

April 16, 1968

J. H. CURRENT

3,378,078

WELL TOOLS

Filed Dec. 1, 1965

5 Sheets-Sheet 1

Fig. 1

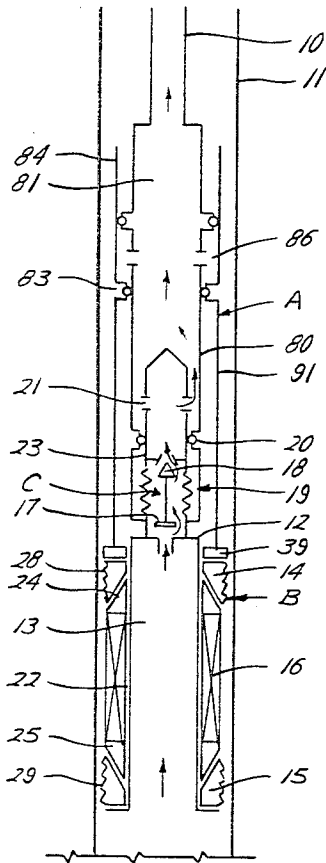


Fig. 2

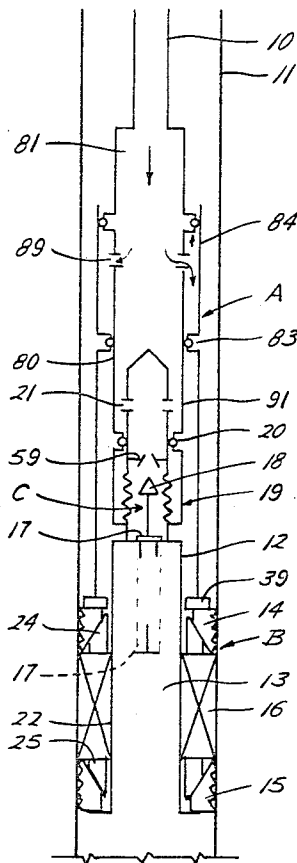


Fig. 3

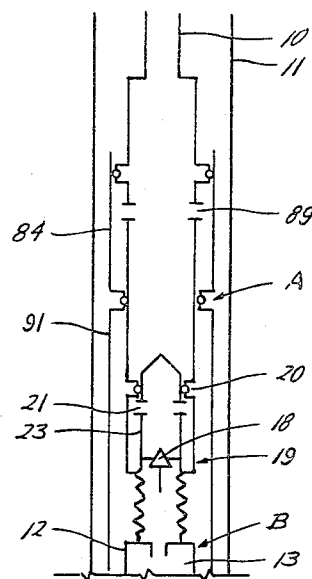
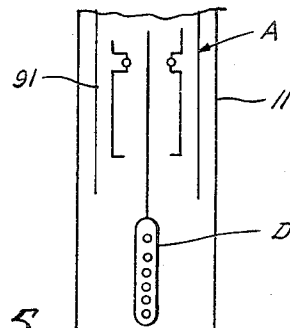
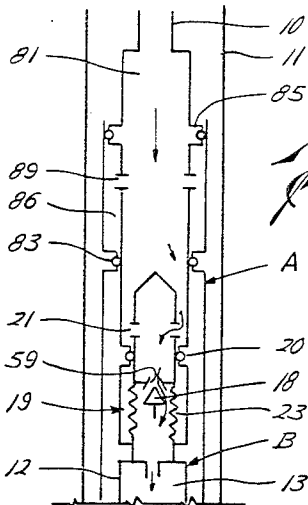


Fig. 5



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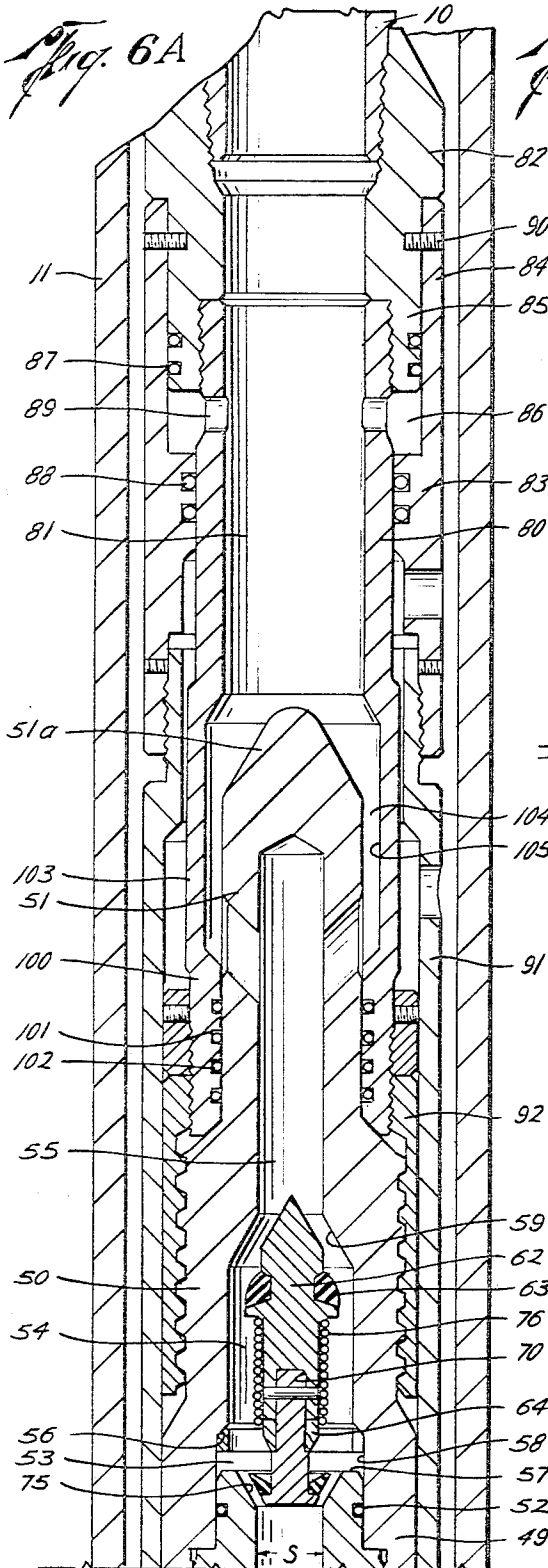
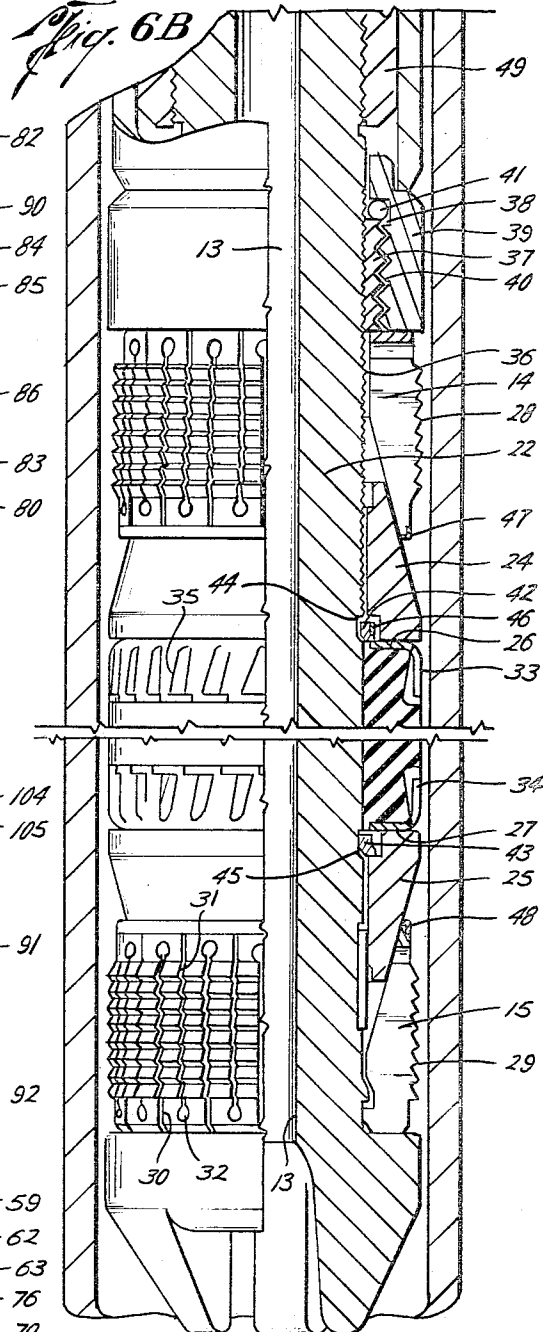
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Fig. 7A

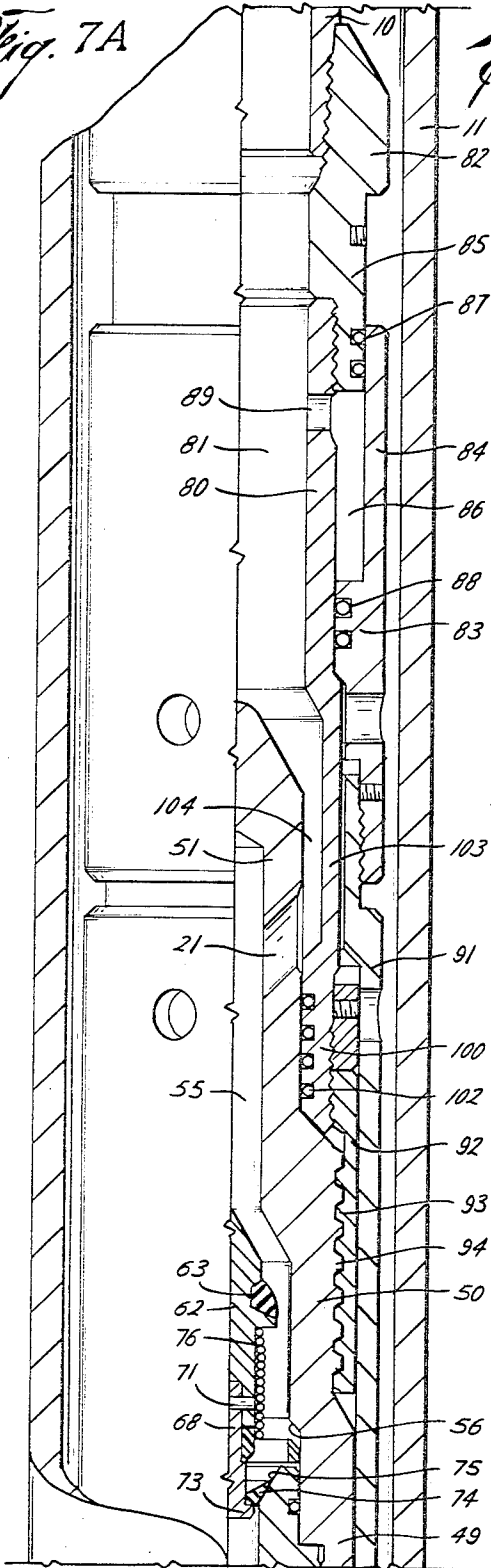
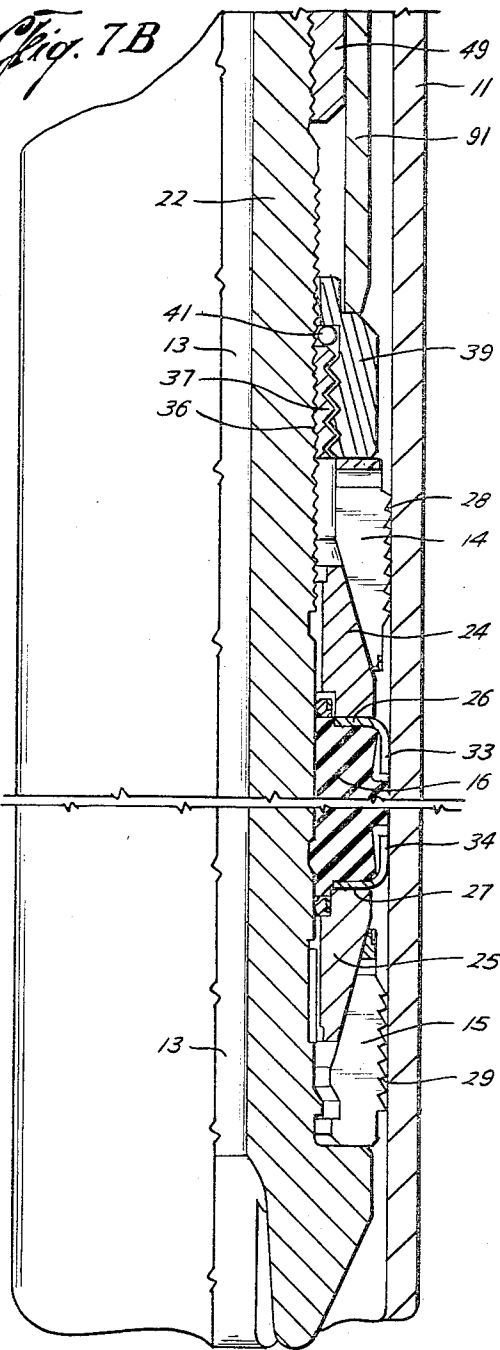


Fig. 7B



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Fig. 8

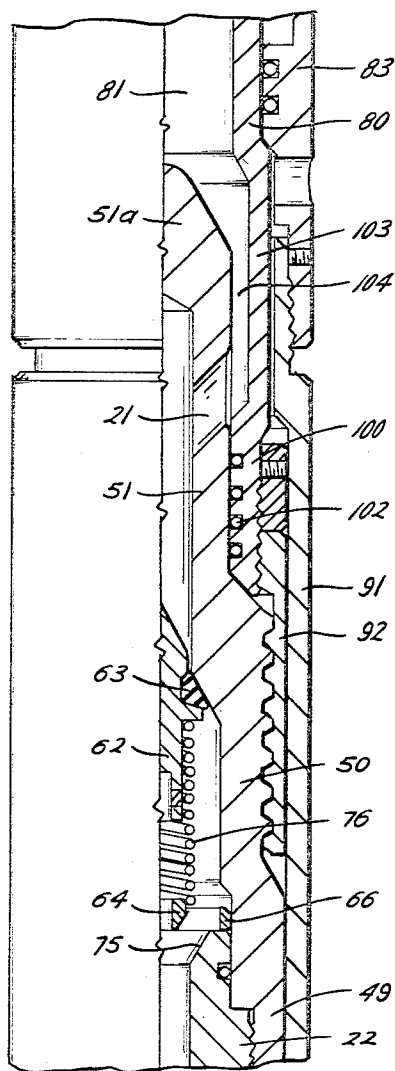
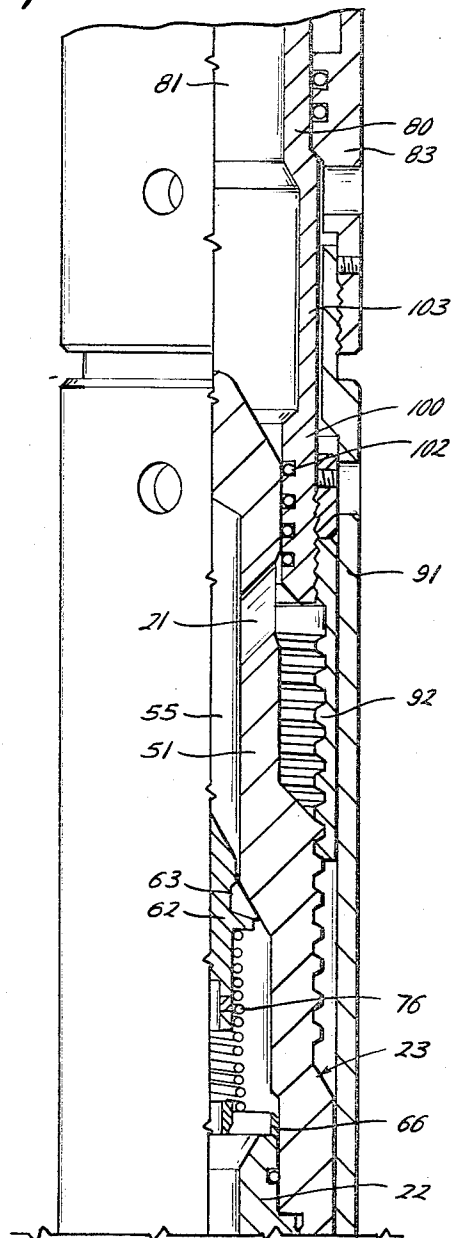


Fig. 9



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Fig. 10

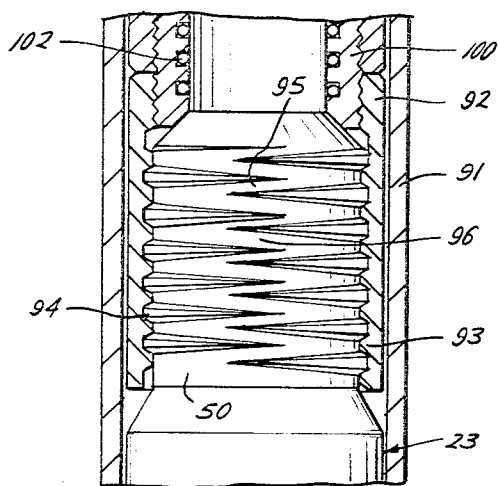


Fig. 11

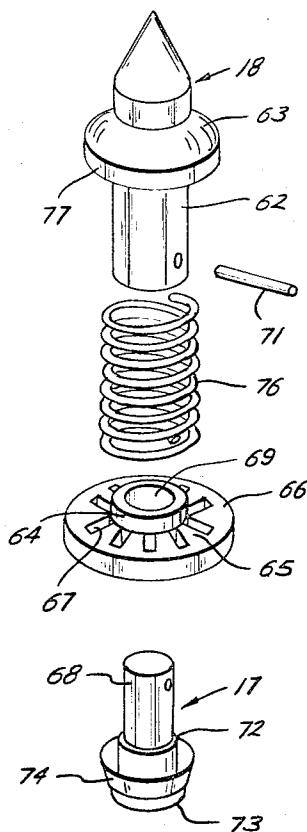
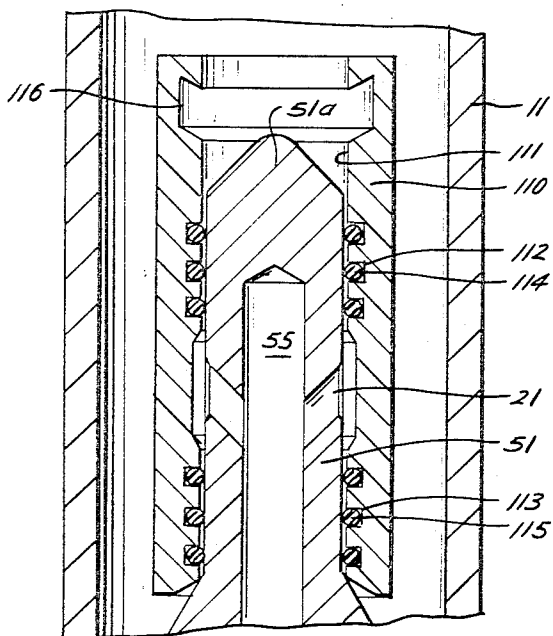


Fig. 12



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Filed Dec. 1, 1965, Ser. No. 510,809

11 Claims. (Cl. 166—124)

ABSTRACT OF THE DISCLOSURE

The particular embodiment disclosed herein as illustrative of one form of the present invention in well packers includes a body member, anchors and packing for sealing off a well bore, and a flow passage in the body member having flow control means therein. The flow control means comprises an upwardly closing valve for retaining fluid pressure, and a downwardly closing valve which permits setting the anchors and packing by hydraulically operable setting means and which is then releasable to enable fluid movement downwardly through the flow passage. The setting means is releasably coupled to the body means, and coengageable means on the setting means and body are selectively operable to enable testing of a running-in string for leaks.

This invention relates generally to subsurface well tools. More particularly, the invention relates to a type of well packer apparatus used primarily in cementing operations.

To place cement behind a well conduit such as a casing or liner, a type of well packer commonly known as a cement retainer may be set by a setting tool into a pack-off condition at a selected level in the well conduit. Cement slurry is displaced under pressure down through tubing or drill pipe and the retainer into an open hole below the conduit or through conduit perforations. Cement retainers generally have expendable anchors which anchor the retainer in the conduit, expandable packing which packs off the annulus between the conduit and drill pipe or tubing, and back pressure valves which permit downward flow of fluids through the retainers while providing back pressure control.

It is particularly desirable that such apparatus be compatible with and capable of use in conjunction with, other commercially available well tools for performing such pressure operations as fracturing, acidizing and squeeze cementing with only a single trip into the well. It is also desirable that a cement retainer employ a back pressure valve which is open while the retainer is being shifted downwardly in a well conduit, thereby allowing the running-in string to fill with whatever fluid may be in the well so as to permit fast run-in speeds and prevent the development of abnormal and damaging pressure differentials across parts of the tool. It is also desirable to utilize a setting tool which is hydraulically operated to set the cement retainer at the desired setting point and that a surface indication be given that the retainer is fully set in a pack-off condition in the well conduit. It is further desirable to provide a means for pressure testing the running-in string for leaks prior to the beginning of cementing operations. Other desirable features in such equipment include the following: the provision of a means for quickly disengaging the setting tool from the

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cement retainer for circulation above the retainer should flash setting of cementing occur in the running-in string, with subsequent re-engagement for further cementing operations upon simple right-hand rotation plus longitudinal movement of the running-in string; the pressure bridge point at the back pressure valve should be located above the upper retainer anchors to eliminate the blow-out problem should the need arise to drill the retainer out of the well conduit; the through bore of the setting tool should be full-opening to allow the performance of further pressure or wireline operations above the cement retainer without having to pull the running-in string out of the well; and the provision of a means for downhole conversion of the cement retainer to a permanent bridge plug.

The present invention, which incorporates all the above-mentioned desirable features, comprises an elongated generally tubular body which is dependently coupled to a hydraulically actuated setting device which forms a lower continuation of a running-in string extending upwardly to the earth's surface. The body has a central passage through which fluids can flow and carries normally retracted slips and packing which are movable to expanded positions in response to the actuation of the setting device for providing an anchored pack-off in a well conduit.

Forming an upper portion of the tubular body above the slips and packing is a housing which contains a flow control device. The flow control device is reciprocally movable therein and includes a pair of closure means which are releasably coupled to one another. The lower closure element is cooperable with a companion seat in the body and initially permits unidirectional flow of fluids through the body passage in an upward direction. The upper closure element is spring pressed but is initially restrained in a position out of engagement with its companion seat.

Fluid pressure responsive means are provided for releasing the connection between the two closure elements. Upon release, the lower closure element is adapted for discharge from the body and the upper closure element is released for coaction with its companion seat to permit unidirectional flow of fluids through the body passage in a downward direction.

The aforementioned setting device is dependently coupled to the body by a means permitting engagement with, or disengagement from each other by clockwise rotation of the running-in string plus longitudinal shifting thereof downwardly or upwardly. The setting device is cooperable with the body in a manner which permits sealably closing the lower end of the running-in string so that it can be pressure tested for leaks.

The setting device is hydraulically operable for moving the aforementioned slips and packing to expanded positions. The fluid pressure required for operating the setting device acts to release the connection between the closure elements in the body. However, the connection between the closure element is released at a fluid pressure in excess of that required to actuate the setting and expand the slips and packing.

A tubular member is provided which can be positioned on the body to sealably close the body passage against fluid flow therethrough.

Novel features of the present invention are set forth

with particularity in the appended claims. The present invention, both as to its structural organization and utility together with further advantages thereof, may be best understood by way of illustration and example of one embodiment when taken in conjunction with the accompanying drawings in which:

FIGS. 1-5 illustrate the present invention schematically during the various phases of operation and use thereof;

FIGS. 6A and 6B are longitudinal sectional views of the cement retainer and setting tool apparatus embodying the present invention and showing the parts in the relative positions they will occupy while the apparatus is being run into the well conduit, FIG. 6B forming a lower continuation of FIG. 6A;

FIGS. 7A and 7B are elevational views in partial section similar to FIGS. 6A and 6B, showing the setting tool and cement retainer with the parts in the relative positions they will occupy when the cement retainer is set in a pack-off condition in the well conduit, FIG. 7B forming a lowering continuation of FIG. 7A;

FIG. 8 is a fragmentary elevational view in partial section illustrating the cooperative relationship of parts embodied in the present invention after the connection between the closure elements is released, the lower closure element being discharged from the body and the upper closure element providing back pressure control;

FIG. 9 is a fragmentary elevational view in partial section similar to FIG. 8 illustrating the cooperative relationship of parts embodied in the present invention when testing the running-in string for leaks;

FIG. 10 is a fragmentary view of the releasable coupling between the setting tool and cement retainer, parts thereof being shown in section for purposes of clarity;

FIG. 11 is an exploded isometric view of the various parts of the flow control device of the present invention; and

FIG. 12 is a fragmentary, sectional view illustrating a means for converting the cement retainer downhole to a permanent bridge plug.

As schematically illustrated in FIG. 1, apparatus which embodies the present invention includes a setting tool A which forms a lower extension of the running-in string 10 to which a cement retainer B is releasably coupled for lowering to a predetermined setting point in a well conduit 11. Cement retainer B has a body 12 having a longitudinally extending passage 13 therethrough. Reciprocally mounted in the passage 13 is a flow control device C which is arranged so that the passage is normally open while the apparatus is being shifted downwardly in the well conduit 11 to allow the running-in string 10 to fill with any fluids which may be in the well conduit.

Cement retainer B is permanently set within well conduit 11 as shown schematically in FIG. 2. An application of hydraulic pressure through the running-in string 10 is effective to actuate the setting tool A and radially expand the upper and lower conduit engaging slip elements 14, 15 and packing element 16 to provide an anchored pack-off in the annular space between the well conduit 11 and the body 12 of the cement retainer. The flow control device C is mounted for reciprocating movement within retainer body passage 13 and includes a lower closure means 17 which holds pressure in excess of the pressure required to actuate the setting tool and set the cement retainer in the well conduit. However, application of such excess pressure will cause the closure means 17 to be discharged from the body 12 and an upwardly biased valve element 18 to be released for back pressure control. Since the lower closure means 17 is released at a pressure in excess of that required to actuate the setting tool, a sudden pressure drop is registered by pump pressure gauges at the rig floor when the closure means is pumped out of the bottom of the retainer, thus giving a positive surface indication that the cement retainer is set.

After setting the cement retainer B, the running-in

string 10 can be pressure tested for leaks as schematically illustrated in FIG. 3. Taking an upward strain on the running-in string 10 while rotating to the right actuates a coupling means 19 between the setting tool A and the cement retainer B to move seal elements 20 above a plurality of body ports 21 to block fluid communication between the interior of the running-in string and the body passage 13. This manipulation closes the lower end of the running-in string 10 to permit pressure testing of the running-in string for leaks.

Cementing operations can be performed as schematically illustrated in FIG. 4. Rotation of running-in string 10 to the right while slacking off is effective to move the seal elements 20 below the body ports 21 and establish fluid communication between the running-in string and cement retainer body passage 13. Cement slurry can be displaced under pressure down through the running-in string, setting tool and cement retainer for discharge into the well conduit 11 below the cement retainer, the slurry acting to open the valve element 18 in the retainer body. Upon completion of cementing operations, back pressure of the cement aids in closing the spring biased valve element 18 to retain the cement therebelow.

Subsequent operations such as perforating may be performed above the cement retainer B after completion of cementing operations as shown schematically in FIG. 5. Rotation of the running-in string 10 to the right while picking up is effective to operate the coupling means 19 and disengage the setting tool A from the cement retainer. The setting tool is full opening so that apparatus such as a perforating gun D can be shifted through the running-in string and setting tool for perforating above the cement retainer B without withdrawing the running-in string from the well conduit 11.

The cement retainer and associated setting tool are adapted for use in conjunction with an upper full bore retrievable packer (not shown) of the type illustrated in the 1960-61 Composite Catalogue of Oil Field Equipment and Services, vol. 2, page 3057. If so used, the running-in string 10 extends downwardly from such a retrievable packer to suspend the apparatus of the present invention therebelow.

The structural details of the apparatus as schematically illustrated in FIG. 1 are shown in detail in FIGS. 6A and 6B. With specific reference to FIG. 6B, the cement retainer B includes a body 12 having a fluid passageway 13 therethrough. The body 12 may be considered as being formed in two elements, namely a tubular mandrel 22 and a flow control housing 23 threadedly coupled to the upper end of the mandrel. The mandrel 22 carries at each end portion thereof opposed, integral, expandable slip members 14, 15 operatively engaged with frusto-conical expanders 24, 25. Positioned around the mandrel 22 and between the expanders is an annular elastomeric packing element 16, each end of the element being bonded to and confined within expandable, anti-extrusion rings 26, 27.

Slip elements 14, 15 each have a plurality of wickers or teeth 28, 29 formed thereon and each slip element is made radially expandable by providing a first series of radially cut slots 30 around the circumference thereof and providing a second series of like slots 31 alternately disposed between the first series, the slots extending from one end of each slip element to points 32 near respective opposite ends of each slip element. Although the slip elements are integrally formed, they have sufficient resiliency to be readily expanded into anchoring engagement with the well conduit wall.

The anti-extrusion rings 26, 27 include skirt portions 33, 34 having series of imbricated fingers 35 with each finger being in overlapping relationship with an adjacent finger as shown in FIG. 6A. This particular design allows the fingers to flex radially outwardly as packing element 16 is foreshortened and expanded, and thereby adapt themselves to the configuration of the well conduit. The

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overlapped relationship of the fingers is maintained during expansion of the packing element so that the skirt portions 33, 34 can be expanded without passages being formed therein through which the elastomeric packing element can cold flow under pressure.

An upper peripheral portion of the tubular mandrel 22 is provided with downwardly facing ratchet teeth 36 which are cooperable with the split ratchet nut 37 received within an annular recess 38 in a setting head 39 to permit the mandrel 22 to move upwardly with respect to the setting head 39 but prevent downward movement of the mandrel with respect to the setting head. The split ratchet nut 37 has a plurality of downwardly diverging tapered surfaces 40 around the outer periphery thereof which cooperate with complementary tapered surfaces around the periphery of recess 38 in the setting head 39 to wedge the split ratchet nut more tightly against the mandrel whenever a downwardly directed force is applied to the mandrel. An annular resilient member 41 within recess 38 maintains a biasing force on the split nut to force it downwardly around the mandrel and prevent backlash as the nut ratchets down on the mandrel during setting of the cement retainer in the well conduit.

The expanders 24, 25 are initially held in inoperative positions by expansible rings 42, 43 fitted tightly within circumferential grooves 44, 45 around the mandrel 22 and engaging the expanders. The upper expansible ring 42 and both slip members 14, 15 are encircled with expansible restraining bands 46, 47, 48 of predetermined strengths for releasably holding these members in their initial positions to allow various members of the cement retainer to be selectively operated in response to setting forces of predetermined magnitudes.

As previously mentioned, forming an upper portion of the retainer body 12 above the slips and packing element it a flow control housing 23 through which body passage 13 continues. As shown in FIG. 6A, the housing 23 includes a lower tubular box portion 49 which is internally threaded for coupling with the mandrel 22, an intermediate tubular portion 50 having external threads formed thereon for releasably coupling the retainer B to the setting tool A, and an upper tubular nose portion 51 having a closed upper end 51a. Ports 21 extend laterally through the wall of the nose portion 51 and provide communication between the body passage 13 and the exterior of the retainer body 12 above the slips and packing element. An O-ring or other suitable seal element 52 seals the threaded joint between the box portion 49 and the mandrel 22 to prevent fluid leakage therethrough.

Internally of the housing 23 is a lower bore 53, an intermediate bore 54, and an upper bore 55 having progressively decreasing diameters. The junctions between the lower and intermediate bores forms a stop shoulder 56 which is spaced above the upper end face 57 of the mandrel 22 to form an internal annular groove 58. The junction between the intermediate and upper bores forms a downwardly facing frusto-conical valve seat 59.

The flow control device C is reciprocally mounted in the housing 23 and includes an upwardly closing valve element 18 and a downwardly acting closure means 17 which is releasably coupled to the valve element. With particular reference to FIGS. 6A and 11, the valve element 18 includes a valve stem or body 62 which carries an annular seal 63. The lower end of the stem 62 abuts the top face of a hub 64 which has a longitudinal bore therethrough. Extending radially outwardly from the hub 64 are a plurality of webs 65 rigidly connecting the hub to an annular guide ring 66 which is slidably received in the annular groove 58. The webs define a plurality of fluid passage spaces 67.

The closure means 17 includes a rod 68 extending upwardly through the bore 69 of hub 64 and into a blind bore 70 formed in the lower end of the stem 62. A frangible pin 71 of predetermined shear valve releasably secures the rod in the blind bore. The rod 68 has formed

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thereon an upwardly facing annular shoulder 72 which abuts the lower face of the hub 64 when the parts are assembled. Formed on the lower end of the rod 68 is an annular piston 73 supporting an upwardly facing annular lip seal 74 which is cooperable with a companion valve seat 75 on the upper end of the mandrel 22.

A compressed coil spring 76 is positioned around the valve stem 62 and its upper end bears against an annular flange 77 on the valve stem and its lower end bears against the upper surface of the webs 65. The spring is initially compressed in an energy-storing condition but is effective when pin 71 is sheared to impart an upward biasing force to the valve element 18 and cause it to close upwardly against its companion valve seat 59.

It will be appreciated that prior to the time when pin 71 is sheared, the entire flow control device C is free to reciprocate between an upper position where the guide ring 66 abuts the stop shoulder 56 and a lower position where the guide ring abuts the upper end face 57 of mandrel 22. The device C is movable to the upper position by an upwardly acting pressure differential thereacross, and in the absence of such pressures will gravitate downwardly to the lower portion. The stop shoulder 56 is formed in a spaced relationship to the valve seat 59 whereby upward movement of the flow control device C will not be sufficient to engage the valve element 18 with the valve seat 59. However, such limited upward travel of the flow control device is sufficient to space the annular lip seal 74 away from the seat 75 and thereby permit fluids to flow upwardly through the body passage 13 as the retainer B is being shifted downwardly in well conduit 11. However, when the setting point is reached and downward shifting of the cement retainer is halted, fluids will not tend to flow upwardly through the body passage 13 and the flow control device C will gravitate downwardly until the lip seal 74 rests against the seat 75 and the guide ring 66 abuts the upper face 57 of the mandrel 22 as shown in FIG. 7. The device C is then in a position whereby a sufficient pressure differential acting downwardly across the effective area S of the closure means 61 can impart a shearing force to pin 71 and cause the pin to shear. The shearing of pin 71 releases the potential energy in the coil spring 76 and the spring acts to impart an upward closing force to valve element 18. Furthermore, when the pin 71 shears, the closure means 17 is itself released and the lip seal 74 will deform radially upwardly to allow the closure means to be pumped downwardly through the seat 75, body passage 13 and out into the well conduit below the cement retainer B as shown in FIG. 8.

As shown in FIG. 6A, the setting tool A includes an inner operating mandrel 80 having a bore 81 there-through, the mandrel being coupled to the lower end of running-in string 10 by a connector sub 82. An annular sleeve piston 83 is slidably disposed about the operating mandrel 80 and is secured to a tubular skirt 84 which extends upwardly over the exterior of an annular head 85 on the connector sub 82. The length of the skirt 84 is such as to provide an expansible pressure chamber 86 between the lower end of the head 85 and upper face of the sleeve piston 83. Suitable O-rings 87, 88 pressure seal the chamber 86. A plurality of ports 89 extend through the wall of the operating mandrel 80 and provide communication between the bore of the mandrel and the pressure chamber 86. Frangible pins 90 releasably hold the sleeve piston 83 and the operating mandrel 80 in the relative position shown in FIG. 6A while the cement retainer B is being lowered to setting depth in the well conduit 11. Extending downwardly from the sleeve piston 83 is a setting sleeve 91 through which setting forces are transmitted from the sleeve piston to the setting head 39 carried by retainer body 12.

Coupled to the lower portion of operating mandrel 80 so as to form an integral part thereof is an annular

collar 92 having internally formed therein a set of special threads 93 which coact with complementary threads 94 on the intermediate portion 50 of the housing 23. As shown in detail in FIG. 10, the threads are double cut, the right-hand cut thread forming a right-hand helical thread track 95 and the left-hand cut thread forming a left-hand helical thread track 96. This particular thread arrangement permits disengagement, engagement or any amount of relative movement between the collar 92 and housing 23 upon the application of either a downward or upward force to the operating mandrel 80 (via the running-in string 10) plus unidirectional rotation of the running-in string either to the right or to the left. Of course, rotation to the right is preferred so that there is no tendency to loosen or uncouple the usual right-hand threaded joints in the running-in string.

A lower section 100 of operating mandrel 80 is internally sized for reception over the tubular nose 51 of housing 23. Internally formed within the lower section are a plurality of annular grooves 101 which receive O-ring seals 102 for sealing between the lower section 100 and the outer surface on the tubular nose 51. Above and adjacent the lower section 100 is an enlarged bore section 103 which provides a fluid passage space 104 between the periphery of the tubular nose 51 and the wall 105 of the enlarged bore section above ports 21. It will be apparent that fluid can flow from the running-in string 10 through passage space 104, ports 21, and into the upper bore 55 of the housing 23 when the seals 102 are below ports 21. However, as shown in FIG. 9, when the mandrel 80 is operated to move seals 102 above ports 21, the lower end of the running-in string is closed and either fluid or gas pressure can be applied to the running-in string 10 to test it for leaks.

FIG. 12 illustrates a means whereby the cement retainer B can be converted down hole to a permanent bridge plug. Cooperable with the upwardly extending tubular nose 51 on the housing 23 is a tubular sleeve valve 110. The bore 111 of the sleeve valve is sized for reception over the nose 51 and has upper and lower internal annular grooves 112, 113 which receive O-rings 114, 115 or other suitable seal means. The O-rings seal between the sleeve valve and the outer peripheral surface of the housing nose 51 above and below ports 21. The areas which the upper and lower seals encompass are equal so that the sleeve valve is pressure balanced and pressure differentials acting across the retainer B from either above or below will not act to move the valve and uncover the ports 21. Near the upper end of the sleeve valve is formed an internal annular groove 116 or other suitable means whereby a fishing tool (not shown) may be attached to the sleeve valve.

In operation the organization of parts is assembled as shown in FIGS. 6A, 6B and the retainer B and setting tool A, suspended from running-in string 10, are lowered into the well conduit 11 to a preselected setting point. As the apparatus shifts downwardly, pressure differentials developed across the closure means 17 will cause the flow control device C to move upwardly and allow such fluids to fill the running-in string. When the setting point is reached, downward shifting of the retainer is halted and the flow control device C will gravitate downwardly to a position whereby the lip seal 74 rests against the seal seat 75 and initially close the retainer body passage 13 to downward flow of fluids therethrough.

To set the retainer in the conduit, hydraulic pressure is applied through the running-in string and acts via the operating mandrel ports 89 on piston 83 and head 85 to expand chamber 86 in the setting tool A. Of course, the pressure also acts via the housing ports 21 on the closure means 17 but the shear member 71 is designed to require a shearing force greater than the product of the pressure required to actuate the setting tool A to fully set the retainer, times the effective area S of the closure means 17. As the chamber 86 expands, the piston skirt-to-

connector sub pins 90 shear and upwardly directed setting forces are applied to the retainer body 12 and downwardly directed setting forces applies to the setting head 39 carried by the retainer body. As shown in FIGS. 7A, 7B these setting forces act to shift the upper and lower slips 14, 15 outwardly over expanders 24, 25 and into anchoring engagement with the conduit wall. The packing element 16 is foreshortened and expanded to form a pack-off between the retainer body 12 and the wall of well conduit 11. Body lock 37 maintains the slips and packing in expanded position and the retainer B will resist dislodgement by pressure differentials acting thereacross from either above or below.

The application of pump pressure through running-in string 10 sufficiently in excess of that required to fully set the cement retainer will act on the closure means 17 to shear the frangible pin 71. The closure means will then be pumped downwardly through body passage 13 and out the bottom of the retainer. The sudden drop in pump pressure applied to the running-in string 10 when the closure means pumps out the bottom of the retainer body gives a positive surface indication that the cement retainer B is set. The upwardly closing valve element 18 is released for back pressure control and the spring 76 imparts an upward biasing force on the valve element and causes it to close upwardly against its companion valve seat 59.

If it is desired to test the running-in string 10 for leaks prior to the performance of cementing operations, the running-in string is manipulated by rotating several turns to the right while picking up to move the seals 102 on the lower portion of operating mandrel 80 above valve housing ports 21 as shown in FIG. 9. This operation sealingly closes the lower end of the running-in string so that it can be pressure tested for leaks.

To place a batch of cement through the retainer, the running-in string is first rotated several turns to the right while slacking off to move the seals 102 on the operating mandrel 80 back below the ports 21. Cement slurry displaced down through the running-in string 10 will pass into the housing 23 via ports 21 and act to open the valve element 18 for passage of the cement slurry through the retainer and into the conduit 11 therebelow. Upon completion of cementing operations, back pressure of the cement slurry and the action of the spring 76 will act to close the valve element to retain the cement below the retainer.

It should be noted that should flash setting of cement start to occur within the running-in string 10, the setting tool A can be quickly and completely disengaged from the cement retainer B by sufficient rotation of the running-in string to the right while picking up. With the disengaged setting tool raised a short distance above housing nose 51 circulation can be established above the retainer. Re-engagement of the setting tool and retainer is effected by lowering the running-in string while rotating to the right.

After completion of cementing operations, subsequent pressure or wireline operations can be performed above the retainer B without time-consuming removal of the running-in string 10 from the well. Since the setting tool A is full-opening, any apparatus which can be shifted through the running-in string can also be shifted through the setting tool. This feature expeditiously allows various wireline services such as perforating, as well as other pressuring operations, to be performed through the running-in string in selected zones above the retainer. The zones can be isolated by the above-mentioned full bore retrievable packer which may be run in conjunction with the cement retainer and setting tool disclosed herein.

If it is desired to convert the cement retainer down hole to a permanent bridge plug, this can be accomplished by dropping the sleeve valve 110 down through the well conduit 11 after the running-in string 10 and setting tool A have been removed from the well. The

sleeve valve will gravitate downwardly and seat over the housing nose 51 to close the housing ports 21 as shown in FIG. 12. The sleeve valve is pressure balanced when seated so that differential pressures acting thereacross from either above or below the retainer will not act to open the valve.

Advantages of the apparatus disclosed are numerous. For example, since the flow control device permits the body passage to remain open while the retainer is being shifted downwardly in the well conduit, fast run-in speeds are permitted and no abnormal pressure differentials are developed across parts of the system. A surface indication is given that the retainer is fully set when the closure means is pumped out the bottom of the retainer. No balls must be dropped through the running-in string which must be later removed by a time-consuming reverse circulation process. The cooperative relationship between the setting tool and cement retainer nose allows pressure testing of the running-in string for leaks. Unidirectional rotation plus longitudinal movement of the running-in string either upwardly or downwardly is effective to position the operating mandrel seals relative to the housing nose ports to permit the above-mentioned testing for leaks as well as placement of cement slurry below the retainer. Disengagement of the setting tool from the retainer for circulation above the retainer with later re-engagement for cementing are also permitted by the same running-in string manipulation.

Furthermore, it will be noted that the pressure bridge point at the back pressure valve seat is well above the upper retainer slips. Therefore, should the need ever arise to drill out the retainer, pressures above and below the retainer will be equilized before the top slips are drilled away so that an upwardly acting pressure differential can never act on the packing element as a piston to blow the drill stem out of the well.

Also, the setting tool is full opening to allow the performance of further operations above the retainer subsequent to the completion of cementing without having to pull the running-in string and setting tool out of the well. The retainer can be converted down hole to a permanent bridge plug by dropping the above-disclosed sleeve valve over the housing nose. The sleeve valve is pressure balanced to hold pressure differentials acting from either above or below the apparatus.

Since certain changes may be made in the above-disclosed apparatus without departing from the scope of the inventive concept involved, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. Apparatus for use in a well conduit comprising: a body having a passage therein; flow control means movably disposed in said passage, said flow control means including first and second closure means, means for releasably connecting said first and second closure means to one another, said first closure means being adapted to close said passage against fluid flow in one direction upon release of said first and second closure means, said second closure means being arranged to be discharged from said passage upon release of said first and second closure means, said releasing means being responsive to fluid pressure to release said first and second closure means.

2. Apparatus as recited in claim 1, the combination further comprising: stop means on said body; abutment means on said first and second closure means cooperable with said stop means for limiting the movement of said first and second closure means when said first and second closure means are releasably connected to one another and ineffective upon release of said first and second closure means to limit movement thereof.

3. Apparatus as set forth in claim 2 and said abutment means being arranged to prevent said first closure

means from closing said passage and arranged to permit said second closure means to close said passage when said first and second closure means are releasably connected to one another.

4. Apparatus for use in a well conduit comprising: a tubular body having a longitudinally extending passage therethrough; means on said body movable to expanded positions to pack-off the annular space between said body and the well conduit; a housing forming an upper portion of said body, and flow control means movably disposed in said housing, said flow control means including first and second closure means, means for releasably connecting said first and second closure means to one another, said first closure means being adapted to close said passage against fluid flow in an upward direction through said passage upon release of said first and second closure means, said second closure means being arranged to be discharged from said passage upon release of said first and second closure means, said releasing means being responsive to fluid pressure in said passage to release said first and second closure means.

5. Apparatus as set forth in claim 4, the combination further comprising: stop means on said housing; abutment means on said first and second closure means cooperable with said stop means for limiting the movement of said first and second closure means when said first and second closure means are releasably connected to one another and ineffective upon release of said first and second closure means to limit movement thereof.

6. Apparatus as set forth in claim 5 and said abutment means being arranged to prevent said first closure means from closing said passage and arranged to permit said second closure means to close said passage when said first and second closure means are releasably connected to one another.

7. Apparatus usable in a well conduit comprising: a body having a longitudinal passage through which fluids can flow; expandable means on said body movable to expanded positions for packing off the annular space between the conduit and body; a housing forming an upper portion of said body above said expandable means; flow control means in said housing, said flow control means including a first and second closure means, releasable means for connecting said closure means to one another, said first closure means being adapted to close said passage against fluid flow therethrough upon release of said closure means from one another, said second closure means being arranged to be discharged from said body upon release of said closure means from one another; and hydraulically operable means releasably coupled to said body for expanding said expandable means, said releasable means being actuated by a fluid pressure in excess of the fluid pressure required to operate said hydraulically operable means.

8. Apparatus usable in a well conduit comprising: a hollow body adapted to be positioned in the well conduit; expandable means carried by said body, said means being movable to expanded positions to block fluid flow in the annular space between the conduit and said body; at least one lateral port in said hollow body above said expandable means; a tubular member slidably received on said hollow body; and seal means between said tubular member and said hollow body for sealably closing said at least one port whereby fluids cannot flow through said body, said tubular member being adapted for insertion into said conduit at the earth's surface for positioning the member on said body.

9. Well tool apparatus for suspension in a well conduit on a tubular running-in string, comprising: a tubular body; casing engaging anchoring and sealing means carried by said body; and setting means releasably coupled to said body, said setting means and body having selectively operable coengageable means to sealingly close the lower end of the running-in string to permit pressure testing of the running-in string for leaks.

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10. Apparatus as in claim 9 and wherein the setting tool has a passage therethrough with a diameter at least as great as the drift diameter of the tubular running-in string whereby any apparatus that may be shifted through the running-in string can also be shifted through the setting means. 5

11. Apparatus as recited in claim 9 and wherein the combination further includes means for releasably coupling said setting means and body, said coupling means being operable upon the application of unidirectional rotary motion plus longitudinal forces to said setting means for selectively engaging or disengaging the setting means and body. 10

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