Dec. 29, 1964 L. E. PERKINS 3,163,225

WELL PACKERS

Filed Feb. 15, 1961 3 Sheets-Sheet 1

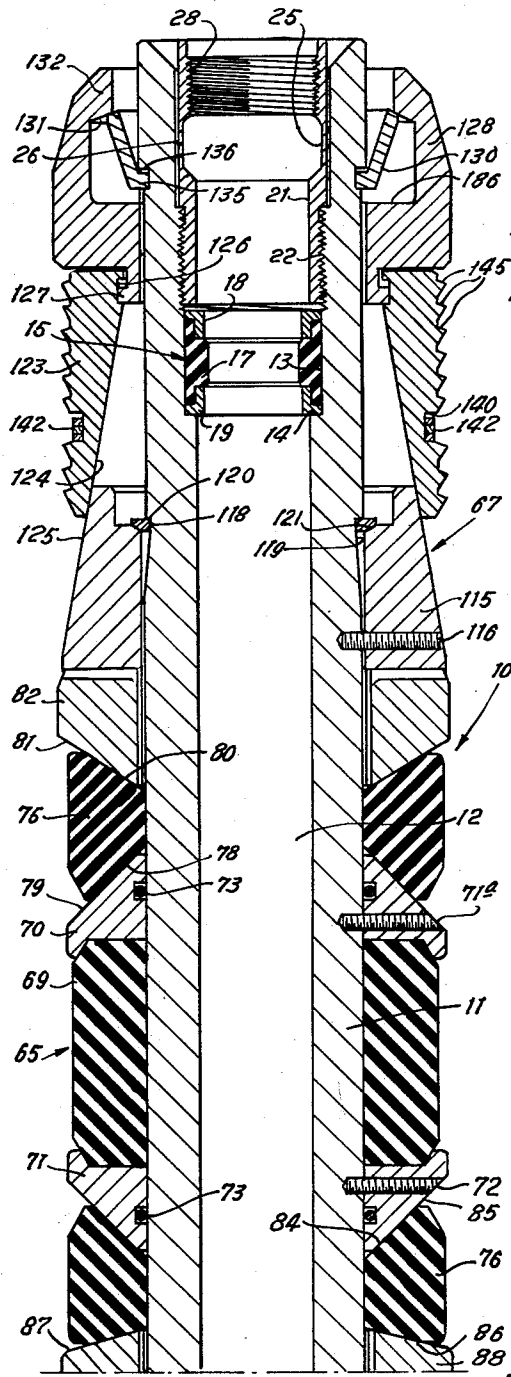


Fig. 1

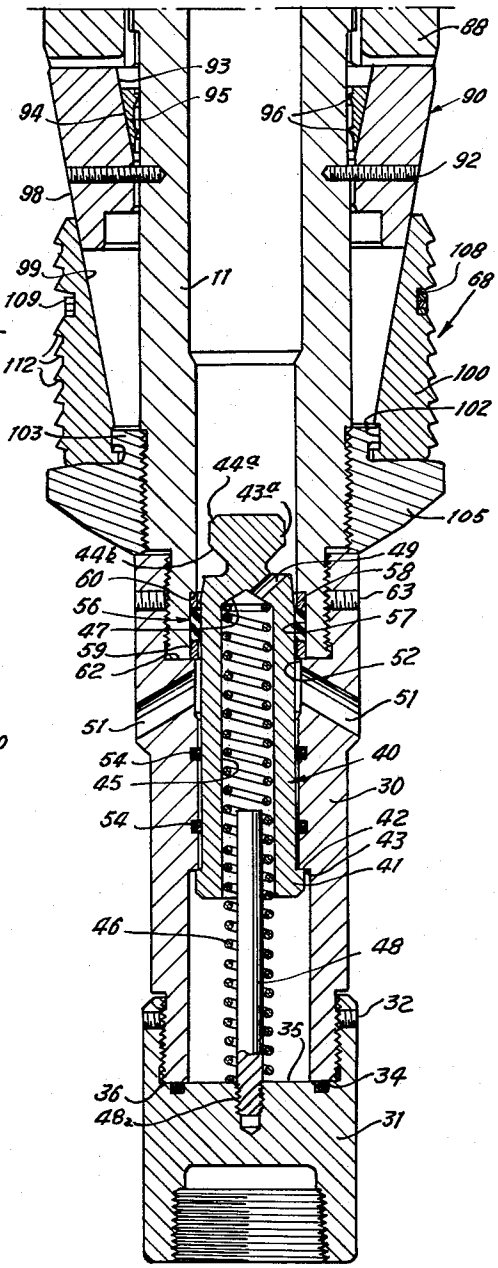


Fig. 2

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Dec. 29, 1964 L. E. PERKINS 3,163,225

WELL PACKERS

Filed Feb. 15, 1961 3 Sheets-Sheet 2

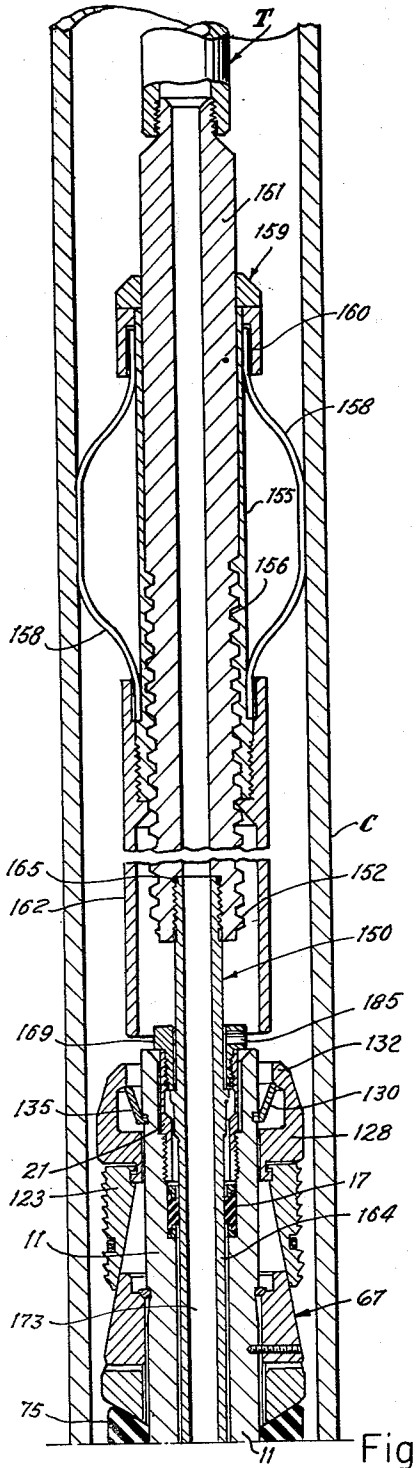


Fig. 3

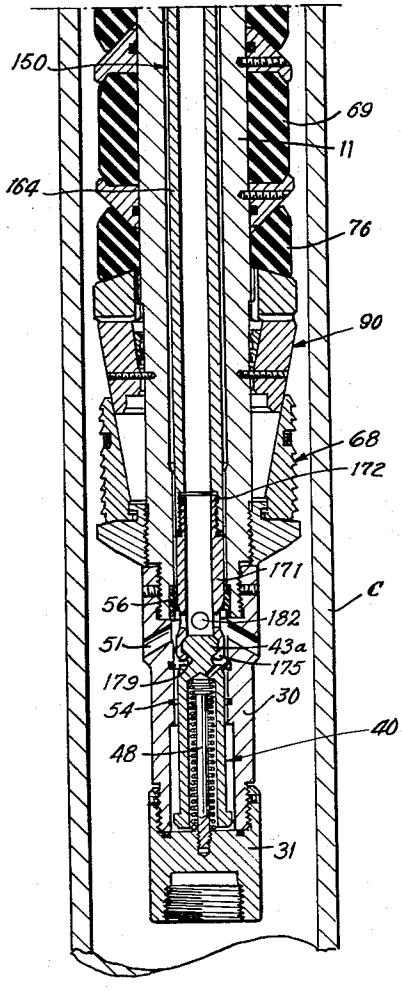


Fig. 4

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Dec. 29, 1964 L. E. PERKINS 3,163,225

WELL PACKERS

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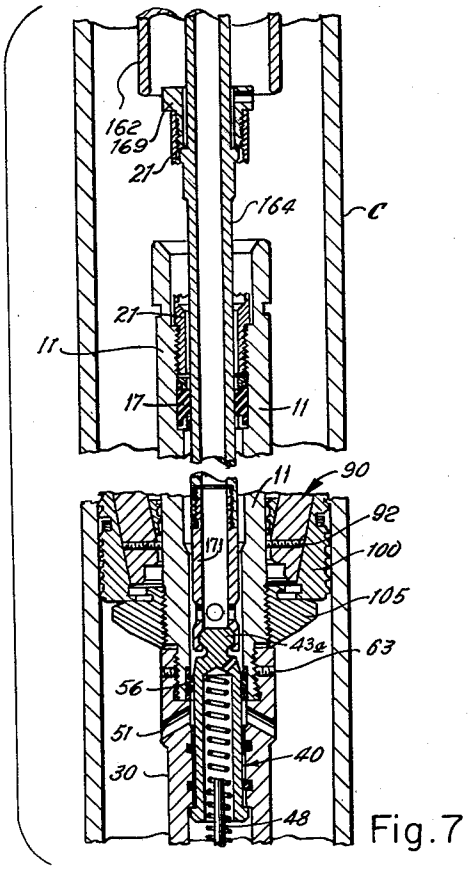


Fig.7

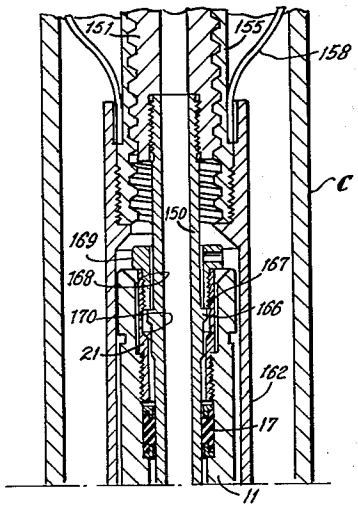


Fig.5

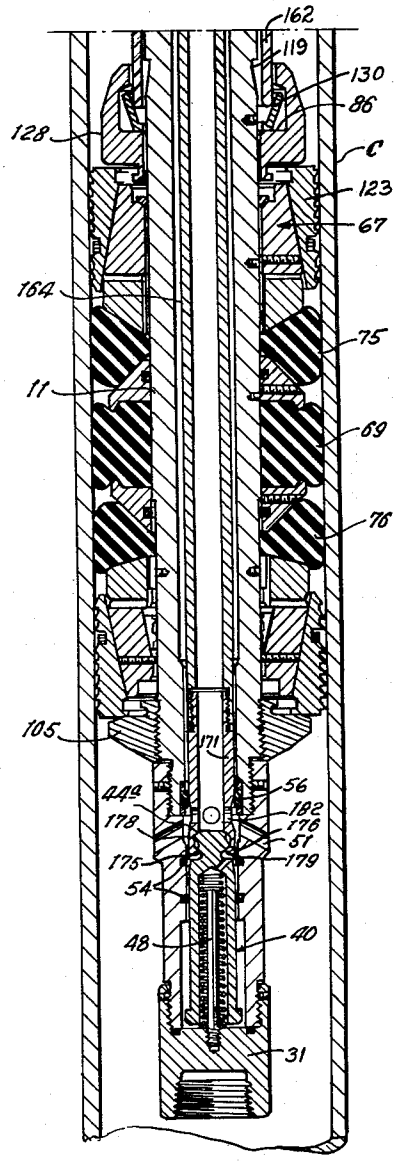


Fig.6

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3,163,225

WELL PACKERS

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Filed Feb. 15, 1961, Ser. No. 89,438
14 Claims. (Cl. 166—123)

This invention relates to well packers and more particularly to a packer for sealing the annular space between two telescoped well flow conductors.

In the drilling or reworking of oil wells, it is often desirable to seal between one well flow conductor, such as tubing or other pipe which is telescoped in another flow conductor, such as the well casing. For example, when it is desired to pump cement or other slurry down a well tubing and to force the slurry out of the tubing into the well casing and thence to a formation, it is necessary to close and seal the annular space between the tubing and the well casing and it is desirable to anchor the tubing to the well casing to prevent the fluid pressure of the cement slurry from lifting the tubing upwardly in the well. It is also desirable that the well tool permit the flow of fluids through the well tubing while the tubing is being moved longitudinally through the well casing, that it permit closing of the lower end of the tubing whereby the tubing may be subjected to fluid pressure to test for leaks therein, and that it close or plug the casing after the tubing has been disengaged from the well tool and positioned with its open lower end above the well tool for other fluid circulating operations which take place above the well tool.

Accordingly, an object of the invention is to provide a new and improved well tool for anchoring one fluid conductor to another in which it is telescoped and to seal therebetween.

Another object is to provide a packer connectable to a tubing string and having anchoring and sealing means which are operable upon rotation of the tubing string relative to the well casing to anchor the packer to the well casing and seal therebetween.

Still another object is to provide a packer, of the type described, having a flow passage communicating with the interior of the tubing and with the casing below the sealing means and a valve for closing the flow passage which is biased toward closed position.

Still another object of the invention is to provide a well packer, of the type described, wherein the forces due to fluid pressure within the tubing acting on the valve are counterbalanced and do not tend to move the valve to open position.

A further object is to provide a well packer, of the type described, having means for moving the valve to closed position after the anchoring and sealing means have been actuated to anchor the packer in the well casing whereby an extension of the tubing telescoped in the packer and communicating with the interior of the packer may be closed so that the fluid pressure within the tubing may be raised to test the tubing for leaks prior to the pumping of cement or other slurry into the well casing and thence to an earth formation.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIGURE 1 is a vertical sectional view of the upper portions of the well tool or well packer embodying the invention;

FIGURE 2 is a view similar to FIGURE 1, being a continuation thereof, showing the lower portions of the well packer;

FIGURE 3 is a vertical sectional view showing the well packer connected to the lower end of a well tubing and to the operating means for setting the anchoring and sealing means of the well packer and for actuating the valve thereof in the well casing, as these devices appear during the lowering of the well packer through the well casing;

FIGURE 4 is a view similar to FIGURE 3, being a continuation thereof, showing the lower portions of the well packer;

FIGURE 5 is a vertical sectional view of the upper portions of the well packer showing the well packer as it appears immediately after it has been anchored in the well casing and its sealing means expanded into sealing engagement with the well casing;

FIGURE 6 is a view similar to FIGURE 5, being a continuation thereof, showing the lower portions of the well packer; and,

FIGURE 7 is a vertical sectional view showing the well packer anchored in the well casing and the valve of the packer in an upper closed position for testing the tubing by fluid pressure.

Referring now to the drawings, the well packer **10** includes a mandrel **11** having a longitudinal bore or flow passage **12** whose upper end is enlarged at **13** to provide an upwardly facing annular shoulder **14** which limits downward movement of an internal seal assembly in the mandrel. The internal seal assembly includes a resilient sealing element **17** to whose opposite ends are bonded retainer rings **18** and **19**. Upward movement of the seal assembly **15** through the mandrel bore **12** is prevented by a tension sleeve **21** disposed in the upper portion of the flow passage whose lower end is threadedly secured, as at **22**, to the mandrel.

The tension sleeve is provided with an internal annular recess **25** which decreases the thickness of an intermediate annular portion **26** of the tension sleeve to provide the tension sleeve with a circumferential area of relatively low mechanical strength so that the tension sleeve will sever or part at the portion **26** when an upward force of predetermined value is applied to the upper threaded portion **28** of the sleeve.

A tubular valve housing **30** threaded on the lower end of the mandrel has its lower end closed by a cap **31** threaded thereon which is held against rotation relative to the valve housing by the set screws **32**. The cap has an upwardly opening annular recess in which is disposed an O-ring **34** or other suitable sealing means for sealing between the upper surface **35** of the cap and the lower annular shoulder or surface **36** of the valve housing.

A valve **40** is slidably mounted in the valve housing and is provided at its lower end with an external annular flange **41** having an upwardly facing annular shoulder **42** which engages the downwardly facing annular shoulder **43** of the valve housing to limit upward movement of the valve in the valve housing. The valve is provided with a longitudinal central bore **45** in which are received the upper portions of a biasing spring **46** whose upper end engages the internal downwardly facing stop surface **47** of the valve. The lower end of the spring abuts or engages the upper surface **35** of the cap. The spring guide **48** has its lower end threaded in a bore **48***a* of the cap and extends upwardly through the biasing spring **46** into the downwardly opening bore **45** of the valve **40**.

A pressure equalizing port **49** of the valve opens upwardly from the central bore **45** thereof. The valve housing has a plurality of lateral ports **51** which communicate with an internal annular recess **52** thereof. The valve housing has a pair of internal annular recesses below the recess **52** which are provided with O-rings **54** or other suitable sealing means which seal be-

tween the valve and the housing below the lateral ports of the valve housing.

The upper portions of the valve, when the valve is in the upper position illustrated in FIGURE 2, extend into the lower reduced end portion of the flow passage 12 of the mandrel and are engaged by an internal resilient seal means 56 disposed in an internal recess 57 of the mandrel between a pair of retainer rings 58 and 59. The assembly of the retainer rings and the seal means, which may be bonded to each other to provide a unitary seal, is held against upward movement by the engagement of the upper end of the upper retainer ring 58 with the downwardly facing annular shoulder 60 of the mandrel and downward movement thereof is limited by the engagement of the lower end of the lower retainer ring with the upwardly facing shoulder 62 of the valve housing. The valve housing is secured against rotational movement relative to the mandrel by the set screws 63.

A packer assembly 65 is disposed about the packer mandrel and above the valve housing between a top anchoring assembly 67 and a bottom anchoring assembly 68. The packer assembly 65 includes a center resilient seal means or packer 69 disposed between top and bottom shoes 70 and 71 releasably secured against movement relative to the mandrel by the shear screws 71*a* and 72, respectively, which extend through threaded bores of the shoes into the suitable threaded lateral bores of the packer mandrel. The shoes are provided with internal annular recesses in which are disposed the O-rings or other suitable sealing means 73 which seal between the shoes and the mandrel.

The packer assembly also includes top and bottom resilient seal elements or packers 75 and 76, respectively. The top seal element 75 has a bottom annular end surface 78 which engages the upwardly and inwardly beveled surface 79 of the top shoe 70 and an annular top surface 80 which is engaged by the inwardly and downwardly beveled surface 81 of a top support ring 82. The lower seal element 76 has an upper annular surface 84 which engages the downwardly and inwardly beveled surface 85 of the bottom shoe 71 and a bottom annular surface 86 which is engaged by the upwardly and inwardly beveled surface 87 of a bottom support ring 88.

The lower anchoring assembly 68 includes an annular wedge or expander 90 disposed about the mandrel whose upper end engages the lower end of the bottom support ring 88. The annular wedge 90 is releasably secured in the position illustrated in FIGURES 2 and 4 to the mandrel by a plurality of shear screws 92 which extend through suitable bores of the wedge 90 into outwardly opening lateral bores of the mandrel.

The wedge 90 of the lower anchoring assembly has a downwardly and inwardly beveled annular internal cam surface 93 which engages the similarly beveled outer cam surfaces 94 of the internal slips 95 disposed between the expander and the mandrel. The internal slips are provided with teeth 96 which engage the outer surface of the mandrel to prevent any tendency of the wedge 90 to move upwardly relative to the mandrel, the camming action between the beveled surfaces 93 and 94 of the wedge and the slips, respectively, tending to move the teeth 96 of the slips into firmer engagement with the mandrel upon any tendency of the wedge or expander 90 to move upwardly relative to the mandrel.

The outer downwardly and inwardly beveled annular cam surface 98 of the expander 90 is engaged by the upwardly and outwardly beveled inner cam surfaces 99 of the circumferentially spaced bottom slips 100 disposed about the mandrel. The bottom slips have internal recesses 102 adjacent their lower ends in which is received the external annular flange 103 of the bottom slip retainer ring 105 threaded on the mandrel above the valve housing, the upper end of the valve housing engaging the lower end of the bottom slip retainer ring to prevent any downward movement thereof relative to the mandrel. The slips are provided with external recesses 108 in which are received a plurality of resilient split rings 109 which bias the slips inwardly relative to the mandrel and into engagement with the expander and with the flange 103 of the retainer ring 105. The bottom slips 100 have downwardly inclined teeth 112 which are adapted to engage the internal surfaces of a well casing C, when moved to an expanded position by upward movement of the slips relative to the expander due to the engagement of the beveled cam surfaces of the expander and the slips, to anchor the mandrel against downward movement in the well casing.

The upper anchoring assembly 67 includes a top wedge or annular expander 115 releasably held against movement relative to the mandrel by a shear screw 116 which extends through a suitable threaded bore of the top wedge into an aligned lateral threaded bore of the mandrel. The lower annular end of the top wedge 115 engages the top end of the top support ring 82. Upward movement of the top wedge 115 relative to the mandrel is prevented by a split ring 118 which is disposed in an external recess 119 of the mandrel. The split ring has its top surface engaging the downwardly facing annular shoulder 120 of the mandrel and its lower surface engaging the upwardly facing shoulder 121 of the top wedge 115. The ring 118 prevents any accidental upward movement of the wedge relative to the top slips 123 whose internal downwardly and outwardly beveled internal cam surfaces 124 engage the upwardly and inwardly beveled outer cam surface 125 of the top wedge 115. The top slips 123 have internal annular transverse recesses 126 in which is received the external annular flange 127 of the top slip retainer ring 128. The engagement of the flange 127 of the top slip retainer ring in the recesses 126 of the slips prevents undesired downward movement of the top slips relative to the top wedge.

The top slip retainer ring is releasably held in an upper position relaitve to the mandrel by a split resilient lock ring 130 whose upper end engages the downwardly facing internal annular shoulder 131 of the retainer ring provided by the internal annular top flange 132 thereof, and whose internal annular flange 135 extends into an external annular recess 136 of the mandrel.

The upper or top slips have external recesses 140 in which are received a plurality of resilient split rings 142 which yieldably bias the slips inwardly toward the mandrel and into engagement with the top wedge and releasably hold the recesses 126 of the slips engaged with the flange 127 of the top slip retainer ring

It will be apparent that the camming or wedging action between the beveled cam surfaces 124 of the top slips and the outer beveled cam surface 125 of the top wedge will cause the top slips to move outwardly relative to the mandrel upon downward movement of the slips relative to the expander. The slips have upwardly inclined external teeth 145 which are adapted to engage the internal surfaces of a well casing C when the top slips are in expanded positions relative to the mandrel, to anchor the mandrel against upward movement relative to the well casing.

The well packer 10 is secured to the lower end of the tubing T by an extension 150 whose upper section 151 has a reduced top end portion threaded into the lower end of the tubing and a lower end portion provided with external threads 152. A setting sleeve 155 is slidably and rotatably disposed on the upper extension section 151 and has internal threads 156 which engage the external threads 152 of the upper section. A plurality of circumferentially spaced drag springs 158 are secured to the setting sleeve 155 by means of the upper annular retainer 159 which provides a plurality of circumferentially spaced recesses 160 between the setting sleeve and the retainer 159 in which are received the upper ends of the springs

158. The lower ends of the springs may be rigidly secured to the setting sleeve by any suitable means, such as welding.

A trip ring or sleeve 162 is threaded on the lower end of the setting sleeve and its lower end is adapted to be moved down past the flange 132 of the top slip retainer ring to engage the lock ring 130 and expand it outwardly to move the flange 135 thereof out of the external annular recess 136 of the mandrel so that the slip retainer ring and the slips may be moved downwardly on the packer mandrel.

The intermediate section 164 of the tubing extension 150 is threaded into the lower end of the top section 151 of the tubing extension. An O-ring 165 or other suitable sealing means is disposed in external annular recess of the intermediate tubing extension to seal between the upper section and the intermediate section. The intermediate section 164 of the tubing extension has an external annular flange 166 (see FIG. 5) whose upwardly facing top shoulder 167 is adapted to engage the lower end of a retainer sleeve 168 threaded into the upper end of the tension sleeve 21. The retainer sleeve 168 is provided with an external annular flange 169 on its upper end which engages the upper end of the mandrel to limit telescoping movement of the retainer sleeve into the tension sleeve. The lower end of the retainer sleeve is spaced from the upwardly facing lower shoulder 170 of the tension sleeve defining the lower end of the internal recess 25 thereof. The tubing extension is engaged by the internal seal element 17 which seals between the packer and the tubing extension.

A bottom section 171 of the tubing extension 150 is threaded into the lower end of the intermediate section of the tubing extension and is provided at its upper end with an external annular recess in which is provided an O-ring 172 or other suitable sealing means which seals between the intermediate and bottom sections. The internal bore or flow pasage 173 of the tubing extension 150 is enlarged at its lower end in the bottom section and an internal annular flange 175, spaced below the shoulder 176 at the upper end of the enlarged portion of the bore, provides an upwardly facing downwardly and inwardly beveled shoulder 178. The lower shoulder 179 of the flange is beveled inwardly and upwardly so that the lower portion of the bottom section of the tubing extension may expand elastically due to the camming action of the shoulder 178 of the tubing extension and the upper shoulder 44*a* of the flange or connector head 43*a* of the valve 40 as the lower end portion of the bottom section of the tubing extension is forced downwardly over the flange 43*a*. The lower end portion contracts as the flange 175 moves below the flange 43*a* so that the upwardly facing shoulder 178 will then engage the shoulder 44*b* of the flange 43*a* to detachably secure the lower end of the tubing extension to the valve. Since the shoulders 178 and 44*b* however are beveled upwardly and outwardly, the lower end of the tubing extension will be again expanded by the camming engagement between these shoulders when an upward force imparted to the tubing extension exceeds a predetermined value and permit the flange 175 to move upwardly past the flange 43*a* of the valve. The lower section of the tubing extension may thus be detached or released from the valve.

The bottom section of the tubing extension is provided with a plurality of lateral ports 182 which communicate with the ports 51 of the valve housing when the valve and the tubing extension are in their lowermost positions relative to the packer mandrel as illustrated in FIGURES 4 and 6.

In use, when it is desired to perform such operations as the pumping of cement slurry down through the tubing to the well casing and then through either the lower end of the well casing or through perforations therein to a formation, the well packer 10 is secured to the lower end of the tubing T by means of the tubing extension 150 in the manner illustrated in FIGURES 3 and 4, the intermediate and bottom sections of the tubing being telescoped into the mandrel 11 until the flange 175 of the tubing extension engages the flange 43*a* at the upper end of the valve 40 whereupon further longitudinal inward telescoping movement of the sections into the mandrel causes the valve to move downwardly from its upper closed position illustrated in FIGURE 2 towards its lower open position illustrated in FIGURE 4 until further downward movement of the valve is stopped by its engagement with the top surface 35 of the cap 31 whereupon the camming engagement of the lower shoulder 179 of the internal flange 175 of the bottom section with the upper shoulder 44*a* causes the lower end of the bottom section to expand, due to the resilience of the substance of which the bottom section is formed, and causes the flange 175 to pass downwardly over the flange 43*a* of the valve. The engagement of the upper shoulder 178 of the flange 175 with the lower shoulder 44*b* of the flange 43*a* of the valve then releasably secures the tubing extension to the valve. If any upward movement is then imparted to the tubing extension, the valve will be moved therewith towards its upper closed position towards which it is biased by the spring 46. The tubing extension then remains secured to the valve until upward movement of the valve relative to the mandrel is stopped by the engagement of its shoulder 42 with the downwardly facing shoulder 43 of the mandrel and an upward force exerted on the tubing tending to move the tubing extension relative to the mandrel and the valve exceeds a predetermined value sufficiently great to cause the camming engagement betwene the shoulders 178 and 44*b* to again expand the lower portion of the tubing extension to permit the flange 175 to move upwardly past the flange 43*a*.

After the bottom tubing extension section has been thus releasably secured to the valve 40, the retainer sleeve 168 is screwed downwardly into the tension sleeve by any suitable means as by a wrench which is inserted into the socket 185 in the flange 169 of the retainer sleeve. The tubing extension and the valve will then be held in the lower positions relative to the mandrel against the force exerted by the spring 46 due to the engagement of the upwardly facing shoulder 167 of the external flange 166 of the intermediate tubing extension section 164 with the lower end of the retainer sleeve. The shifting sleeve 155 is now in the upper position on the top tubing extension section 151 with the lower end of the trip sleeve 162 held above and out of engagement with the lock ring 130, as seen in FIGURE 3. The seal elements of the sealing assembly 65 are now in their retracted positions since the shoes 67 and 68 and the bottom and top wedges 90 and 115 are held in the spaced positions relative to one another illustrated in FIGURES 1 through 4.

The well packer and the tubing are then lowered through the well casing C with the drag springs 158 engaging the internal wall surfaces of the casing until the packer reaches the desired depth or location in the well casing. During such downward movement of the well packer and the tubing, fluids may flow into the tubing string through the ports 51 of the valve housing, the ports 182 of the bottom section of the tubing extension and the flow passage 173 of the tubing extension thus facilitating such downward movement. The tubing is then rotated in a clockwise direction at the surface to cause the tubing extension 150 to rotate relative to the shifting sleeve and the trip sleeve since these sleeves are held against rotation relative to the well casing due to the engagement of the drag springs 158 with the well casing. This rotation of the tubing extension relative to the shifting sleeve rotates the threads 152 with respect to the threads 156 and causes the shifting sleeve and the trip sleeve 162 to move downwardly on the upper tubing section until the lower end of

the trip sleeve engages the lock ring 130 to expand it and move its lower internal flange 135 out of the external recess 136 of the mandrel 11. The top slip retainer ring 128 and the top slips 123 are now free to move downwardly relative to the mandrel 11 and continued rotation of the tubing now causes the top slip retainer ring to move downwardly relative to the mandrel and the top wedge or expander 115 since the lock ring, once it is moved out of engagement in the external recess 136 of the mandrel, engages the upwardly facing shoulder 186 of the top slip retainer ring, as illustrated in FIGURE 6, and further downward movement of the shifting sleeve 162 thus forces the top slip retainer ring downwardly. As the top slips 123 move downwardly relative to the top wedge 115, the camming engagement between the cam surfaces 124 and 125 of the slips and of the expander, respectively, moves the slips outwardly into engagement with the internal wall surfaces of the well casing whereupon the upwardly inclined teeth 145 of the top slips dig or bite into the internal wall surfaces of the well casing. Further rotation of the tubing now causes upward movement of the mandrel 11 relative to the top slips. The top wedge 115 continues to move upwardly with the mandrel until the further outward movement of the slips becomes impossible whereupon the shear screw 116 shears, having a lesser shear strength than the other shear screws.

Further continued rotation of the tubing or upward movement thereof causes successive expansion of the seal elements 75 and 76 and the successive shearing of the shear screws 71*a* and 72, since the shear screw 71*a* has a lesser shear strength than the shear screw 72.

When the seal elements are fully expanded, further upward movement of the bottom support ring 88 is arrested whereupon further upward movement imparted to the mandrel due to the continued rotation of the tubing now causes the shear screw 92 to shear since the wedge 90 can no longer move upwardly with the mandrel. As a result, the bottom slips 100 now move upwardly with the mandrel and are caused to move outwardly, due to the camming engagement of their cam surfaces 99 of the slips with the cam surface 98 of the bottom wedge or expander 90, until the downwardly inclined teeth 112 of the slips engage and bite into the internal wall surfaces of the well casing.

The various elements of the well packer are now in the positions illustrated in FIGURES 5 and 6 wherein the sealing elements 69, 75 and 76 are in expanded positions engaging the internal wall surfaces of the well casing and sealing between the mandrel and the well casing and are held locked in such expanded sealing positions due to the engagement of the top and bottom slips with the well casing. The mandrel is also now anchored against movement in either direction through the well casing. The top slips 123 prevent upward movement of the anchoring and sealing assemblies in the well casing and the bottom slip retainer ring 105 is rigidly secured to the mandrel. Downward movement of the mandrel is now prevented by the internal slips 95 whose teeth 96 tend to dig or bite into the mandrel upon any downward movement of the mandrel relative thereto due to the camming engagement of the cam surfaces 94 thereof with the cam surface 93 of the bottom expander 90 and by the bottom slips 100 which are forced further outwardly into more intimate tighter engagement with the internal wall surfaces of the well casing upon any downward movement of the bottom expander.

If desired, the cement slurry may now be pumped downwardly through the well tubing T, the flow passage 173 of the tubing extension, the lateral ports 182 of the tubing extension and the lateral ports 51 of the valve housing to the bore of the well casing and thence through the open lower end of the well casing, or through perforations provided in the well casing below the packer, to the formation. The tubing is held anchored against upward movement by the well packer since the shoulder 167 of the flange 166 of the tubing extension engages the lower end of the retainer sleeve so that the pressure of the slurry cannot lift the tubing upwardly in the well casing. Alternatively, if it is desired prior to any cementing operations to subject the tubing itself to fluid pressure to discover any possible leaks or holes therein, the tubing is either further rotated or pulled upwardly until a predetermined upward force is exerted on the upper portion of the tension sleeve which is of sufficient force to cause the weakened annular section 26 thereof to fail or part, whereupon upward movement of the tubing extension relative to the packer mandrel may take place. The tubing is then moved upwardly relative to the mandrel until the valve is in the closed position illustrated in FIGURE 7. At this time the lateral ports 182 of the tubing extension are below the top internal seal element 17 and above the seal element 56, and the valve is in its upper position wherein the seal element 56 seals between the valve and the mandrel above the lateral ports 51 of the valve housing. Any fluid pumped into the tubing at the surface cannot now flow out of the lower end of the tubing extension. There is no tendency for any increased fluid pressure within the tubing and the mandrel to move the valve downwardly, since the equalizing port 49 of the valve transmits the fluid pressure to the downwardly facing surfaces of the valve so that the fluid forces exerted on the valve tending to move it in opposite directions are equalized or balanced.

If it is found that the tubing has leaks or holes, the tubing may be removed upwardly out of the well for repair, the bottom section of the tubing extension releasing from the connector head or flange 43*a* of the valve when a predetermined upward force is applied to the tubing. After the tubing has been repaired, it may again be lowered downwardly into the well until the tubing extension again moves the valve downwardly to fully open position and the lower end of the tubing moves downwardly over the flange 43*a*. If the tubing after testing is found not to have any leaks, it is moved downwardly to again move the valve to open position whereupon the cement or other slurry or fluids may be pumped downwardly through the tubing to the well casing below the packer.

When the cementing operation is completed, the tubing may be pulled upwardly relative to the well packer, the engagement of the flange 175 of the bottom section of the tubing extension moving the valve to its upper fully closed position prior to the release of the tubing extension from the valve. The tubing may then be further raised until the lower end of the tubing extension is located above the well packer, whereupon other fluid circulating operatons may be carried on above the packer without any fluid flowing downwardly past the packer to a formation since the valve is now in the upper closed position in which it is held by the spring 46. The valve will remain closed even if a great pressure differential exists across the well packer since the forces exerted by pressure of fluids in the flow passage of the mandrel above the valve is equalized across the valve due to the provision of the equalizing port 49. As a result, even if the formation pressure below the packer is quite low, there will be no loss of the fluids being circulated between the tubing and the well casing above the packer to the formation due to the opening of the valve. The circulation above the packer may be either downwardly through the well tubing and the tubing extension and thence upwardly through the annulus or annular passage between the tubing and the well casing or, reversely, downwardly through the annulus and upwardly through the tubing.

The well packer 10 may be formed of relatively soft substances so that upon the completion of the cementing operations or any other operations found desirable, the well packer may be drilled out after the tubing has been removed upwardly from the well.

It will now be seen that a new and improved well packer has been illustrated and described which includes a mandrel having anchoring and sealing means disposed thereon for anchoring the mandrel in a well casing and for sealing between the mandrel and the well casing.

It will further be seen that the mandrel is provided with a valve housing or extension which permits flow of fluids through the mandrel past the sealing means and that the mandrel is provided with a valve which is movable between a lower open position permitting flow of fluids through the well packer and an upper closed position wherein flow of fluids through the mandrel is prevented.

It will further be seen that the valve, when in closed position, is not moved toward open position by fluid pressure within the mandrel because the packer and valve have means for equalizing or balancing the forces exerted on the valve by the fluid pressure within the mandrel.

It will further be seen that the fluid pressure in the well casing below the sealing means of the well packer also does not tend to cause movement of the valve when the valve is in closed position, since the forces exerted by such fluid pressure on the valve are equalized or counterbalanced because O-ring or seal means 54 encompass the same area as the seal 56.

It will further be seen that the valve is movable to its lower closed position by a tubing extension having port means permitting flow of fluids through the tubing and into the mandrel whereby fluids may be pumped downwardly through the tubing and to the well casing below the packer when the valve is held in its lower open position by the tubing extension.

It will further be seen that the well packer is provided with seal means for sealing between the tubing extension and the mandrel above the valve whereby the tubing may be fluid pressure tested when the valve is in upper closed position since flow of fluid out of the lower end of the tubing is thus prevented.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A packer including: a mandrel; anchoring and sealing means carried by said mandrel and movable to expanded positions to anchor the packer in a flow conductor and seal between the mandrel and the flow conductor, said mandrel having a longitudinal flow passage therein closed at its lower end and a port providing communication between the flow passage and the exterior of the mandrel below said anchoring and sealing means; elongate cylindrical valve means in said flow passage of said mandrel for closing said port movable between a lower open position and an upper closed position; internal annular seal means carried in the bore of the mandrel above and below said port means for sealing between the external cylindrical surface of said valve means and said mandrel; said cylindrical means being movable longitudinally in said seal means; means biasing said valve towards said upper closed position, said valve means having means providing fluid communication from the flow passage above said seal means and said valve means to below said seal means whereby fluid pressure in the flow passage of the mandrel above the valve means may be conducted through the valve means to opposite ends thereof above and below the internal seal means in the mandrel so that the forces of the fluid pressure in the flow passage acting on the valve means are equalized and do not tend to move said valve means from said upper closed position to said lower open position; and internal seal means mounted in the longitudinal flow passage of said mandrel spaced longitudinally above the upper seal means adjacent said port means.

2. A well packer including: a mandrel having external anchoring and sealing means thereon for positioning said mandrel in anchored sealing position in a well; said mandrel having a bore providing a longitudinal flow passage closed at its lower end and a lateral port below the sealing means providing communication between the flow passage and the exterior of the mandrel below said sealing means; a valve in said flow passage for closing said port, said valve being movable longitudinally in said flow passage from a position closing said lateral port to a position opening said port; means sealing between said valve and said mandrel; connector head means on the upper end of said valve and accessible through the bore of the mandrel for moving said valve longitudinally of said bore; means conducting fluid to opposed surfaces of said valve on opposite sides of said seal means whereby fluid pressures within the bore of the mandrel acting on the valve are balanced when said valve is in closed position.

3. A well packer of the character set forth in claim 1 and in combination with a tubular member telescoped into the bore of said packer and having means at its lower end engaging the connector head means at the upper end of said valve member for moving said valve member longitudinally in either direction between open and closed positions as said tubular member is moved longitudinally in the bore of said packer.

4. A well packer including: a mandrel having external anchoring and sealing means thereon for positioning said mandrel in anchoring sealing position in a well; said mandrel having a bore providing a longitudinal flow passage closed at its lower end and having a port means disposed laterally of said longitudinal flow passage and communicating with the exterior of the packer below the sealing means and disposed to provide communication between said longitudinal flow passage and the exterior of the mandrel below said sealing means; an elongate cylindrical valve member slidable longitudinally in said flow passage of said mandrel for closing and opening said port means; internal annular sealing means disposed in the flow passage of the mandrel above and below said port means and sealing against the exterior cylindrical surface of said valve member when said valve member is in closed position to close off flow through said port means between the flow passage of the packer and the exterior thereof below the sealing means; said valve member being movable longitudinally downwardly from an upper position in engagement with said sealing means closing said port to a lower position in which the valve member is out of engagement with the sealing means above the port whereby fluids may flow from the flow passage of the packer through the port to the exterior of the packer below the external sealing means thereon; and means conducting fluid to opposed surfaces of said valve member on opposite sides of said seal means in the bore of said flow passage whereby fluid pressure forces within the longitudinal flow passage of the mandrel act upon opposite ends of the valve and are balanced when said valve is in closed position so that fluid pressure does not displace said valve member from closed position.

5. A well packer of the character set forth in claim 4 wherein the valve member is provided with shoulder means at its upper end; and an elongate tubular member is telescoped into the bore of the packer and has means at its lower end couplingly engaging said shoulder means of said valve member for moving said valve member longitudinally in either direction between open and closed positions with respect to said port as the tubular member is moved longitudinally in the bore of said packer.

6. In combination: a well packer having external anchoring and sealing means thereon for positioning it in sealing position in a well; well flow conductor releasably connected to said well packer and extending therefrom to the surface of the well when said packer is in anchoring sealing position; said packer having a mandrel with a bore providing a longitudinal flow passage closed at its

lower end and a port means providing a laterally disposed flow passage extending from the longitudinal flow passage of the packer to the exterior of said packer below the external sealing means thereon whereby fluids may flow from the longitudinal flow passage of the packer to the bore of the well below the packer; a valve member movable longitudinally in said longitudinal flow passage of said packer for closing said port; seal means in the bore of the packer on longitudinally opposite sides of said lateral port means sealing between the exterior of said valve and said packer, whereby said valve when in one longitudinally disposed position engages both said seal means and closes said port and prevents flow of fluids from the longitudinal flow passage of the packer to the exterior thereof through said port, and when in a second longitudinally disposed position in the bore of the mandrel engages only the seal means below said port and opens said port to passage of fluids therethrough from the longitudinal flow passage of the packer to the bore of the well therebelow; means conducting fluid to opposite surfaces of the valve on opposite sides of said seal means whereby fluid pressure forces within the longitudinal flow passage of the mandrel acting on the valve are balanced when the valve is in closed position whereby said well flow conductor may be disconnected from said packer and fluids may be circulated within the bore of the well above the packer without opening the valve.

7. The combination of claim 6 and an elongate tubular valve operator member carried by said well flow conductor and having means at its lower end releasably connecting it to said valve; said operator member having port means adjacent its lower end communicating with the bore of the packer mandrel above the valve; and seal means in the bore of the packer mandrel engaging said elongate tubular valve operator member above said port means therein for sealing between member and packer mandrel whereby fluid pressure may be applied within the bore of the packer mandrel and throughout the length of the well flow conductor to ascertain the presence of leaks in the well flow conductor or packer, said valve member remaining closed due to the application of fluid pressure forces equally to opposite ends thereof whereby opening movement of said valve by the fluid pressure within the longitudinal flow passage of the mandrel is prevented.

8. A packer including: a mandrel; anchoring and sealing means carried by said mandrel and movable to expanded positions to anchor the packer in a flow conductor and seal between the mandrel and the flow conductor, said mandrel having a longitudinal bore providing a flow passage closed at its lower end and a lateral port providing communication between the flow passage and the exterior of the mandrel below said anchoring and sealing means; elongate cylindrical valve means in said flow passage of said mandrel for closing said port movable between a lower open position and an upper closed position; internal annular seal means disposed in the bore of said mandrel above and below said port means for sealing between the external cylindrical surface of said valve means and said mandrel, said cylindrical valve means being movable longitudinally in said seal means between an upper position in which said valve means is disposed in engagement with the upper seal means and the lower seal means and a lower position in which said valve means is in sealing engagement with only the lower seal means in said mandrel; means biasing said valve means toward said upper closed position, said valve means having means providing fluid communication from the flow passage of the mandrel above said seal means and said valve means to the bore of the mandrel below said seal means whereby the fluid pressure in the mandrel flow passage above the valve means is conducted through said passage to opposite ends of said cylindrical valve means on opposite sides of said seal means when said valve is in the closed position so that the forces of the fluid pressure in the flow passage of the mandrel acting on the valve means are equalized and do not tend to move said valve means from said upper closed position to said lower open position; flow conductor means telescoped in said flow passage of the mandrel and having a flow passage; cooperable means on said valve means and said flow conductor means releasably connecting the lower end of said flow conductor means to said valve means, said flow conductor means holding said valve means in said lower open position when said flow conductor means is in said lower position, said flow conductor means having means providing communication between the flow passage of the flow conductor means and the flow passage of the mandrel; said flow conductor being movable longitudinally of said packer to move said valve means upwardly from said lower open position to said upper closed position; and seal means for sealing between the mandrel and said flow conductor means above said valve means above the means providing communication between the flow passage of the flow conductor means and the flow passage of the mandrel when said flow conductor is telescoped in said mandrel flow passage.

9. A packer including: a mandrel; anchoring and sealing means carried by said mandrel and movable to expanded positions to anchor the packer in a flow conductor and seal between the mandrel and the flow conductor, said mandrel having a longitudinal flow passage and a port providing communication between the flow passage and the exterior of the mandrel below said anchoring and sealing means; and elongate cylindrical valve means in said flow passage of said mandrel for closing said port movable between a lower open position and an upper closed position; the flow passage of the mandrel below said valve means being closed; internal annular seal means mounted in the bore of the mandrel above and below said port means for sealing between the external cylindrical surface of said valve means and said mandrel; means biasing said valve means toward said upper closed position, said valve means having means providing fluid communication from the flow passage above said seal means and said valve means to the flow passage of the mandrel below said seal means whereby fluid pressure within the flow passage of the mandrel above the valve means may pass through the valve means to the opposite end thereof below said internal annular seal means in the mandrel so that the forces of the fluid pressure in the flow passage acting on the valve means are equalized and do not tend to move said valve from said upper closed position to said lower open position; said valve means being movable longitudinally downwardly from said upper closed position to the lower open position in which the cylindrical exterior surface of the valve is moved out of sealing engagement with the seal means in the bore of the mandrel above the port means, whereby the port means and the flow passage of the mandrel are in fluid communication; and cooperable means on said mandrel and said valve means for limiting both downward and upward movement of said valve means in said mandrel.

10. A well packer including: a tubular mandrel closed at its lower end; anchoring means carried by said mandrel for movement to expanded position for engaging a well flow conductor to hold said mandrel against movement in the flow conductor; sealing means carried by said mandrel and movable to expanded position for sealing between the mandrel and the flow conductor, said mandrel having port means providing communication between the interior of the mandrel and the exterior thereof below said sealing means; elongate cylindrical valve means having connector means at its upper end, said valve means being mounted for movement relative to said port means between one extreme longitudinal position wherein said valve means closes said port means and another extreme longitudinal position spaced longitudinally from said one position wherein said valve means permits communication between the interior and the exterior of the mandrel

through said port means; means yieldably biasing said valve means toward said one position; internal annular seal means carried by the mandrel in the bore thereof above and below said port means and engaging the external cylindrical surface of said valve means when said valve means is in closed position to close off flow through said port means when said valve means is in said one position; and means providing fluid communication between opposite ends of said valve means whereby fluid pressure within the bore of the mandrel is conducted through the valve means to opposite ends thereof above and below the seal means when said valve means is in said one position closing said port means so that the forces of the fluid pressure in the mandrel exerted on the valve means are counterbalanced and do not tend to move the valve means from closed to open position when the valve is in closed position.

11. The well packer of claim 10 including: internal seal means in said mandrel spaced above said valve means; and an operator member telescopable into said mandrel, said operator member having means thereon for connecting the lower end of the same with the connector means of said cylindrical valve means for moving said valve means between each of said longitudinally spaced extreme longitudinal positions of said valve, said seal means in said mandrel sealing between said mandrel and said operator member.

12. The well packer of claim 10, and an operator member telescopable into said mandrel and having means on its lower end operatively connecting said operator member with the connector means at the upper end of said cylindrical valve means for moving said valve means in both directions between said longitudinally spaced extreme longitudinal positions.

13. The well packer of claim 10, and an operator member telescopable in said mandrel and having means on its lower end operatively connecting said operator member with the connector means at the upper end of said cylindrical valve means for moving said valve means in both directions between said longitudinally spaced extreme longitudinal positions, said mandrel having internal seal means for sealing between said mandrel and said operator member, said operator member having a flow passage communicating with the interior of said mandrel below said seal means when said operator member is telescoped in said mandrel.

14. A well packer including: a mandrel having external anchoring and sealing means; said mandrel having a longitudinal flow passage closed at its lower end and a lateral port providing communication between said flow passage and the exterior of the mandrel; an elongate cylindrical valve in said flow passage for closing said port, said valve being movable longitudinally in said flow passage between a position closing said lateral port and a position opening said port; internal annular seal means in said flow passage and engaging the exterior surface of said cylindrical valve for sealing therebetween when said valve is in said port closing position; said valve having a longitudinal flow passage provided therein for conducting fluid pressure from the flow passage of the mandrel above said valve to the flow passage of the mandrel below the valve whereby fluid pressure conducted through the valve acts on opposed areas thereof above and below said seal means so that the forces of fluid pressure in said flow passage acting on said valve are balanced when the valve is in closed position and have no tendency to move said valve to open position; and connector head means on the upper end of said cylindrical valve accessible through the flow passage of the mandrel for moving said valve longitudinally in said flow passage.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,163,225 December 29, 1964

Lee E. Perkins

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 32, for "betwene" read -- between --; column 10, line 19, for the claim reference numeral "1" read -- 2 --.

Signed and sealed this 20th day of July 1965.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents