 of the uppermost mandrel member 60. Each dog 91 has upper and lower extensions 95 engaging the inner wall
of the sleeve 93 when the dog threads 90 are in full mesh with the internal threads 89 on the collar 80. The dogs 91 are urged in the outward direction to hold their threads 90 engaged with the collar threads 89 by an expansible split spring 96 which fits within inner grooves 97 in the dogs, urging the latter outwardly. However, the spring 96 will permit the dogs 91 to shift inwardly, as when the dogs are moved longitudinally downward along the control collar threads 89, the dogs ratcheting thereupon in view of the characteristic nature of these threads. However, upward movement of the dogs 91 relative to the control collar 80 is prevented by the fact that the generally radial transverse shoulders 98 of the threads engage one another, as is most clearly shown in FIG. 4.

The mandrel 59, 60 is released from the lower control collar 59 of the drag assembly 81 in response to its rotation, which will effect rotation of the threaded dogs 91. The rotary motion of the mandrel 59 is transmitted to the dogs by securing a key 99, as by means of welding material 180, to the sleeve 93, this key being received within a longitudinal keyway 101 in the mandrel member. Thus, right-hand rotation of the mandrel 59 will be transmitted to the sleeve 93, and through the latter to the threaded dogs 91. Since the drag assembly is resisting or preventing rotation of the lower control collar 59, the dogs will thread in an upward direction from the control collar threads 89 until the dogs 91 are completely disconnected therefrom, which will then permit the mandrel 59, 59, 60 to be moved longitudinally upwardly, without rotation, to effect a setting of the apparatus A in the well bore, as well as closing of the circulation valve D.

In the use of the apparatus, the well packer A has its parts initially disposed in the condition illustrated in FIG. 4, in which it is to be noted the lower abutment 29 has a shoulder 105 spaced above the upper end 104 of the lower body member 12. The mandrel 50 is inserted in the packer and the nut 55 threaded into the packer box 11. At this time, the dogs 91 are in full threaded mesh with the threads 89 of the lower control collar 59 and the setting slips 71 are spaced a substantial distance above the upper expander 12. The control valve sleeve member 62 is also in its port opening position. The apparatus is secured to the tubing string E and is lowered in the well casing B. During such lowering motion, a shoulder or flange 107 on the mandrel 60 engages the lower control collar 59 to push the entire drag assembly 81, setting sleeve 79, sleeve extension 78, and setting slips 71 downwardly in the well casing. At the same time, the lower end of the mandrel section 53 engages the upper end of the clamp sleeve 39 to move the entire packer apparatus A down through the well casing. When the parts in retracted position and with the flapper valve head 35 held positively off its seat 42. The fluid in the well casing is by-passed through the tool, flowing upwardly through the holding skirt 34 and the slip 35, up through the clamp sleeve 39 into the mandrel 59, 59, 60, and either continuing up through the tubing string E or flowing outwardly through the ports 61 into the annulus between the tubular string and the well casing, B.

When the setting location in the well casing is reached, the tubular string E is rotated in a right-hand direction to turn the mandrel 69, 59, 50. The frictional engagement of the outwardly bowed spring 92 against the wall of the well casing will prevent rotation of the drag assembly 81, as well as its longitudinal movement in the well casing. Rotation of the setting sleeve 79, sleeve extension 78, spring arms 75, and setting slips 71 is also prevented. Rotation of the mandrel 69, 59, 50 will result in turning of the entire packer with it, so that the threaded nut 55 does not unscrew from the threaded box 11.

However, the dogs 91 will thread upwardly from the control collar 80 until they are completely disconnected therefrom. The mandrel structure 59, 59, 50 can now be moved upwardly, the upward movement of the mandrel being transferred through its shoulder 58 to the threaded nut 59, and from the latter through the threaded box 11 to the body 10 of the tool, shifting the entire packer structure upwardly relative to the normally retracted setting slips 71, which are prevented from moving upwardly by the drag springs 82. The upper expander 12 is shifted upwardly behind the setting slips, expanding the latter outwardly into engagement with the well casing, and precluding further upward movement of the upper expander 19.

The downward movement of the mandrel and body 10 of the tool will result in shearing of the screws 20, 25 holding the upper and lower expanders 19, 24 to the body of the tool, as the screws 31 holding the housing 30 to the lower body member 12. Accordingly, the body 10 will move upwardly, carrying the clamp sleeve 39 and flapper valve head 35 upwardly with it, lifting the flapper valve head above the holding member or skirt 34, whereupon it can swing upwardly about its hinge pin 37 into engagement with the valve seat 42. When the upper end 106 of the lower body member engages the lower abutment 29, it will shift the packing sleeve 23 and lower expander 24 upwardly behind the normally retracted two-way holding slips 13, sliding such slips upwardly along the upper expander 19 and radially outwardly into engagement with the well casing. The lower expander 24 moves upwardly toward the upper expander 19 until the slips 13 are fully engaged with the well casing and their wickers 26, 27 anchored therein. When this occurs, the lower expander 24 cannot move upwardly to any further extent. Accordingly, continued upward movement of the mandrel 69, 59, 59 and body 10 of the tool will move the lower abutment 29 toward the lower expander 24, to forestall the normally retracted packing sleeve 23 and effect its outward expansion into sealing engagement with the wall of the well casing B, and also into sealing engagement with the periphery of the body 10. As assurance against leakage around the packing structure 28, suitable side seal rings 110 may be disposed in the lower expander 24 and lower abutment 29 for sealing engagement against the periphery of the body 10.

A sufficient upward strain is taken on the tubing string E, mandrel 69, 59, 50, and body 10 of the tool to ensure the firm anchoring of the slips 13 against the well casing and the sealing of the packing structure 28 against the wall of the well casing. Upward movement of the body is permitted by the ratcheting of the body teeth 45 within the ratchet sleeve 47. When the body 10 is fully set, then its release is precluded by the interlocking of the body teeth 45, 46, downward movement of the body 10 being transmitted through the ratchet structure to the upper expander 19, and thence through the upper portions 16 of the holding slips to the well casing. Any tendency for the body 10 to move upwardly is transmitted through the lower abutment 29 and packer structure 28 to the lower expander 24, and through the lower expander to the lower portions 21 of the holding slips to the well casing. It is evident that the packer A has been anchored in packed-off condition in the well casing, and that the back pressure valve member 35 has been freed and can swing upwardly into engagement with its companion seat 42 to prevent upward movement of fluid through the well packer.

After release of the control unit 58 and upward movement of the mandrel 69, 59, 50 relative to the drag assembly 81, the sleeve valve member 62 is carried upwardly with the valve mandrel 59 until the upper end 111 of the sleeve valve member engages a downwardly facing shoulder 112 on the setting sleeve 79. Such engagement will occur before the well packer A has been fully set. When the engagement occurs, a continuation of upward movement of the mandrel 69, 59 will result in release of the retaining ring 64 from the upper lock groove 65 and a relative downward movement of the sleeve valve member 62 along the mandrel 59 to a posi-
tion closing the ports 61 (FIG. 2). When this occurs, the valve mandrel 59 cannot move upwardly to any further extent relative to the drag assembly 81 and setting sleeve 79. However, if the well packer A has not as yet been anchored fully in packed-off condition in the well casing, the taking of an additional upward strain on the mandrel 59 will result in a transmission of the upward force from the mandrel 59 through the sleeve valve member 62 to the setting sleeve 79 and the sleeve extension 78, pulling upwardly on the spring arms 75 and bearing the pins or rivets 76 securing the arms to the setting slips 71 (FIG. 2a). When such shearing occurs, the entire drag assembly 81, setting sleeve 79, sleeve extension 78, and spring arms 75 can move upwardly without restraint, other than the friction of the springs 82 against the well casing. Ordinarily, the sleeve valve 62 will be shifted to closed position over the ports 61 substantially before full setting of the packer A, permitting a continuation in the upward movement of the mandrel 60, 59, 59 and devices surrounding it with the body 10 of the well packer to occur, to effect a shearing of the rivets or pins 76 and release of the setting mechanism C from the setting slips 71.

After the apparatus has been anchored in packed-off condition in the well casing, a suitable operation can occur. If cement slurry is to be pumped down the tubing string E and through the apparatus, it will force the flapper valve head 35 out of the way and be ejected from the well packer, to be forced into the formation thereafter. Following completion of the cementing operation, the flapper valve head will swing upwardly into engagement with its companion seat 42 to prevent back flow of the cement slurry, or other fluent material into the well packer. The setting and valve portion C of the apparatus can now be disconnected from the well packer, if desired. All that need be done is to rotate the tubular string E and mandrel 60, 59, 50 to the right, this right-hand rotation being transmitted through the key 56 to the nut 55, the latter threading in an upward direction from the box 11 until the mandrel is completely disconnected from the well packer A. The tubing string E and setting portion C of the apparatus can now be elevated in the well casing B and removed completely therefrom, if desired, leaving the well packer A anchored in packed-off condition in the well casing.

The apparatus A can be converted to a bridge plug, in which fluid is prevented from flowing in both directions through the well packer. It is to be noted that the upper end of the clamp sleeve 39 has axial clutch teeth or dogs 120 formed thereon, these clutch teeth or dogs being adapted to mesh with companion clutch teeth or dogs 121 on the lower end of the mandrel section 55. When the mandrel shoulder 58 engages the nut 55, the clutch members 120, 121 are out of engagement with one another, so that rotation of the mandrel is not transmitted to the clamp sleeve 39. However, lowering of the mandrel 59 with respect to the body 10 will bring the clutch members 120, 121 in engagement with one another. Such engagement normally will only be required after the packer has been anchored in packed-off condition in the well casing. Rotation of the tubular string E and mandrel 60, 59, 50 will effect a rotation of the clamp sleeve 39, with the flapper valve head 35 engaging its seat 42, the flapper valve head also turning the clamp sleeve 39. The clamp sleeve is thread reversely downwardly within the body 10 of the tool, shifting the flapper valve head 35 downwardly with it until the latter engages the upper end or back-up seat 122 of the holding skirt 34.

The flapper valve head 35 is thus clamped between the retaining skirt 34 and the valve seat 42, as shown in FIG. 3. If fluid tends to flow upwardly through the apparatus, it is precluded from doing so by the upward seating of the flapper valve head 35 against its companion seat 42. Fluid tending to flow downwardly through the packer is prevented from doing so by seating of the underside 123 of the flapper valve head against the back-up seat 122 of the holding skirt. Since the external threads 40 on the clamp sleeve 39 preferably fit loosely in the respective seat 42 in the clamp sleeve, and thereby form an assembly of a nonremovable nature, the threaded portion received into the inner wall 44 of the body 60 is greater than the seating diameter of the valve seat 42 against the flapper valve head 35. Accordingly, a differential area is present facing in an upward direction over which fluid pressure can act to shift the clamp sleeve 39 downwardly and hold the valve head 35 clamped securely between the valve seat 42 and the back-up seat 122.

Following conversion of the packer to a bridge plug, the mandrel 59 can be released from the well packer by un-screwing the nut 55 therefrom. If such release has previously taken place and the mandrel reinserted in the packer to effect an engagement of the clutch 121, 120 and a rotation of the clamp sleeve 39, the tubing string E need merely be elevated in the well casing to remove the mandrel 50 from the well packer and withdraw all of the apparatus, with the exception of the well packer A from the well casing B.

The control unit 88 will effect an automatic recoupling of the mandrel 60, 59, 50 to the drag assembly 81. During lowering of the apparatus in the well casing, there might be some inadvertent turning of the tubing string E and mandrel to the extent at which the dogs 91 are thread from the companion thread box 89 in the lower control collar 80. If this occurs, additional lowering of the tubular string E, as sections of tubing are added there to the top of the well bore, will result in the threaded dogs 91 being forced back into the lower control collar 89, the dogs catching past the left-hand threads 89 in the lower control collar until the shoulder 107 on the mandrel engages the upper end of the collar 80, the dogs being urged outwardly into full threaded mesh with the internal collar threads 89 by the spring ring 96. Thus, it is evident that inadvertent unthreading or disconnection between the mandrel 60, 59, 50 and the drag assembly 81 will result in automatic reengagement of the threads 90, 89, merely as a result of continued downward or longitudinal movement of the apparatus in the well casing B.

The inventor claims:

1. In a well tool adapted to be set in a well bore on a running-in string: a body having a longitudinal passage and adapted to be connected to the running-in string; normally retracted means on said body expandable outwardly; laterally movable valve means adapted to be disposed in open position on said side of said passage and movable laterally across said passage to close said passage; retainer means; means mounting said retainer means in a position engaging and holding said valve means in open position; means on said body for expanding said normally retracted means; and means responsive to movement of said body for relatively shifting said retainer means and valve means to release said retainer means from said valve means to permit said valve means to close said passage.

2. In a well tool adapted to be set in a well bore on a running-in string: a body having a longitudinal passage and adapted to be connected to the running-in string; normally retracted means on said body expandable outwardly; laterally movable valve means adapted to be disposed in open position on one side of said passage and movable laterally across said passage to close said passage; retainer means; means mounting said retainer means in a position engaging and holding said valve means in open position; means responsive to movement of said body in one direction for expanding said normally retracted means; and means responsive to movement of said body in said one direction for relatively shifting said retainer means and valve means to release said retainer
means from said valve means to permit said valve means to close said passage.

3. In a well tool adapted to be set in a well bore on a running-in string; a body having a longitudinal passage and adapted to be connected to the running-in string; normally retracted means on said body expandably outwardly; valve means adapted to be disposed across said passage to close said passage; retainer means; means mounting said retainer means in a position engaging and holding said valve means in open position; means on said body for expelling said normally retracted means; means responsive to movement of said body for relatively shifting said retainer means and valve means to release said retainer means from said valve means to permit said valve means to close said passage; and means rigidly engaging said valve means when in passage closing position to prevent opening of said valve means.

4. In a well tool adapted to be set in a well bore on a running-in string; a body having a longitudinal passage and adapted to be connected to the running-in string; normally retracted means on said body expandably outwardly; valve means adapted to be disposed across said passage to close said passage; retainer means; means mounting said retainer means in a position engaging and holding said valve means in open position; means responsive to movement of said body in one direction for expanding said normally retracted means; means responsive to movement of said body in said one direction for relatively shifting said retainer means and valve means to release said retainer means from said valve means to permit said valve means to close said passage; and means rigidly engaging said valve means when in passage closing position to prevent opening of said valve means.

5. In a well tool adapted to be set in a well bore on a running-in string; a body having a longitudinal passage and adapted to be connected to the running-in string; normally retracted means on said body expandably outwardly; valve means adapted to be disposed across said passage to close said passage; retainer means; means mounting said retainer means in a position engaging and holding said valve means in open position; means on said body for expelling said normally retracted means; means for relatively shifting said retainer means and valve means to release said retainer means from said valve means to permit said valve means to close said passage; and means rigidly engaging said valve means when in passage closing position to prevent opening of said valve means.

6. In a well tool adapted to be set in a well bore on a running-in string; a body having a longitudinal passage surrounded by a valve seat, said body being adapted to be connected to the running-in string; normally retracted means on said body expandably outwardly; valve means adapted to be disposed across said passage in engagement with said seat to close said passage; retainer means; means mounting said retainer means in position engaging and holding said valve means from said seat; means on said body for expelling said normally retracted means; means for relatively shifting said retainer means and valve means to release said retainer means from said valve means to permit said valve means to engage said seat and close said passage against flow of fluid therethrough in one direction; and means rigidly engageable with said valve means to hold it against said seat to prevent flow of fluid therethrough in the opposite direction.

7. In a well tool adapted to be set in a well bore on a running-in string; a body having a longitudinal passage surrounded by a valve seat, said body being adapted to be connected to the running-in string; normally retracted means on said body expandably outwardly; valve means movable across said passage and into engagement with said seat to close said passage; retainer means; means mounting said retainer means in position engaging and holding said valve means from said seat; means on said body for expelling said normally retracted means; means for relatively shifting said retainer means and valve means to release said retainer means from said valve means to permit said valve means to shift across said passage and engage said seat to close said passage against flow of fluid therethrough in one direction; and means engageable with said valve means for rigidly clamping said valve means between said seat and retainer means.

8. In a well tool adapted to be set in a well bore on a running-in string; a body having a passage surrounded by a valve seat, said body being adapted to be connected to the running-in string; normally retracted means on said body expandably outwardly; valve means engageable with said seat to close said passage; retainer means shiftable on said body and initially in position engaging and holding said valve means from said seat; means responsive to longitudinal movement of said body in one direction for expanding said normally retracted means and for relatively shifting said retainer means and valve means to release said retainer means from said valve means to permit said valve means to engage said seat and close said passage against flow of fluid therethrough in one direction; and means for relatively shifting said valve seat toward said retainer means to clamp said valve means between said seat and retainer means.

9. In a well tool adapted to be set in a well bore on a running-in string; a body having a passage and adapted to be connected to the running-in string; a sleeve threaded to said body in said passage and having a valve seat; normally retracted means on said body expandably outwardly; valve means engageable with said seat to close said passage; retainer means; means mounting said retainer means in position engaging and holding said valve means from said seat; means for expanding said normally retracted means; means for relatively shifting said valve means and retainer means to release said valve means from said retainer means to permit said valve means to engage said seat; and means responsive to upward movement of said body for expanding said normally retracted means and for relatively shifting said valve means and retainer means to release said valve means from said seat to close said passage against flow of fluid therethrough in one direction; and means engageable with said valve means upon rotation and threading of said sleeve in said body to hold said valve means against said seat to prevent flow of fluid therethrough in the opposite direction.

10. In a well tool adapted to be set in a well bore on a running-in string; a body having a passage and adapted to be connected to the running-in string; a sleeve threaded to said body in said passage and having a valve seat; normally retracted means on said body expandably outwardly; valve means movable upwardly into engagement with said seat to close said passage against upward flow of fluid therethrough; retainer means; means mounting said retainer means in position engaging and holding said valve means from said seat; means responsive to upward movement of said body for expanding said normally retracted means and for relatively shifting said valve means and retainer means to release said valve means from said seat and means for rotating said sleeve in said body to shift said sleeve toward said retainer means and clamp said valve means between said seat and retainer means.

11. In a well tool adapted to be set in a well bore on a running-in string; a body having a passage and adapted to be connected to the running-in string; a sleeve threaded to said body in said passage and having a valve seat; normally retracted means on said body expandably outwardly; valve means movable upwardly into engagement with said seat to close said passage against upward flow of fluid therethrough; retainer means; means mounting said retainer means in a position engaging and holding said valve means from said seat; means responsive to upward movement of said body for expanding said normally retracted means and for relatively shifting said valve means and retainer means to release said valve means from said seat; and mandrel in said body; and coengageable clutch means on said mandrel to said sleeve for transmitting rotation of said mandrel to said sleeve and effect downward
11. In a well tool adapted to be set in a well bore on a running-in string: a body having a longitudinal passage and adapted to be connected to the running-in string; normally retracted means on said body movable outwardly; valve means adapted to be disposed across said passage in engagement with said body to close said passage against flow of fluid therethrough in one direction; means for expanding said normally retracted means; holding means movable into rigid engagement with said valve means when in passage closing position to prevent flow of fluid through said passage in the opposite direction; and means for moving said holding means into such rigid engagement.

12. In a well tool adapted to be set in a well bore on a running-in string: a body having a longitudinal passage and adapted to be connected to the running-in string; normally retracted means on said body expandable outwardly; laterally-movable valve means adapted to be disposed in open position to one side of said passage and movable laterally across said passage to close said passage against flow of fluid therethrough in one direction; means for expanding said normally retracted means; holding means movable into rigid engagement with said valve means when in passage closing position to prevent flow of fluid through said passage in the opposite direction; and means for moving said holding means into such rigid engagement.

13. In a well tool adapted to be set in a well bore on a running-in string: a body having a longitudinal passage surrounded by a valve seat, said body being adapted to be connected to the running-in string; normally retracted means on said body expandable outwardly; valve means adapted to be disposed across said passage in engagement with said body to close said passage against flow of fluid therethrough in one direction; means on said body for expanding said normally retracted means; holding means movable into rigid engagement with said valve means to hold it against said seat to prevent flow of fluid therethrough in the opposite direction; and means for moving said holding means into such rigid engagement.

14. In a well tool adapted to be set in a well bore on a running-in string: a body having a passage and adapted to be connected to the running-in string; a sleeve threaded on said body; valve means on said body for expanding said normally retracted means; valve means movable upwardly into engagement with said sleeve to close said passage against upward flow of fluid therethrough; holding means forming a portion of said tool and disposed below said valve means; and means for rotating said sleeve in said body to shift said sleeve downwardward toward said holding means and clamp said valve means between said seat and holding means.

15. In a well tool adapted to be set in a well bore on a running-in string: a body; a mandrel releasably connected to said body; normally retracted setting slip means; a carrier releasably connected to said mandrel for longitudinal movement therewith; means releasably connecting said setting slips to said carrier; normally retracted means on said body movable longitudinally with said mandrel and body into engagement with said setting slip means, after release of said carrier from said mandrel, to expand said setting slip means outwardly followed by expansion of said normally retracted means; means for expanding said normally retracted means outwardly; said releasable means being released after outward expansion of said setting slips to permit said mandrel and carrier to be removed from the well bore.

16. In a well tool adapted to be set in a well bore on a running-in string: a body; a mandrel releasably connected to said body; normally retracted setting slip means; a carrier releasably connected to said mandrel for longitudinal movement therewith; valve means releasably connecting said setting slips to said carrier; normally retracted means on said body movable longitudinally with said mandrel and body into engagement with said setting slip means, after release of said carrier from said mandrel, to expand said setting slip means outwardly followed by expansion of said normally retracted means; means for expanding said normally retracted means outwardly; said shear means being disrupted by an upward pull on said mandrel and carrier after outward expansion of said setting slips to permit said mandrel and carrier to be removed from the well bore.
22. In a well tool adapted to be set in a well bore on a running-in string: a body; a mandrel releasably connected to said body and having a side port; a sleeve valve on said mandrel for controlling flow of fluid through said port; normally retracted setting slip means; a carrier on said mandrel; threaded latch means releasably connecting said mandrel to said carrier; shear means releasably connecting said setting slip means to said carrier; normally retracted means on said body movable longitudinally with said mandrel and body into engagement with said setting slip means, after release of said latch means, to expand said setting slip means outwardly followed by expansion of said normally retracted means; means on said carrier engageable with said sleeve valve for shifting said sleeve valve along said mandrel to port closing position; said shear means being disrupted by a longitudinal strain on said mandrel and carrier after outward expansion of said setting slip means to permit said mandrel and carrier to be removed from the well bore.

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