

June 11, 1968

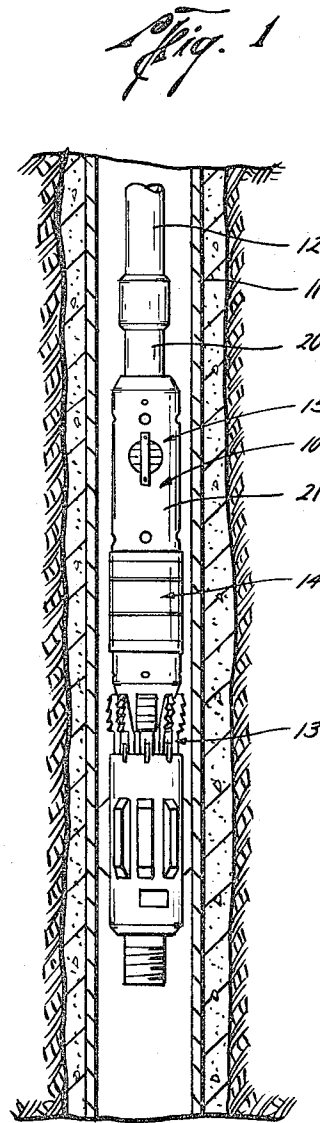
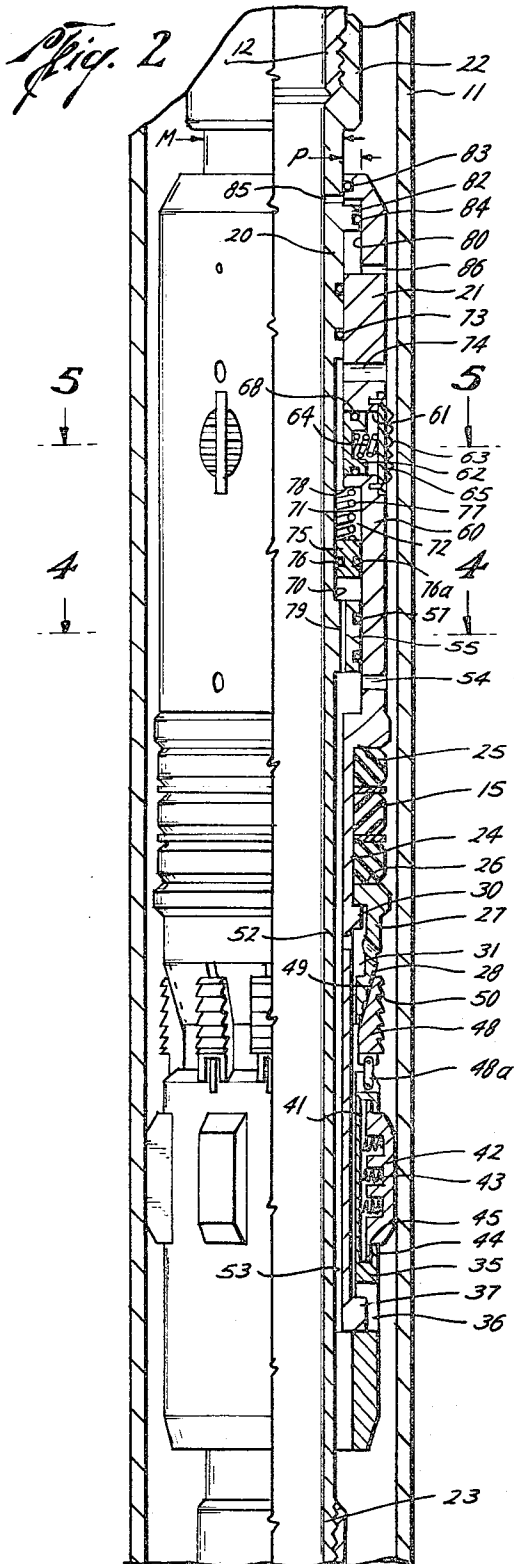
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WELL PACKER APPARATUS

Filed Aug. 3, 1966

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Fig. 3

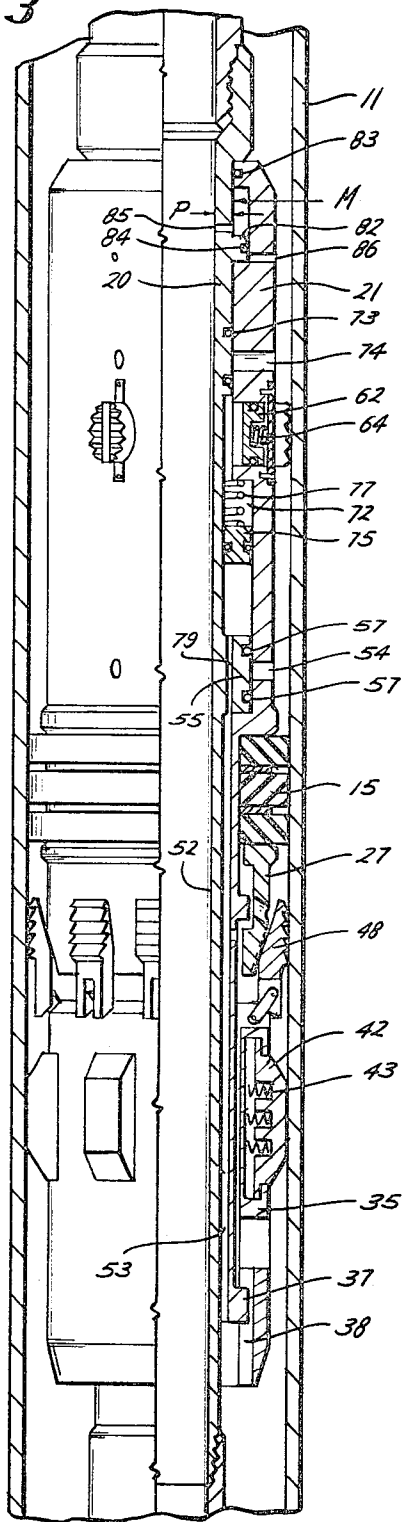


Fig. 4

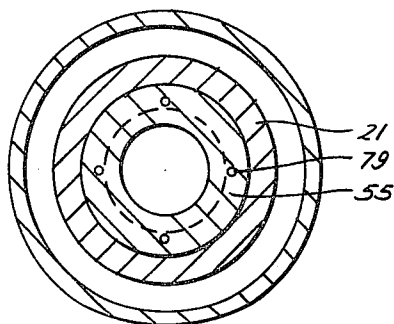


Fig. 5

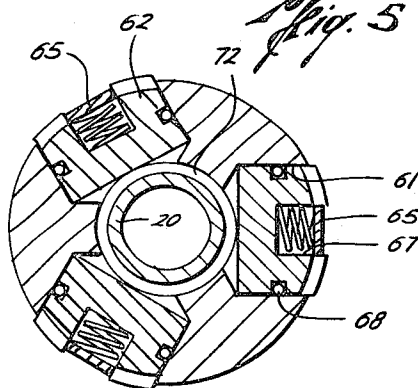
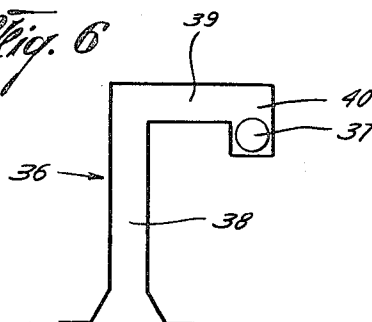


Fig. 6



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WELL PACKER APPARATUS

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Filed Aug. 3, 1966, Ser. No. 570,079

7 Claims. (Cl. 166—129)

This invention relates generally to subsurface well tools and more particularly to a well packer apparatus adapted to be positioned in a well conduit and anchored against longitudinal movement therein.

A number of retrievable well packers for packing off a well conduit are lowered on a tubular string into the well conduit, anchored against downward movement by slips and expanders and anchored against upward movement by hydraulically actuated gripping pistons. A fluid bypass passage is generally provided to permit rapid shifting of the packer within the well conduit. With the slips set and the bypass passage closed, fluids are displaced under pressure through the tubular string and the well packer and into the well conduit below the packer for performing various pressure operations such as squeeze cementing, acidizing or hydraulic fracturing. The pressures developed actuate the gripping pistons.

It is desirable to isolate the gripping pistons of the above described type of well packer from direct communication with well fluids which pass within and through the packer during its descent into a fluid filled well bore. Such isolation is desirable to prevent pressure surges which are often developed from effecting outward movement of the gripping pistons until their wickers or teeth engage and drag along well conduit wall, an occurrence which can cause the wickers or teeth to be dulled or damaged to an extent that they will not function properly. Moreover, piston isolation is desirable so that foreign substances such as trash or cuttings in the well fluids cannot enter into the piston mechanism to foul or possibly render it inoperative.

Accordingly, an object of the present invention is to provide a new and improved well packer apparatus constructed and arranged such that the gripping pistons are isolated from foreign substances in the well fluids while lowering into the well conduit.

Another object of the present invention is to provide a new and improved well packer apparatus constructed and arranged such that possibilities are minimal of premature operation of the gripping pistons due to pressure surges within the packer while lowering into a well conduit.

Yet another object of the present invention is to provide a new and improved well packer apparatus which is effective, simple and reliable in operation.

These and other objects are attained in accordance with the present invention by providing an apparatus comprising inner and outer tubular members telescopically movable between spaced longitudinal positions. The inner member is adapted for connection to a tubular string extending upwardly to the earth's surface and means are provided for anchoring the outer member against longitudinal movement in a well conduit. The anchoring means including hydraulically operable means is movable outwardly of the outer member to grip a well conduit wall. A first passageway is provided between said members through which fluid can bypass and a second passageway communicates with both the first passageway and the hydraulically operable means. Movable barrier means is contained in the second passageway, and valve means are provided between the members for selective bypass of fluids through the first passageway.

The novel features of the present invention are set forth

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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 of a preferred embodiment illustrated in the accompanying drawings in which:

FIGURE 1 is an elevational view of a well packer which embodies the principles of the present invention shown in connection with a well;

FIGURE 2 is a longitudinal sectional view of the present invention with parts in positions they will occupy when the apparatus is moved longitudinally in a well conduit;

FIGURE 3 is a longitudinal sectional view of the present invention with parts in positions they will occupy when the apparatus is anchored against the longitudinal movement in the well conduit;

FIGURE 4 is a cross-section taken on line 4—4 of FIGURE 2;

FIGURE 5 is a cross-section taken on line 5—5 of FIGURE 2; and

FIGURE 6 is a developed plan view of the J-slot and lug control mechanism utilized in the present invention.

Referring now to FIGURE 1, a well packer 10 is shown suspended within a well conduit 11 on a tubular string 12 extending to the earth's surface. The well packer 10 has a lower anchor assembly 13 adapted, when activated, to anchor against downward movement in the well conduit 11, a packing assembly 14 adapted, when expanded, to pack off in the well conduit, and a hydraulically operable gripping assembly 15 which is adapted when activated, to anchor against upward movement in the well conduit.

Referring to FIGURE 2 for details of the packer 10 with parts thereof in "running-in" positions, a tubular anchor body 21 is telescopically disposed within a tubular anchor body 21 for sliding movement therein. The mandrel 20 extends throughout the full length of the packer and a threaded box portion 22 at its upper end is adapted for connection with the tubular string 12 and its lower end has a threaded pin portion 23 to which a section of pipe or another well tool can be connected.

The anchor body 21 has a reduced diameter tubular section 24 around which the pliant, elastomer packing assembly 14, having rings 15 made of rubber or rubber-like material is mounted. The upper end of the packing assembly 14 engages a downwardly facing annular shoulder or abutment 25 and the lower end engages an upwardly facing annular abutment 26 which forms the upper end of a typical expander member 27. The expander member 27 has downwardly and inwardly inclined outer surfaces 28 thereon and is retained for limited longitudinal movement relative to the anchor body by an annular flange 30 which engages in an internal annular recess 31 in the expander member, the bore of the expander being sized for sliding movement on the reduced section 24 of the anchor body.

Movably mounted on the tubular section 24 of the anchor body 21 is a tubular drag block and slip carriage member 35. A typical J-slot 36 is formed in the lower end of the carriage member 35 and cooperates with a lug 37 extending outwardly from the lower end of the tubular section 24 to permit control of relative movement between the carriage member 35 and the anchor body 21. The J-slot 36, shown in developed view of FIGURE 6, has a longitudinally extending segment 38, a horizontal segment 39 and a relatively short vertical segment 40 in which the lug 37 engages when the parts are in a "running-in" position as shown in FIGURE 2.

The carriage member 35 has a plurality of circumferentially spaced, radially directed recesses 41 in its periphery, each of the recesses receiving a drag block 42. The drag blocks are urged outwardly by springs 43 into frictional engagement with the well conduit wall and function to retard movement of the carriage member 35 in a conventional manner. Outward movement of the drag blocks

42 is limited by coengaging tangs 44, 45 on the carriage member and the drag blocks respectively.

A plurality of the slip segments 48 are movably mounted on the upper end of the carriage member 35 by a plurality of links 48a. Each of the slip segments has upwardly and outwardly inclined inner surfaces 49 which slidably engage the inclined surfaces 28 on the expander member 27 in a manner whereby relative movement between the slip segments and the expander member will cause outward shifting of the slip segments to engage the well conduit wall. A conventional tongue and groove connection between each slip segment and the expander member 27 may be provided so that relative movement between the slip segments and the expander member will effect movement of the slip segments to and from the wall of the conduit 11. Wickers or teeth 50 on the peripheral surface of each slip segment 48 are adapted to bite into the conduit wall and anchor the well packer 10 against downward movement therein.

A lower portion 52 of the mandrel 20 has its outer surface laterally spaced from the inner wall surface of the tubular section 24 and provide an annular fluid bypass passageway 53 extending from the lower end of the well packer to a plurality of lateral ports 54 through the wall of the anchor body above the packing assembly 14. The mandrel 20 has an enlarged portion adjacent the upper end of the passageway 53 to form a valve head 55. Seal elements 57 are received in peripheral grooves around the valve head and are normally spaced above the ports 54 when the parts are in their "running-in" positions. When the mandrel 20 is moved downwardly relative to the anchor body 21, the valve head 55 is positioned adjacent the ports 54 and the seal elements 57 are positioned above and below the ports 54 to block fluid flow therethrough.

An upper portion 60 of the anchor body 21 has a plurality of radial cylinders of bores 61 therein, each of which receives a movable gripping piston 62 having wickers or teeth 63 on its outer face adapted to anchor the well packer against upward movement when engaged with the well conduit wall. Of course, it will be appreciated that although a single radial series of gripping pistons is shown, several radial series can be used which can be either vertically aligned or circumferentially staggered. The gripping pistons 62 are pressed inwardly to retracted positions by springs 64 which bear against retainer bars 65 extending across the faces of the pistons and secured on both sides of the pistons to the anchor body 21 by screws or other suitable fastening means. As shown in FIGURE 5, each bar 65 fits within a diametrical slot 67 in the face of a respective piston to prevent the piston from turning in its cylinder and thereby insuring that the teeth 63 are properly oriented in the direction they will hold. Seal elements 68 encircle each piston 62 to fluidly seal between the pistons and their respective cylinders.

The mandrel 20 is formed with an external annular recess 70 behind the gripping pistons 62 and the anchor body 21 has an internal annular recess 71, the recesses providing a chamber 72. Upper seal elements 73 are normally positioned above a plurality of lateral ports 74 when the parts are in their "running-in" positions so that the chamber 72 is vented and in communication with the well annulus. In this manner, fluid pressures in the chamber 72 and the well annulus are permitted to equalize as the packer is shifted longitudinally in the well bore.

An annular, floating barrier member 75 is movably received in the chamber 72 and has seal elements 76, 76a fluidly sealing between its inner and outer surfaces and the mandrel 20 and the anchor body 21, respectively. A spring 77 encircles the mandrel 20 with its upper end engaging a shoulder 78 at the upper end of the recess 71 and its lower end pressing against the barrier member 75 to yieldably resist upward movement of the barrier member 75 within the chamber 72.

A plurality of axially directed, radially spaced ports 79 extend longitudinally through the valve head 55 and function at all times to communicate the bypass passageway 53 with the chamber 72 below the barrier member 75. Thus, it will be appreciated that fluid pressures within the bypass passageway 53 will be transmitted through the ports 79 to the fluids within the chamber 72 below the barrier member 75 and that the barrier member will transmit pressures to the fluids within the chamber 72 immediately behind the gripping pistons 62. It will also be appreciated that the barrier member 75 will function to isolate the gripping pistons 62 from trash or other debris that may be in the fluids passing through the bypass passageway 53. Moreover, the ports 79 will function to choke fluid movement from the bypass passageway 53 into the chamber 72 should a pressure surge occur within the bypass passageway while the packer is being run into the well bore, thus assuring that any unanticipated pressures within the chamber 72 will be vented therefrom through the equalizing ports 74 and will not act to prematurely operate the gripping pistons 62.

An internal annular recess 80 in the anchor body 21 above the cylinders 61 forms a chamber which slidably receives an annular bias piston 82 which is integrally formed on the mandrel 20. Seal elements 83, 84 fluidly seal between the mandrel 20 and the anchor body 21. The upper face of the bias piston 82 is in fluid communication with the bore of the mandrel 20 via mandrel ports 85, and the lower face of the piston 82 is in fluid communication with the well annulus via body ports 86. It will be appreciated that any fluid pressures in the mandrel bore greater than fluid pressures in the annulus will be effective as a downward force on the bias piston 82 and thus on the mandrel 20, tending to move the mandrel 20 downwardly. The effective area P of the bias piston 82 can be made to have a value relative to the effective area M of the mandrel 20 such that the forces on the mandrel 20 during the performance of pressuring operations will be substantially balanced. In this manner, the bypass passageway 53 will remain closed during such operations and can be easily opened by upward pull on the tubular string 12 when desired.

In operation, the parts are assembled as shown in FIGURE 1 and lowered into the well on the tubular string 12 to a desired setting depth. During lowering, the lug 37 is in the short vertical segment 40 of the J-slot 36 to prevent relative movement between the carriage member 35 and the anchor body 21, thereby preventing actuation of the slips 48 and the packing means 14. Also, the seal elements 57 on the mandrel 20 are spaced above the bypass ports 54 so that the bypass passageway 53 is open for bypassing fluids around the packing assembly 14. The gripping pistons 62 are in retracted positions and the chamber 72 behind the pistons is vented to the well annulus by the body ports 74. Thus, any pressure surges which may be developed within the chamber 72 as previously described will not tend to prematurely actuate the gripping pistons 62. The barrier member 75 functions to completely isolate the gripping pistons 62 from trash or other foreign matter which may be in the fluids bypassing through the bypass passageway 53.

When setting depth is reached, the well packer is halted. The tubular string is manipulated to free the lug 37 from the slot segment 40 of the J-slot 36 and then rotated a part turn by right hand torque to move the lug 37 into the long segment 38 of the J-slot, the drag blocks 42 frictionally resisting turning movement of the carriage member 35. Then the string 12 can be moved downwardly to move the mandrel 20 and the anchor body 21 downwardly relative to the carriage member 35 which is held stationary in the well conduit 11 by the frictional engagement of the drag blocks 42 therewith.

The mandrel 20 can move downwardly relative to the carriage member 35 until the bore portion 22 engages the top of the anchor body 21, this movement positioning the valve head 55 adjacent the bypass ports 54 and the seal

elements 57 to block fluid flow therethrough. Also, the seal elements 73 are positioned to close the chamber vent ports 74 and the chamber 72 remains in communication with the passageway 53 via the valve head ports 79.

Further downward movement of the mandrel 20 causes the anchor body 21 to move downwardly relative to the carriage member 35 and the expander member 27 inside the slips 48 to expand them into anchoring engagement with the conduit wall. Continued downward movement of the anchor body 21 serves to compress and expand the packing means 14 into sealing engagement with the conduit wall and provide an annulus seal between the tubular string 12 and the conduit 11.

Fluids under pressure can now be displaced downwardly through the tubular string 12, the mandrel 20 and into the conduit 11 below the well packer 10. The pressure of the fluids is transmitted through the bypass passageway 53 and the valve head ports 79 into the space below the barrier member 75. The barrier member 75 will transmit such pressures to fluids in the chamber 72 behind the gripping pistons 62. Pressure differentials between these fluid pressures and the pressures of fluids in the well annulus will act on the pistons and, overcoming the force of the springs 64, will move the pistons outwardly into gripping engagement with the conduit wall to anchor the well packer against upward movement. Of course, the barrier member 75 will move upwardly against the bias of the spring 77 as the gripping pistons 62 are shifted outwardly. The barrier member 75 continues to isolate the gripping pistons 62 and it will be appreciated that fluids such as cement slurry being displaced through the well packer cannot migrate into the chamber 72 and there harden to an extent which might prevent retraction of the gripping pistons.

Pressures of the fluids also act through the mandrel ports 85 on the upper face of the bias piston 82 and the pressure difference between these pressures and the hydrostatic fluid pressures in the annulus will be effective as a downward force on the mandrel 20 insuring that the bypass passageway 53 remains closed during pressuring operations.

When it is desired to release the packer, fluid pressures in the tubular string 12 are relieved to equalize pressures across the gripping pistons 62. The springs 64 then cause the pistons to retract and release. Pressures are also equalized across the bias piston 82 and the mandrel 20 can be moved upwardly relative to the anchor body 21 by upward pull on the tubular string 12. This movement will open the bypass ports 54 and move the expander 27 upwardly to release the slips 48. Compression on the packing assembly 14 is also released and the packing rings will normally retract due to their inherent resilience.

Any fluids such as cement slurry or acid can be reverse circulated from the tubular string 12 and the entire bore of the mandrel 20. With the packing assembly 14 retracted, fluid can be circulated between the outer surfaces thereof and the conduit wall, around the lower end of the mandrel 20 and upwardly through the mandrel 20. Even if the packing means has not retracted, fluid can be circulated through the annulus, the bypass passageway and ports 53, 54, around the lower end of the mandrel 20 and up through the mandrel bore. Thus, in either event, full mandrel circulation is permitted so that no undesired substances remain within the well packer 10.

It will now be apparent that anew and improved well packer has been disclosed wherein the gripping pistons which anchor the packer against upward movement in a well conduit are isolated from foreign matter that may be in the well bore fluids. The possibilities that pressure surges developed in the packer while "running-in" are minimal and active forces due to pressures developed during pressuring operations will not open the packer bypass. The new and improved well packer is effective and simple to operate.

Since certain changes may be made in the embodiment disclosed without departing from the inventive concept, it

is intended that all matter contained in the foregoing description or shown in the attached drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. Apparatus for use in a well comprising: inner and outer tubular members telescopically movable between spaced longitudinal positions, said inner member being adapted for connection to a tubular string extending to the earth's surface; hydraulically operable means for anchoring said outer member in a well conduit; a first passageway between said members through which well fluids can bypass; a second passageway in said members communicating with said hydraulically operable means; valve means between said members operable when said members are in one of said positions to prevent bypass of fluids through said first passageway; means communicating said first and second passageways whereby fluid pressure can act through said passageways and communicating means to operate said hydraulically operable means; and movable barrier means in said second passageway.

2. The apparatus of claim 1 further including another valve means between said members operable only when said members are in another of said positions for communicating said second passageway with the well annulus whereby fluid pressures in said second passageway and the well annulus can equalize.

3. The apparatus in claim 1 wherein said barrier means includes a piston means movable responsive to fluid pressures in said passageways.

4. The apparatus of claim 3 further including biasing means engaging said piston means for yieldably resisting movement of said piston means.

5. A well packer comprising: inner and outer tubular members telescopically movable between extended and contracted relative positions, and said inner member being adapted for connection to a tubular string of pipe; packing means and anchor means on said outer member for respectively packing off and anchoring the members in a well conduit, said anchor means including hydraulically operable gripping pistons; a first passageway between said members; first port means in said outer member registering with said first passageway when said members are in one of said positions so that well fluids can bypass through said first passageway and said port means; a second passageway in said members communicating with said gripping pistons; first valve means between said members operable when said members are in the other of said positions to block the bypass of fluids through said port means; means communicating said first and second passageways whereby fluid pressure can act through said passageways and said communicating means to operate said gripping pistons; and barrier means movably received in said second passageway, said barrier means being effective to transmit fluid pressures therein while preventing any substantial fluid movement therethrough.

6. The well packer of claim 5 wherein said barrier means comprises a piston means; and seal means between said piston means and the wall surfaces of said second passageway.

7. The well packer of claim 5 further including second port means in said outer member communicating with said second passage means; and second valve means between said members for selectively closing said second port means.

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