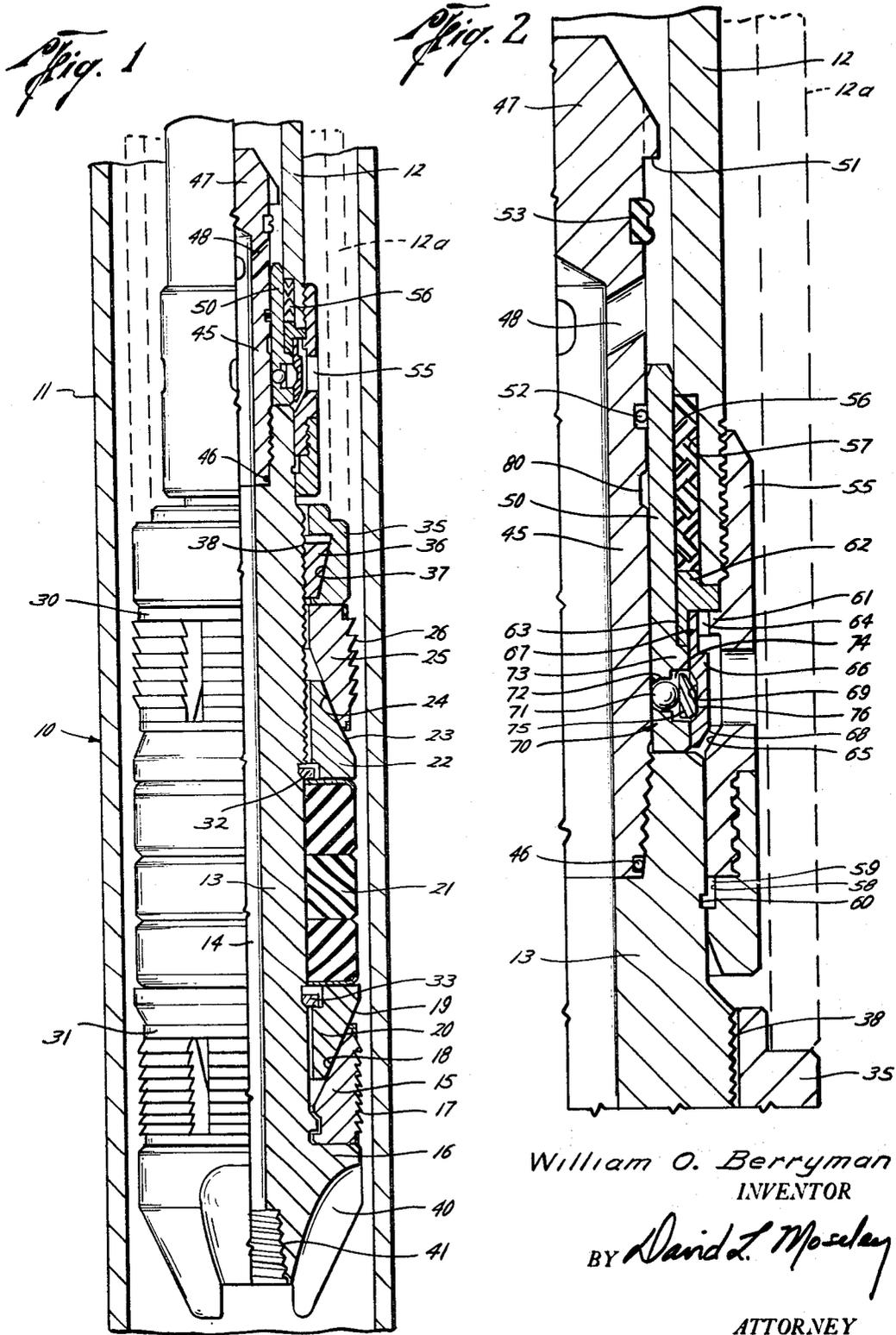


June 11, 1968

W. O. BERRYMAN
CEMENT-RETAINING WELL PACKER

3,387,660

Filed July 7, 1966



William O. Berryman
INVENTOR

BY *David L. Moseley*

ATTORNEY

1

3,387,660

CEMENT-RETAINING WELL PACKER

William O. Berryman, Houston, Tex., assignor to Schlumberger Technology Corporation, Houston, Tex., a corporation of Texas

Filed July 7, 1966, Ser. No. 563,406

12 Claims. (Cl. 156-133)

ABSTRACT OF THE DISCLOSURE

The particular embodiment described herein to illustrate one form which the present invention can take includes a body member having a flow passage and anchors and packing for providing an anchored pack-off in a well bore. A selectively operable, pressure balanced valve sleeve is slidable on an upper end portion of said body member between an upper position closing off said flow passage and a lower position where said flow passage is open above said valve sleeve.

This invention relates generally to subsurface well tools and more particularly to a type of well packer apparatus for use primarily in connection with cementing operations in a well.

To place cement behind a well conduit such as a casing or liner, a type of well packer commonly known as cement retainer may be set by a setting tool into a packed-off condition at a selected level in the well conduit. Cement slurry is then displaced under pressure down through a fluid conducting string, either tubing or drill pipe, which is attached to the retainer, and through the retainer into open hole below the conduit or through conduit perforations. Cement retainers generally have expandable anchors carried by a tubular mandrel to anchor the retainer in the conduit, expandable packing disposed around the mandrel to pack off the annulus between the well conduit and the conducting string, and valving to control fluid flow through the retainer.

Prior art devices of this type have suffered various shortcomings. For example, some devices incorporate a one-way check valve for back pressure control which holds pressure in an upward direction only; if it is desirable to perform a pressure operation above the device, time-consuming steps must be taken to insert another valve for holding pressure acting in a downward direction. Also, many prior art devices have valving located at the lower end of the mandrel; this location is undesirable because pressure differentials acting across the device are not equalized during drill-up before the anchors are released.

Moreover, the connection between the fluid conducting string and the cement retainer has in many instances in the prior art taken the form of a tubular stringer which is inserted into the through bore of the mandrel. This arrangement is undesirable for at least two reasons. First, sedimentation or debris can settle into the bore to an extent that engagement, or re-engagement after disconnection, of the stringer is difficult if not impossible. Secondly, the through bore of the fluid conducting string is not full opening so as to be capable of passing various wireline instruments such as a casing perforator, after completion of a cementing operation.

Accordingly, an object of the present invention is to provide a new and improved cement retainer of the type described wherein the valving is pressure balanced when closed so that pressures acting from either above or below cannot act to open the valving.

Another object of the present invention is to provide a new and improved cement retainer of the type described wherein the valving is located at its upper end so that

2

if the retainer must be drilled out of the conduit, pressures are equalized across the packer element before the anchors are released.

A further object of the present invention is to provide a new and improved cement retainer of the type described wherein the coupling between the cement retainer and the fluid conducting string is constructed and arranged to be full opening, to permit ease of engagement, and wherein the forces develop during pressure operations tending to cause release of the fluid conducting string from the cement retainer are low.

Yet another object of the present invention is to provide a new and improved cement retainer of the type described wherein the valving is simple, easy to operate, free from mechanical difficulties, and inexpensive to manufacture.

These and other objects are attained in accordance with the present invention by providing a well tool having a body with a central passageway therethrough, slip and expander means for anchoring in a well conduit, and packer means expandable for packing-off the annular space between the body and the well conduit. A tubular member on the upper end of the body above the slip and expander means and the packing means has a closed nose portion and port means through its wall to provide a fluid communication to the body passageway. A pressure balanced sleeve valve is positioned on the tubular member and is slidable thereon between first and second longitudinal positions. Seal means between the sleeve valve and the tubular member are effective in one of the said positions to block fluid communication through the port means. Means are provided for releasably coupling the sleeve valve to a fluid conductor string so that longitudinal movement of the string will effect movement of the sleeve valve between its longitudinal positions.

The novel features of the present invention are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood by way of illustration and example when taken in conjunction with the accompanying drawings which:

FIGURE 1 is longitudinal partial sectional view of the present invention with parts in positions they will occupy when the apparatus is moved longitudinally and in a well conduit; and

FIGURE 2 is an enlarged, fragmentary sectional view of the valving of the present invention and the mechanism for coupling the conductor string to the cement retainer.

With reference to FIGURE 1, there is shown a cement retainer designated generally by the numeral 10 positioned within a well conduit 11 and connected to a tubular fluid conducting string 12 extended upwardly to the earth's surface. The parts as shown in this figure are in a "running-in" position so that the apparatus can be lowered into the well conduit 11 to a selected setting depth therein. A tubular sleeve 12a, shown in phantom lines for convenience of illustration, may be the setting sleeve of a conventional hydraulic or mechanical setting tool through which setting forces are applied to the retainer 10 in a well-known manner. Of course, if the retainer is set by a conventional wireline setting tool, it will be appreciated that the setting tool is withdrawn from the well and the conducting string 12 thereafter inserted and connected to the retainer 10.

Essentially, the cement retainer 10 includes a tubular body 13 having a central passageway 14 therethrough. The body 13 carries lower slips 15, whose lower end engages a lower abutment or flange 16 on the body. The outer peripheries of the slips 15 are provided with wickers or teeth 17 adapted to engage in the wall of the well

conduit 11 to anchor the cement retainer against downward movement therein. The inner surfaces 18 of the slips 15 are tapered in a downward and inward direction for slidable engagement with a corresponding external tapered surface 19 on a frusto-conical expander 20 which is slidable on the body. This expander abuts the lower end of a packing element 21 constructed of a pliant, elastomer material, disposed around the body 13, the upper end of the packing element abutting an upper expander 22 having an upward and inwardly inclined external surface 23 engageable with corresponding tapered surfaces 24 on upper slips 25. The upper slips 25 have wickers or teeth 26 on their peripheries which are adapted to engage in the wall of the well conduit 11 to anchor the cement retainer against upward movement therein.

Initially, the slips 15, 25 and the packing element 21 are retained in retracted positions with respect to the body 13. For this purpose, restraining bands 30, 31 may be used which encircle and engage the upper and lower slips to prevent their outward shifting under abnormal forces. Also, stop bands 32, 33 may be received in annular grooves in the body 13 to engage the upper end of the packer element 21 and the lower expander 20 so that if trash or debris should hang on the packer element or the lower expander, they will not move longitudinally relative to the body and cause premature setting. The restraining bands 30, 31 can be constructed of a ductile, stretchable material having a predetermined strength such that the operating sequence of the slips and expanders and the packing element responsive to longitudinally directed setting forces thereon can be controlled.

The upper ends of the upper slips 25 abut an annular setting head 35 which is slidably received on the body 13. A split ratchet nut 36, or other suitable means, is received within an internal tapered recess 37 in the setting head 35 and is cooperable with a plurality of ratchet teeth 38 on an upper portion of the body 13 to permit downward movement of the setting head relative to the body but to prevent converse relative movement therebetween.

A guide member 40 forms an integral part of the lower end of the body 13 to permit ease of insertion of the cement retainer into the well conduit. If desired, a member (not shown) can be secured in the threads 41 at the lower end of the body 13 and function to prevent any debris or "junk" encountered in the well bore from entering the passageway 14 in the body.

A tubular member 45 is threaded into the upper end of the tubular body 13 with a seal element 46 fluidly sealing the threaded connection. A blunt nose portion 47 closes the upper end of the tubular member and a plurality of ports 48 extends through the wall of the tubular member to communicate with its bore.

Referring to FIGURE 2 for detail, a tubular sleeve valve 50 is slidably received on the tubular member 45 for movement between a lower position, as shown, and an upper position where the upper end of the sleeve valve engages a downwardly facing shoulder 51 on the nose portion 47. In the upper position, the sleeve valve 50 closes the lateral ports 48 and suitable seal elements 52, 53 fluidly seal between the valve and tubular member above and below the ports 48. The cross-sectional areas encompassed by these seal elements are substantially the same whereby fluid pressure differences between fluids in the bore of the tubular member 45 and exteriorly of the sleeve valve 50 when the ports 48 are closed cannot be effective as forces tending to move the sleeve valve 50.

The lower portion of the tubular conducting string 12 is formed by a threadedly attached collar 55 which is received over the sleeve valve 50. A suitable seal element 56 is received within a recess 57 in the conducting string 12 to provide a fluid tight connection between the string and the sleeve valve 50.

The lower end portion of the collar 55 has an internal recess 58 which is adapted to receive an annular shear member 59 having a predetermined shear value. A por-

tion of the shear member 59 can engage in a groove 60 in the periphery of the body 13 to releasably secure the lower portion of the conducting string 12 to the body 13. Thus it will be appreciated that the conducting string 12 can form the central mandrel of a mechanical or hydraulic setting tool which can be manipulated from the surface in a well-known manner to apply push-pull forces to the setting head 35 and the body 13, respectively. When the setting forces build to a magnitude sufficient to properly set the retainer 10, the shear member 59 will fail to free the tubular string 12 for separation from the retainer 10.

The collar 55 has an inwardly extending flange 61 which retains a guide ring 62 against the end face of the conductor string 12. The guide ring 62 has a bore which is sized for sliding reception on the sleeve valve 50 and a downwardly extending annular portion 63 which is spaced from the flange 61 to provide an annulus 64 therebetween. The annulus 64 may be considered as extending downwardly below the flange 61 and is terminated by an annular downward and inwardly inclined surface 65 on the collar 55.

A resilient, split latch ring 66 is received within the annulus 64 and is radially movable therein between contracted and expanded positions. The latch ring 66 has an upper annular portion 67 which extends upwardly into the annulus 64 between the portion 63 and the flange 61 to limit inward and outward movement of the latch ring. A lower portion of the latch ring 66 has an upward and outwardly inclined surface 68 which can cooperate with the inclined surface 65 on the collar 55 in a manner whereby upward movement of the collar relative to the latch ring will shift the latch ring toward its fully contracted position. Intermediate the ends of the latch ring 66 is an internal annular recess 69 having inclined surfaces which define the top and bottom of the recess.

In the lower position of the sleeve valve 50, a ball-latch mechanism 70 releasably locks the sleeve valve 50 to the conducting string 12 so that the sleeve valve becomes, in effect, an integral part thereof in this position. The latch mechanism includes a plurality of metal balls 71 movably received within radial holes 72 in a lower enlarged portion 73 of the sleeve valve 50. The radial holes 72 open at their outer ends into an external annular recess 74 intermediate the ends of the enlarged portion. The recess 74 receives a split snap ring 75 having an outer portion 76 arranged to engage within the latch ring recess 69.

When the sleeve valve is in its lower position as shown in FIGURE 2, the balls 71 are urged outwardly by the outer surface of the tubular member 45 and the balls 71, in turn, hold the snap ring 75 in an outer position wherein its outer portion 76 engages in the annular recess 69 in the latch ring 66. Any downward movement of the sleeve valve 50 relative to the collar 55 will cause the latch ring 66 to be wedged inwardly into a more forceful engagement with the snap ring 75. With the parts thus latched together and the seal element 56, 52 positioned therebetween, the pressures of fluids being displaced through the cement retainer will act upwardly on the internal cross-sectional area of the conducting string 12. However, the pressures are also acting downwardly on the cross-sectional area of the upper portion of the sleeve valve 50. Thus, it will be appreciated by those skilled in the art that with the structural arrangement of the present invention, the effective area over which fluid pressure can act tending to disengage the conducting string 12 from the body 13 is the relatively small area encompassed by the seal element 52 between the sleeve valve 50 and the tubular member 45. It will be further appreciated that the through bore of the guide ring 62 continues the full bore of the conducting string 12 so that various wireline instruments can be lowered through the string after its disconnection from the cement retainer 10.

When the sleeve valve 50 is moved to its upper position, the metal balls 71 are placed adjacent an annular recess 80 in the exterior of the tubular member 45 and are free to move inwardly into the recess. When the balls move inwardly, the snap ring 75 also can move inwardly and disengage from the latch ring recess 69. When this occurs, the conducting string 12 is released from the sleeve valve 50 and can be moved upwardly within the well bore.

OPERATION

In operation, the parts are assembled as shown in FIGURES 1 and 2 and lowered into a well conduit 11 to a selected setting point. With the sleeve valve 50 in its lower position, fluids in the well conduit 11 can bypass into the conducting string 12 via the body passageway 14, the bore of the tubular member 45 and the ports 48, thereby permitting fast run-in speeds.

At the setting depth, a suitable mechanism (not shown) of a type commonly used in the art can be operated to apply upwardly direct setting forces to the body 13 and to apply downwardly direct setting forces through the setting sleeve 12a to the setting head 35. Such forces will cause the setting head 35 to move downwardly relative to the body 13, thereby shifting the slips 15, 25 over their respective expanders toward one another, and, due to the arrangement of the inclined surfaces therebetween, outwardly of the body 13 into anchoring engagement with the well conduit wall. As the slips shift, the restraining bands 30, 31 can yield and stretch in manner to permit uniform, controlled expansion of the slips. The setting forces applied to the slips 15, 25 are also applied through the expanders 20, 22 to the packing element 21 to compress and expand it outwardly into sealing engagement with the well conduit wall. As the packing element expands, the stop bands 32, 33 are displaced from their respective body grooves to permit relative movement between parts.

When the slips and packing element are fully expanded, the interengagement between the ratchet nut 36 and the teeth 38 on the body 13 will maintain the parts in their expanded positions. The shear member 59 between the collar 55 and the body 13 may be designed to fail in response to setting forces of slightly greater magnitude than those required to fully expand the slips and the packing element. When the member 59 fails, simple up and down movement of the conductor string 12 will be effective to move and operate the sleeve valve 50.

After setting of the cement retainer is completed, fluids under pressure can be displaced down through the conductor string 12, the fluids passing through the ports 48, the body passageway 14 and then into the well conduit below the cement retainer 10. When the desired volume of fluid has been placed in this manner, the conductor string 12 can be moved upwardly to close the sleeve valve 50 for back-pressure control.

As the conductor string is moved upwardly, the sleeve valve 50 will also move upwardly inasmuch as it is latched thereto by the latch mechanism 70. The sleeve valve will move until its upper end engages the downwardly facing shoulder 51 on the nose portion 47 and the metal balls 71 are adjacent the recess 80. At this point the balls are free to move inwardly into the recess, thereby permitting the split snap ring 75 to retract from the latch ring recess 69. The conductor string 12 will then come free, leaving the sleeve valve in its upper position and spanning the seal elements 52, 53 to block fluid communication through the ports 48. Since the effective pressure area encompassed by the seals 52, 53 are substantially the same, the sleeve valve 50 is pressure balanced and will not move longitudinally due to fluid pressures acting through the ports 48 or from the exterior of the sleeve valve. Thus, it will be appreciated that whenever the conductor string 12 is disengaged from the cement retainer 10, the cement retainer is automati-

cally converted to a permanent bridge plug which will hold fluid pressures acting from either above or below.

If it is desired to re-engage the conductor string 12 with the cement retainer 10 for further pressuring operations, the string is merely lowered until its lower portion formed by the collar 55 is received over the tubular member 45 and the sleeve valve 50. When the annular portion 63 of the guide ring 62 abuts the upwardly facing shoulder provided by the enlarged portion 73 of the sleeve valve 50, the latch ring recess 69 is positioned adjacent the snap ring 75 and downward forces due to conductor string weight on the sleeve valve will force the metal balls 71 outwardly of the recess 80. The snap ring 75 is thereby moved outwardly into the latch ring recess 69 to again latch the sleeve valve to the conductor string 12. Then the sleeve valve can be moved to its lower position wherein the ports 48 are open.

In the eventuality that the sleeve valve 50 should be pushed downwardly to its lower position ahead of the guide ring 62 and without the snap ring 75 engaging in the latch ring recess 69 as previously described, the latch mechanism 70 can still engage in the following manner. The latch ring 66, being radially expandible, can expand within the annulus 64 to an inside diameter sufficient to pass over the snap ring 75. After passing over the snap ring 75, the latch ring will flex inwardly to its normal position for interlocking engagement therewith.

A new and improved well apparatus has been disclosed for well bore pressuring operations and includes pressure balanced valving for pressure control, the valving being operated by simple up and down motion of a fluid conductor string. The location of the valving permits pressure equalization during drill-up, and the valving is simple and reliable in operation. Forces develop during well pressuring operations tending to disengage the conductor string from the retainer are low and the full bore of the conductor string is maintained throughout.

Since certain modifications or changes may be made in the disclosed embodiment without departing from the inventive concepts involved, it is intended that all matter contained in the foregoing description are shown in the attached drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A cement retainer comprising: a tubular body member having a bore therein and port means communicating with said bore; anchor means and packing means on said body member below said port means for respectively anchoring in a well bore and packing-off the cross-section of the well bore; and selectively operable valve means for controlling fluid flow through said bore, said valve means including a sleeve member on said body member adjacent said port means and slidable on said body member between an upper position wherein said sleeve member spans said port means and a lower position wherein said port means is open above said sleeve member.

2. A well tool comprising a tubular member; means for anchoring said tubular member in a well conduit, said tubular member extending to a location above said anchoring means; port means in said tubular member; valve means slidably received on said tubular member for movement between a first position wherein said port means is open and a second position adjacent said port means; seal means between said valve means and said tubular member fluidly sealing therebetween when said valve means is in said second position to block fluid flow through said port means; latch means on said valve means adapted to releasably connect said valve means to an operating member during movement between said first and second positions; and means on said tubular member for releasing said latch means from an operating member when said valve means is in said second position.

3. The well tool of claim 2 wherein said tubular member has a closed end portion, and said port means ex-

tend through the side walls of said tubular member.

4. The well tool of claim 3 wherein said latch means includes radially directed recesses in said valve means, and movable means received in said recesses.

5. In combination, a tubular member; means for anchoring said tubular member against longitudinal movement in a well conduit; a fluid conducting member receivable over said tubular member; port means in said tubular member; valve means between said conducting member and said tubular member slidably received on said tubular member for movement between spaced positions; first seal means between said valve means and said tubular member effective in one of said positions to block fluid flow through said port means; second seal means between said valve means and said fluid conducting member effective in the other of said positions to prevent fluid leakage between said valve means and said fluid conducting member; and means for connecting said conducting member to said valve means in said other position whereby longitudinal movement of said conducting member can effect movement of said valve means and whereby force due to fluid pressure in said fluid conducting member acting on said sleeve member is transmitted to said conducting member itself.

6. The combination recited in claim 5 wherein said connecting means includes latch means releasably coupling said conducting member to said sleeve valve so that said conducting member can be selectively disconnected from said sleeve valve.

7. The combination recited in claim 6 wherein said latch means includes a recess in said valve means, movable means in said recess, and means on said conducting member selectively engageable with said movable means.

8. In combination, a tubular member having a passageway; means for anchoring said tubular member against longitudinal movement in a well conduit; valve means for controlling fluid flow through said passageway, said valve means including a sleeve member slidably arranged on said tubular member; a fluid conducting member adapted to be received on said sleeve member and to operate said valve means by effecting movement of said sleeve member between first and second spaced positions; and latch means between said sleeve member and said conducting member for connecting said conducting member to said sleeve member in one of said positions and for releasing said conducting member from said sleeve member in the other of said positions.

9. The combination recited in claim 8 wherein said passageway includes laterally extending port means in

said tubular member, said port means communicating with said conducting member when said sleeve member is in said one of said positions, said sleeve member closing off said port means when said sleeve member is in said other of said positions.

10. The combination recited in claim 9 further including seal means fluidly sealing between said sleeve member and said tubular member when said sleeve member is in said other of said positions, said seal means being arranged whereby fluid pressure differentials will not be effective as forces tending to move said sleeve member to said one of said positions.

11. The combination recited in claim 8 wherein said latch means includes recess in said sleeve member, means in said recesses movable between inner and outer positions, and means on said conducting member engageable with said movable means only when said movable means is in said outer position.

12. A well tool comprising: a tubular body member having a bore therein; means closing the upper end of said bore; port means extending through the wall of said body member and communicating with said bore; anchor means and packing means on said body below said port means for respectively anchoring in a well conduit and packing off the annulus between said body member and surrounding wall of the well conduit; valve means for controlling fluid flow through said bore and said port means including a sleeve member slidably arranged on said body member for movement between a lower position where said port means is open and an upper position where said port means is closed; a fluid conducting member adapted to be received on said sleeve member to move said sleeve member between said positions; and latch means for connecting said sleeve member to said conducting member when said sleeve member is moved to said lower position and for disconnecting said sleeve member and conducting member when said sleeve member is moved to said upper position.

References Cited

UNITED STATES PATENTS

1,889,772	12/1932	Campbell	166—152
2,776,015	1/1957	Bielstein	166—133
3,131,765	4/1964	Myers	166—133
3,164,210	1/1965	Lewis	166—133
3,180,420	4/1965	Manson et al.	166—133

JAMES A. LEPPINK, *Primary Examiner.*