Feb. 21, 1967 J. W. KISLING III 3,305,022

WELL PACKING APPARATUS

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Fig. 1

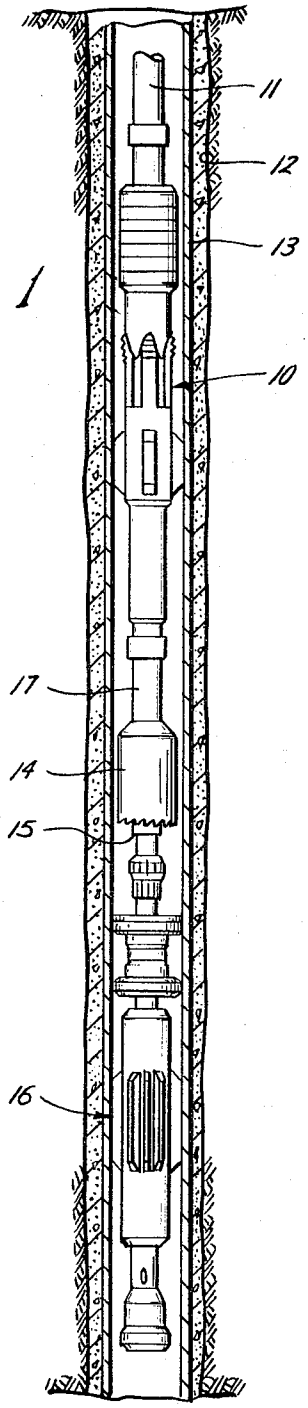


Fig. 3

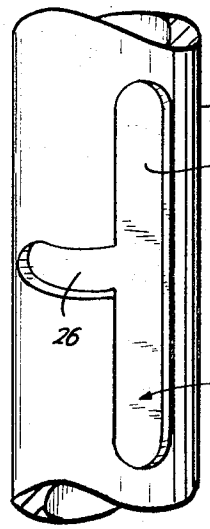
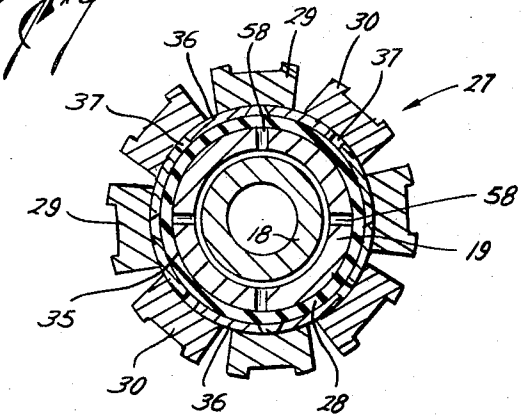


Fig. 4



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WELL PACKING APPARATUS

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Fig. 2A

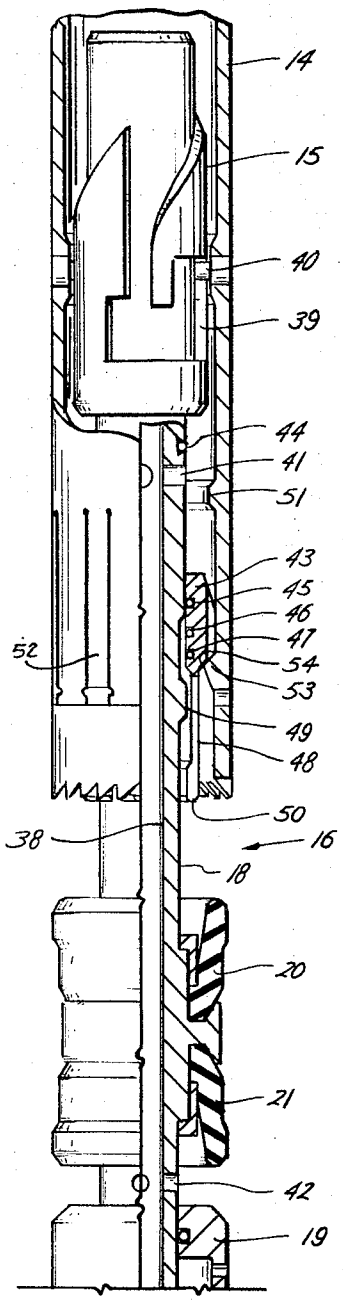
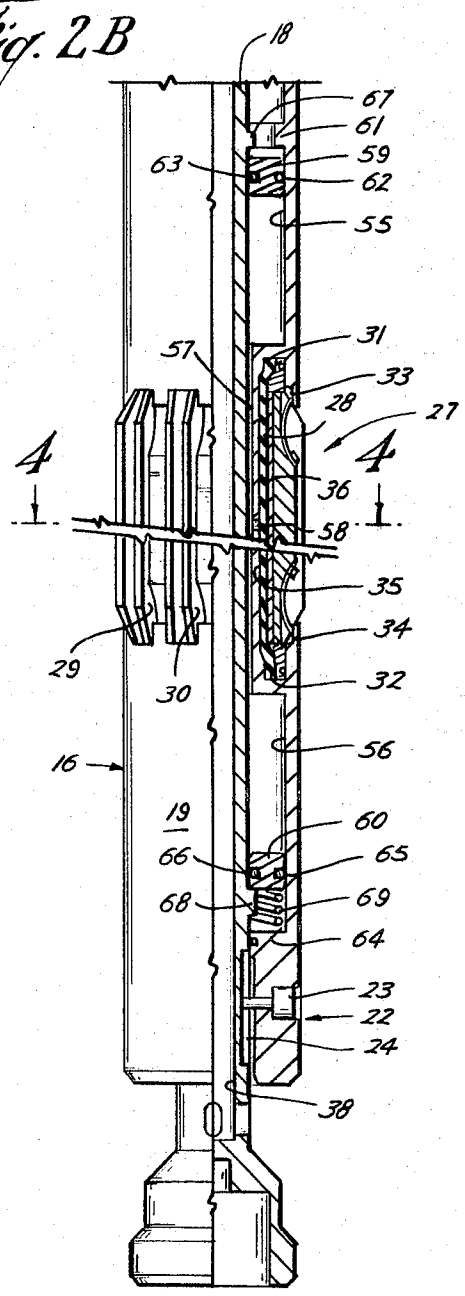


Fig. 2B



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WELL PACKING APPARATUS

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Fig. 5A

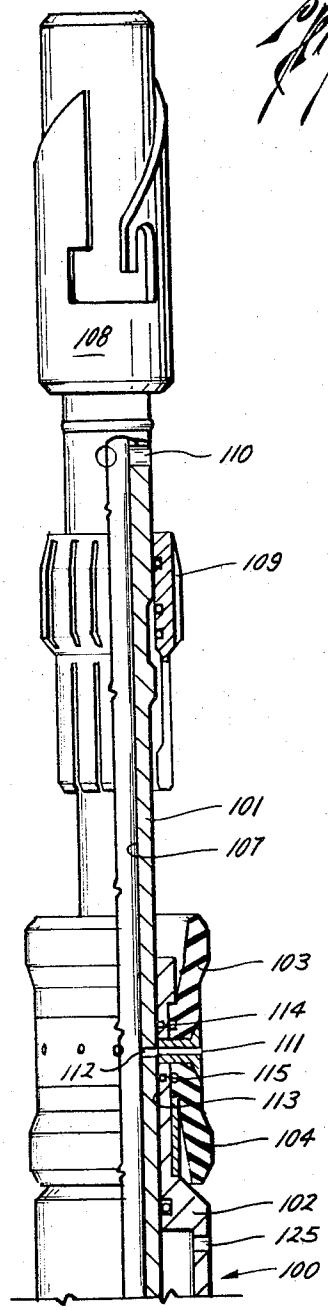
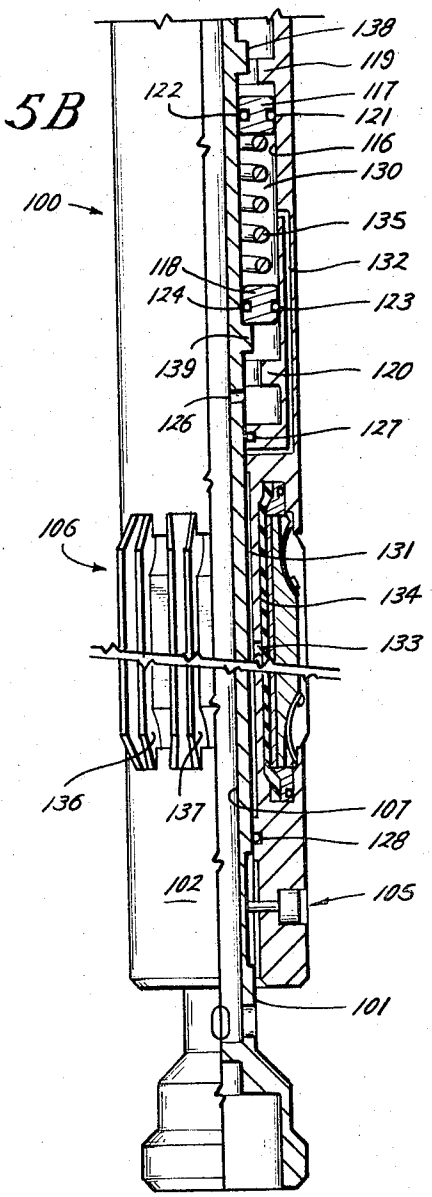


Fig. 5B



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WELL PACKING APPARATUS

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Fig. 6A

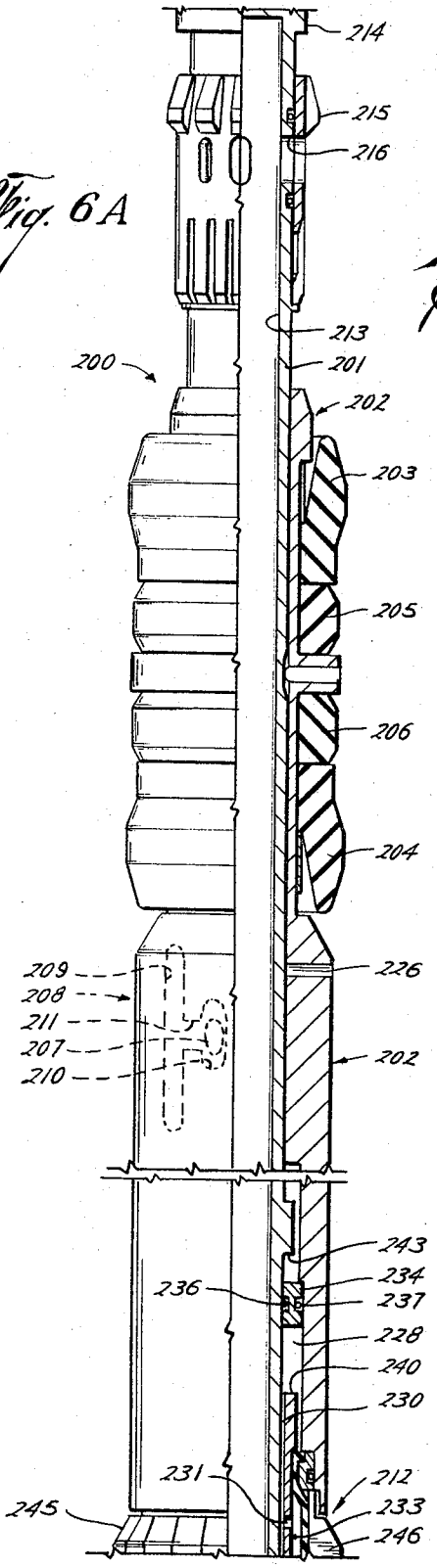
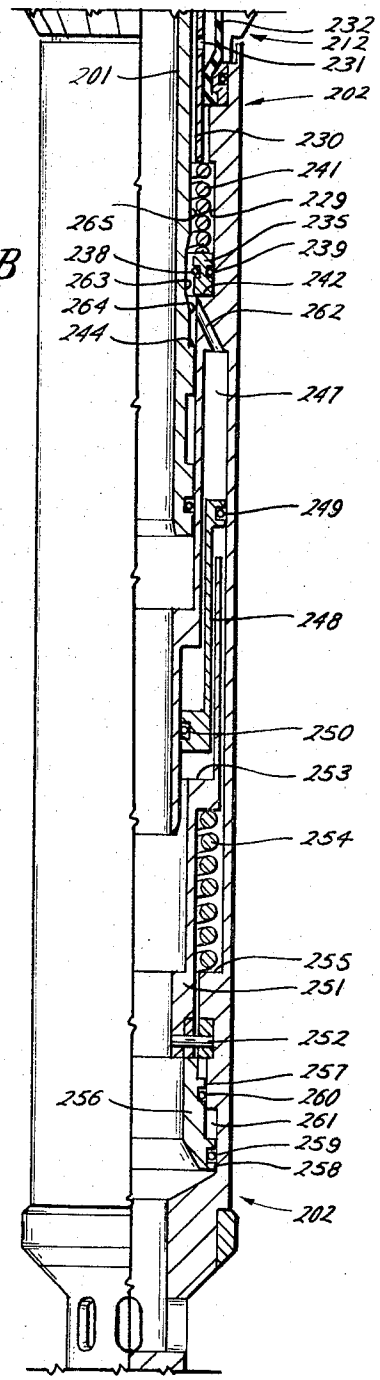


Fig. 6B



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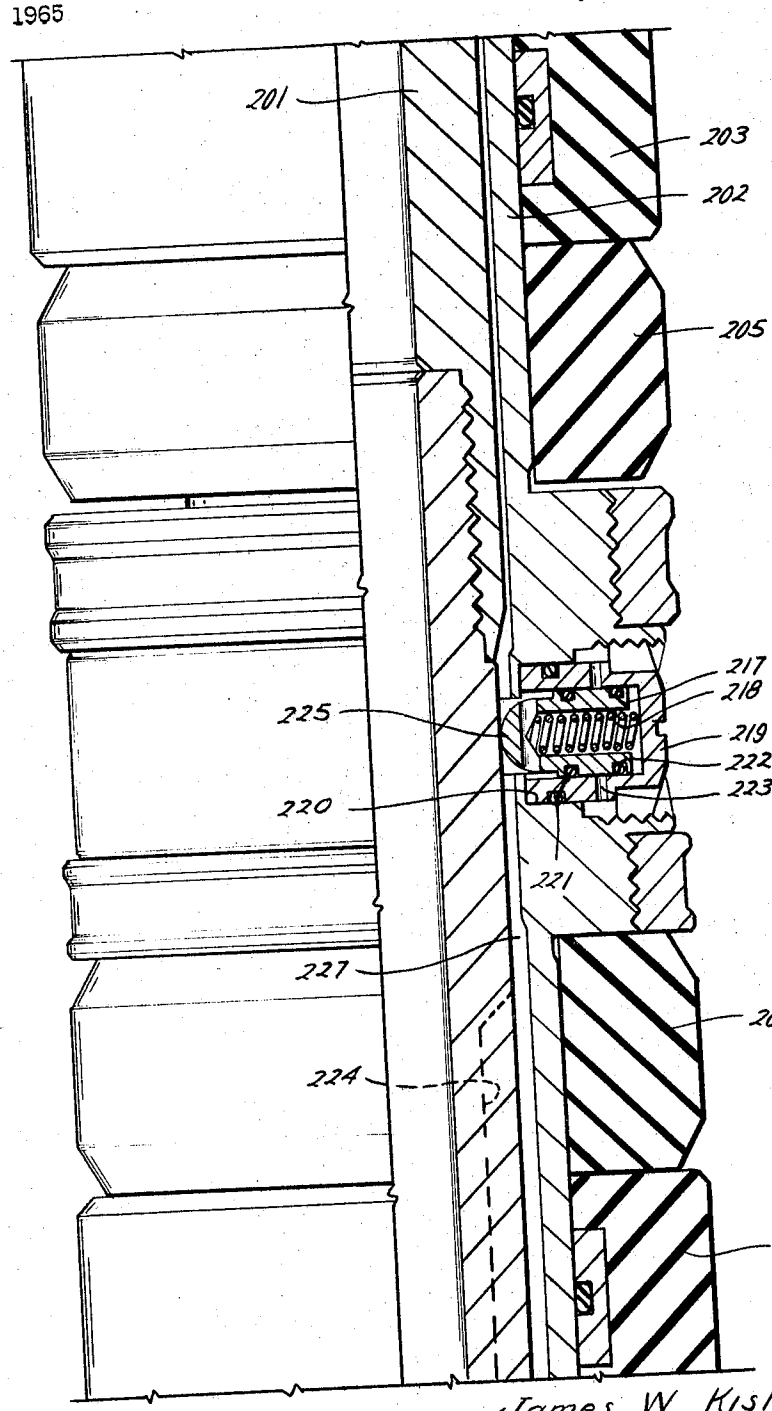
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Fig. 7



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United States Patent Office 3,305,022 Patented Feb. 21, 1967

3,305,022

WELL PACKING APPARATUS

James W. Kisling III, Houston, Tex., assignor, by mesne assignments, to Schlumberger Technology Corporation, Houston, Tex., a corporation of Texas

Filed Aug. 9, 1965, Ser. No. 482,009
24 Claims. (Cl. 166—122)

This is a continuation-in-part of application Serial No. 374,490, filed June 11, 1964, now abandoned.

This invention relates to packers or plugs for packing-off a well bore; and, more particularly, to packers or plugs which, when set in place, will be anchored in the well against hydraulic pressures acting from either direction on the packers or plugs by an anchoring force proportionately related to the acting pressure.

In conducting such well-completion operations as acidizing, cementing, or fracturing, a full-opening well packer dependently coupled from a tubing string is positioned at a particular depth in a cased well and the packer set to isolate the formation interval to be treated from the remainder of the well bore thereabove. Treating fluids are then pumped downwardly at high pressure through the tubing into the packer and introduced into the formation being treated through perforations appropriately located in the casing. In those instances where a well having several producing formations is being completed, a selectively operable bridge plug can be dependently coupled beneath the full-opening packer. Such a bridge plug permits formation zones of selected length to be packed-off for selective treatment of different formation intervals with only a single trip into the well.

It will be appreciated that such packers and bridge plugs must be capable of withstanding high fluid pressures acting on them from either direction. Furthermore, during the course of typical completion operations, such apparatus are usually subjected to high fluid pressures acting alternately from both above and below them. Thus, it is necessary that the packers and bridge plugs be securely anchored against movement in either longitudinal direction.

Heretofore, extendible slip members have typically been employed to anchor packing apparatus from movement in at least one direction. Extendible anchoring members have also been developed which are hydraulically actuated by the fluid being pumped through the tubing for securing the apparatus against shifting.

Accordingly, it is an object of the present invention to provide new and improved packing apparatus having hydraulically actuated wall-engaging members which are pressed into anchoring engagement with a force proportionately related to the pressure of fluids in the well.

It is a further object of the present invention to provide new and improved well-packing apparatus capable of being releasably anchored in a packed-off condition and resist extreme pressure differentials acting from either longitudinal direction.

Packing apparatus arranged in accordance with the present invention includes selectively operable hydraulic means which, in response to a fluid pressure differential across the apparatus, maintains wall-engaging means in anchoring engagement with a force proportionately related to this differential.

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

FIG. 1 is a view of a full-bore packer and a bridge plug employing principles of the present invention and depicted as they would appear within a well bore;

FIGS. 2A and 2B are detailed, successive cross-sectional views of an embodiment of a bridge plug;

FIG. 3 is an isometric view showing particular details of a locking groove employed with the bridge plug of FIG. 2;

FIG. 4 is a cross-sectional view taken along the lines 4—4 of FIG. 2B;

FIGS. 5A and 5B is a view of an alternate embodiment of a bridge plug;

FIGS. 6A and 6B are detailed, successive cross-sectional views of still another embodiment of a bridge plug; and

FIG. 7 is a view showing particular details of a valve employed with the bridge plug of FIG. 6.

As seen in FIG. 1, a typical full-bore packer **10** is dependently connected from a tubing string **11** and positioned within a well bore **12** having a casing **13** set therein. An overshot **14** dependently connected beneath the well packer **10** is releasably coupled over a fishing neck **15** on the upper end of a retrievable bridge plug **16**. This releasable coupling allows the bridge plug **16** to be set at the lower limit of a particular formation interval and the packer **10** subsequently set at any point thereabove irrespective of the length of the tubing sub **17** connecting the packer to the bridge plug.

Turning now to FIG. 2, the retrievable bridge plug **16** depicted in FIG. 1 includes a rotatable actuating body member or index mandrel **18** telescopically arranged within and slidably engaged with a tubular housing member **19**. Oppositely directed elastomeric packing cups **20** and **21** are secured around the upper end of the mandrel **18** in such a manner that one or the other of them will be tightly sealed against the casing **13** whenever there is a pressure differential across the cups.

Normally engaged latch means **22** releasably secure the mandrel **18** to the housing **19** and prevent the mandrel from shifting longitudinally therein until it has first been rotated a predetermined amount. The releasable latching means **22** are comprised of a lug member **23** and groove **24** normally holding the index mandrel **18** fixed against longitudinal movement with respect to the housing **19**, but arranged to release the mandrel for limited longitudinal shifting whenever it is torqued in a clockwise direction. This lug **23** projects inwardly from a central portion of the housing **19** with its inner end being engaged within the T-shaped groove **24** formed in the periphery of the mandrel **18**. As shown in detail in FIG. 3, the flat-bottomed T-shaped groove **24** has an elongated portion **25** extending longitudinally along the mandrel **18** and a branch portion **26** extending to the left and perpendicularly away from the center of the longitudinal groove portion **25**.

Thus, so long as the inner end of the lug **23** is within the branch portion **26** of the groove **24**, the mandrel **18** cannot shift longitudinally in either direction relative to the housing **19**. The mandrel **18**, therefore, must first be torqued to the right to move the lug end into the longitudinal groove portion **25**. Once the lug **23** is disengaged from the branch portion **26** of the T-groove **24**, the index mandrel **18** is of course free to shift longitudinally relative to the housing **19**.

A hydraulically actuated radially expansible friction anchor **27** mounted around the housing **19** is adapted to be pressed against the casing to initially hold the housing relatively fixed against rotation of the mandrel **18** as well as to subsequently anchor the bridge plug **16** against pressure differentials acting from either direction. This anchor **27** includes an elastomeric sleeve **28** encircling the housing **19** with a plurality of elongated casing-engaging members **29** and **30** being mounted uniformly around

the periphery of this sleeve. The enlarged upper 31 and lower 32 ends of the elastomeric sleeve 28 are sealingly secured within opposed annular recesses 33 and 34 around the housing 19 to provide a fluid-tight space 35 between the the sleeve and housing.

Each of the casing-engaging members 29 and 30 are elongated and have a thick, arcuate, cross-section (FIG. 4). Alternate ones 29 of the casing-engaging members are centrally aligned and mounted along the outer convex surface of relatively thin, elongated, arcuate backing members 36. These mounted members 29 are arranged uniformly around the periphery of the elastomeric sleeve 28 so that the backing members 36 substantially encompass the sleeve. The unmounted casing-engaging members 30 are alternately disposed between the mounted casing-engaging mebers 29 in such a manner that the unmounted members 30 straddle adjacent bracking members 36 and cover the gap 37 therebetween. The beveled ends of the casing-engaging memebrs 29 and 30 are loosely disposed within the opposed annular recesses 33 and 34 around the housing 19 at opposite ends of the members.

A central axial bore 38 extends the full length of the mandrel 18 and is capped at its upper end by the conventional fishing neck 15. The fishing neck 15 is arranged for cooperatively receiving the conventional tubular overshot 14 which may be dependently coupled from either the full-bore packer 10 or by itself from the tubing string 11. Matched J-slots 39 on opposite sides of the fishing neck 15 are arranged to receive cooperatively arranged J-pins 40 projecting radially inwardly from the overshot 14 whenever the overshot is lowered over the fishing neck. After the J-pins 40 enter the open upper end of the long portion of the slots 39, the pins are lockingly engaged in the closed short portion of the slots by a concerted application of left-hand torque and a slight upward pull on the tubing 11. Conversely, the overshot 14 is selectively disengaged from the fishing neck 15 by lowering the tubing 11 slightly, torquing the tubing to the right, and then pulling upwardly.

Radial ports 41 and 42 in the mandrel 18 above and below the packing cups 20 and 21 allow fluid to bypass the packing cups as the bridge plug 16 is being shifted within a fluid-filled well bore. Thus, the packing cups 20 and 21 are prevented from becoming tightly sealed against the casing which otherwise could retard or even prevent shifting of the bridge plug 16.

Fluid communication through the lateral equalizing ports 41 above the packing cups 20 and 21 is selectively controlled by an annular valve member 43 which is slidably disposed around the mandrel 18 immediately below the ports. O-rings 44–47 around the inner surface of the valve member 43 and outer surface of the mandrel 18 fluidly seal the ports 41 whenever the equalizing valve member 43 is shifted upwardly to its closed position.

This slidable valve member 43 is cooperatively arranged to be longitudinally shifted by the running overshot 14 so that the equalizing ports 41 are uncovered whenever the overshot is engaged over the fishing neck 15 and covered whenever the overshot is removed.

Whenever the valve member 43 is pulled upwardly, depending resilient fingers 48 around the lower end of the valve member are cammed outwardly as they pass over an annular shoulder 49 around the index mandrel 18 and then retracted after clearing the shoulder. The lower ends 50 of these fingers 48 will then engage the upwardly facing portion of the annular shoulder 49 and hold the slidable valve memebr 43 in its uppermost or port-closed position after the overshot 14 has been removed.

A shoulder 51 projecting inwardly from the central portion of the overshot 14 is arranged to engage the upper end of valve member 43 and shift it downwardly to its open position as the overshot is being coupled over the fishing neck 15. Whenever the overshot 14 is removed by torquing it to the right and picking up, a group of resilient fingers 52 spaced around the lower portion of the overshot 14 have inwardly projecting shoulders 53 arranged to engage a shoulder 54 on the sliding valve member 43 to pull it upwardly and close the equalizing ports 41.

Whenever it is desired to move the bridge plug 16, the overshot 14 is dropped over and re-engaged with the fishing neck 15. As the overshot 14 is being lowered over the fishing neck 15, the slidable valve member 43 is of course again shifted downwardly to reopen the equalizing ports 41 and equalize pressure across the packing cups 20 and 21.

Turning now to the hydraulic system of the present invention, the housing 19 is formed in such a manner as to provide an annular chamber 55 above the upper end of the anchor 27 and a similar annular chamber 56 below the lower end of the anchor. An annular clearance space 57 between the index mandrel 18 and housing 19 provides fluid communication from the upper chamber 55 to the lower chamber 56. A plurality of radial ports 58 through the housing 19 adjacent the elastomeric sleeve 28 provide fluid communication from this clearance space 57 into the sealed space 35 beneath the elastomeric sleeve.

The upper end of the upper annular chamber 55 and the lower end of the lower annular chamber 56 are respectively closed by annular piston members 59 and 60 which are slidably mounted relative to both the housing 19 and the index mandrel 18. The upper slidable piston member 59 is disposed under a shoulder 61 projecting into the annular chamber 55 from the housing 19. Annular grooves around the outer and inner surfaces of the upper piston member 59 receive O-rings 62 and 63 to fluidly seal the slidable piston member relative to the housing 19 as well as to the index mandrel 18.

In a similar manner, the lower slidable piston member 60 is disposed in the lower annular chamber 56 above an upwardly directed shoulder 64 projecting inwardly from the housing 19. The lower slidable piston member 60 is biased upwardly toward the upper end of the lower chamber 56 by a spring 69. External and internal annular grooves around the piston member 60 receive O-rings 65 and 66 for fluidly sealing the slidable piston member relative to both the housing 19 and the index mandrel 18.

A shoulder 67 provided on the mandrel 18 a short distance above the upper slidable piston 59 is arranged to engage the upper piston and force it downwardly whenever the mandrel shifts downwardly. Similarly, a shoulder 68 on the mandrel 18 beneath the lower piston member 60 engages and shifts the lower piston member upwardly whenever the mandrel shifts in that direction.

It will be appreciated that with a suitable hydraulic fluid in the above-described hydraulic system, the lower piston member 60 will normally be biased upwardly by the spring 69 to develop and maintain a slight hydraulic pressure in the system. This slight pressure will expand the elastomeric sleeve 28 of the anchor 27 and extend the casing-engaging members 29 and 30 against the casing. Accordingly, the spring 69 is appropriately selected to press the casing-engaging members 29 and 30 against the casing with a force sufficient to restrain the housing 19 from moving as the mandrel 18 is being manipulated but not so great as to prevent the bridge plug 16 from being shifted easily along the casing. Once, however, the mandrel 18 is freed from the latch 22, longitudinal movement of the mandrel 18 in either direction will of course shift one of the piston members 59 and 60 toward the other and increase the hydraulic pressure further. It will be realized that this increase of hydraulic pressure will be proportionately related to the extent of longitudinal movement of the mandrel 18.

Turning now to the operation of the bridge plug 16, whenever the bridge plug has been positioned at a desired point in the well bore, the tubing string 11 is lowered slightly, slowly rotated to the right and then picked up a short distance as it is rotating. This action suc-

cessively rotates the J-pins 40 of the overshot 14 into the bottom of the open portion of the J-slots 39 in the fishing neck 15 and then engages the J-pins against downwardly facing shoulders formed in one side of the open slot portions. The lug 23 is simultaneously shifted into alignment with the longitudinal portion 25 of T-groove 24 on the mandrel 18. Once the lug 23 moves into this longitudinal slot portion 25, the upward travel of the tubing 11 will carry the mandrel 18 upwardly as well. As the mandrel moves, mandrel shoulder 68 will engage the lower piston 60 and shift it upwardly to increase the hydraulic pressure acting on the anchor 27. Upper piston member 59 is of course forced upwardly against the housing shoulder 61 by this pressure increase.

This concerted action sets the anchor 27 and allows the overshot 14 to be released from the fishing neck 15. The tubing 11 is rotated slightly to the left and then pulled upwardly to remove the overshot 14 and, as previously described, shift the sliding valve member 43 upwardly to close the equalizing ports 41.

As soon as the overshot 14 has been removed from the fishing neck 15 and the slidable valve member 43 pulled upwardly to close the equalizing ports 41, whatever pressure differential there is across the packing cups 20 and 21 will act against the concave side of one of these cups to press it into sealing engagement against the casing.

It will be appreciated, therefore, that after the equalizing ports 41 are closed, should the pressure in the well bore above the bridge plug 16 be greater than the pressure below, the pressure differential will act on the upwardly facing cup 20 and tend to shift the mandrel downwardly. Downwardly shifting of the mandrel 18, of course, drives the upper slidable piston member 59 downwardly, which action will further increase the hydraulic pressure within the system to press the casing-engaging members 29 and 30 of the anchor 27 even more tightly against the well casing. It will be realized, of course, that the developed hydraulic pressure will be proportionately related to the pressure differential.

Should, perchance, the pressure in the well bore below the bridge plug 16 become greater than that thereabove, the mandrel 18 will similarly be shifted upwardly. As the mandrel 18 shifts upwardly, the hydraulic pressure will be momentarily reduced as the upper piston member 59 returns to its initial position against housing shoulder 61. As the mandrel 18 continues to travel upwardly, however, the lower slidable piston member 60 is quickly engaged by the lower mandrel shoulder 68 which shifts this piston 60 upwardly. This upward movement will, of course, again increase the hydraulic pressure within the fluid-filled system to maintain the casing-engaging members 29 and 30 tightly pressed against the well casing.

Turning now to FIG. 5, it will be appreciated that this embodiment is similar in many respects to the embodiment of FIG. 2 already described. The retrievable bridge plug 100 depicted in FIG. 5 has a rotatable actuating body member or index mandrel 101 telescopically arranged within and slidably engaged with a tubular housing member 102. Annular elastomeric packing cups 103 and 104 are secured around the upper end of the housing 102 and oppositely directed so that one or the other of them will be tightly sealed against the casing 13 whenever there is a pressure differential across the cups.

Normally engaged latch means 105, such as previously described and illustrated in FIGS. 2 and 3, releasably secure the mandrel 101 to the housing 102 and prevent the mandrel from being shifted longitudinally therein until it has been first released by rotation.

A hydraulically actuated radially expansible friction anchor 106 is arranged and mounted around the lower portion of the housing 102 in the same manner as that previously described and illustrated in FIGS. 2 and 4.

An axial bore 107 extending the full length of the mandrel 101 is capped at its upper end by a fishing neck 108 identical to that already described. The fishing neck 108 is arranged to cooperatively receive an overshot (not shown) as previously described.

A slidable valve member 109 is operatively arranged around the upper end of the mandrel 101 in the same manner as shown in FIG. 2 to selectively close a plurality of equalizing ports 110 whenever the overshot (not shown) is removed.

It will be appreciated that when the usual bridge plug of the type illustrated is being shifted downwardly, for example, in a fluid-filled well, a pressure differential may develop between fluids trapped in the annular space between the packing cups and the well fluids surrounding the tool above and below the packing cups. Such pressure differential tends to expand the cups into sealing engagement with the casing wall, resulting in a "swabbing action" which can damage the packing cups and deleteriously affect the speed at which the bridge plug can be lowered into the well.

Accordingly, to eliminate this "swabbing action" as the bridge plug 100 is being shifted within a fluid-filled well, radial ports 111 and 112 are provided respectively in the housing 102 and mandrel 101. These ports are appropriately arranged to equalize any fluid pressure differential across the inner and the outer surfaces of the packing cups 103 and 104 whenever the bridge plug 100 is being shifted in a fluid-filled well bore. Annular grooves around the inner bore 113 of the housing 102 above and below the port 112 receive O-rings 114 and 115 which seal-off the port whenever the mandrel is not secured by the latching means 105. Thus, it will be appreciated that whenever the equalizing valve 109 is open and the mandrel 101 is secured against shifting relative to the housing 102, the fluid pressure intermediate the packing cups 103 and 104 will always be equal to the fluid pressure above and below the packing cups.

Turning now to the hydraulic system of the bridge plug 100, an elongated annular space 116 is formed in the housing 102 above the anchor 106. Annular piston members 117 and 118 are slidably mounted at spaced positions within the annular space 116 intermediate inwardly projecting housing shoulders 119 and 120. O-rings 121–124 around the outer and inner surfaces of the piston members 117 and 118 fluidly seal the slidable piston members relative to the housing 102 and mandrel 101 to provide a hydraulic chamber 130 between the piston members. A radial port 125 through the housing 102 provides fluid communication from the exterior of the bridge plug 100 to the upper portion of the annular space 116 above the upper piston member 117. Similarly, a second radial port 126 through the mandrel 101 provides fluid communications from the axial bore 117 of the mandrel to the lower portion of the annular space 116 below the lower annular piston 118.

O-rings 114 and 115 around the inner bore 113 of the housing 102 above and below the anchor 106 fluidly seal the housing relative to the mandrel 101 as well as seal the annular clearance space 131 between the mandrel 101 in that portion of the housing 102 adjacent to the anchor 106. A fluid passage 132 formed through the housing 102 provides fluid communication from the annular clearance space 131 to the hydraulic chamber 130 between the slidable piston members 117 and 118. A radial port 133 provides fluid communication from the sealed-off portion of the annular clearance space 131 into the fluid-tight space 134 beneath the sleeve 28.

The hydraulic chamber 130 between the piston members 117 and 118, as well as the fluid passage 132, annular clearance space 131 and fluid-tight space 134, is of course filled with a suitable hydraulic fluid. A tension spring 135 attached between the opposed surfaces of the piston members 117 and 118 normally biases the piston members toward one another to develop a slight hydraulic pressure within the fluid-filled system. This slight pressure is of course sufficient to press the casing-engaging

members 136 and 137 of the anchor 106 against the casing to secure the housing 102 against movement relative to the mandrel 101.

Turning now to the operation of the bridge plug 100, after the overshot (not shown) has been removed as previously described, the equalizing valve 109 is of course closed and the mandrel 101 is now free to shift within the elongated slot portion of a T-groove (not shown) formed as previously described. Downward shifting of the mandrel 101 will bring an outwardly projecting mandrel shoulder 138 above the upper piston member 117 into engagement with the upper surface of the piston and shift it downwardly. As the upper piston member 117 is shifted downwardly, the hydraulic pressure within the fluid-filled system begins increasing and shifts the lower piston member 118 against housing shoulder 120 therebelow. After the piston 118 has shouldered, continued shifting of the upper piston 117 will further increase the hydraulic pressure applied against the anchor 106. Correspondingly, whenever the mandrel 101 shifts upwardly, an outwardly projecting shoulder 139 on the mandrel 101 below the lower piston 118 will engage the lower surface of the lower piston member to shift it upwardly. This again increases the hydraulic pressure and forces the upper piston member 117 against the housing shoulder 119 thereabove to further increase the hydraulic pressure within the fluid-filled hydraulic system. Thus, it will be appreciated that longitudinal shifting of the mandrel 101 in either direction will impose a proportionately related hydraulic pressure against the anchor 106 for securing the bridge plug 100 relative to the casing.

It should be noted that in the bridge plug 100 depicted in FIG. 5, the packing cups 103, 104 are secured to the housing 102 and accordingly will not be shifted whenever the mandrel 101 shifts.

Turning now to FIGS. 6A and 6B, another embodiment is shown of a retrievable bridge plug 200 employing the principles of the present invention. The retrievable bridge plug 200 depicted in FIGS. 6A and 6B is similar in many respects to those already described and includes a movable actuating body member or mandrel 201 telescopically arranged within a tubular housing 202. Oppositely directed elastomeric packing cups 203 and 204 are mounted around the upper end of the housing 202 and separated from one another by elastomeric backup rings 205 and 206.

For establishing the longitudinal position of the mandrel 201 relative to the housing 202, an outwardly projecting lug 207 on the central portion of the mandrel is slidably received within a generally T-shaped slot system 208 formed in the adjacent internal housing wall. The slot system 208 is comprised of an elongated longitudinal slot 209 that is parallel to a shorter slot 210 and interconnected at their centers by a circumferential slot portion 211. Thus, so long as the lug 207 is confined within the shorter slot portion 210, the mandrel 201 cannot shift appreciably in either longitudinal direction relative to the housing 202 and, therefore, is less susceptible to inadvertent release as it is being positioned in a well bore. The mandrel 201, therefore, must first be torqued to the right to move the lug 207 through the connecting slot 211 into the longer longitudinal slot 209. Once the lug 207 is shifted into the longer slot 209, the mandrel 201 is, of course, free to shift longitudinally an appreciable distance relative to the housing 202.

A hydraulically actuated, radially expansible friction anchor 212 is arranged and mounted around the central portion of the housing 202 in the same manner as that previously described and illustrated in FIGS. 2 and 4. An axial bore 213 extending the full length of the mandrel 201 is capped at its upper end by a fishing neck 214 arranged to cooperatively receive an overshot (not shown) as also previously described. A slidable valve member 215 is operatively arranged around the upper end of the mandrel 201 in the same manner as that shown in FIG. 2A to selectively close a plurality of equalizing ports 216 whenever the overshot is removed.

To eliminate the "swabbing action" previously discussed, means are provided for equalizing the fluid pressure between the cups 203 and 204 with that of the fluids above and below the cups so long as the mandrel lug 207 is confined within the shorter slot portion 210. To accomplish this, as seen in greater detail in FIG. 7, an inwardly biased valve member 217 having an axial passage 218 is slidably disposed in a hollowed valve body 219 that is closed at its outer end and fluidly sealed within a lateral bore 220 through the housing 202 between the cups 203 and 204. When the valve member 217 is in one position, O-rings 221 and 222 around the valve member are arranged to be spaced inwardly and outwardly of a port 223 through the valve body 219 and opening to the exterior of the housing 202 between the cups 203 and 204.

A flat surface 224 formed across the mandrel 201 is so aligned that whenever the mandrel lug 207 is confined within the shorter housing slot 210, the inner end 225 of the valve member 217 is engaged with the mandrel flat. With the valve member 217 in this position, the valve member and O-ring 222 are displaced inwardly from the port 223 to admit fluids in the well through a lateral housing passage 226 below the packing cups 203 and 204 into the clearance 227 between the mandrel 201 and housing 202 to equalize the pressure between the cups. Then, whenever the mandrel 201 is manipulated to bring the mandrel lug 207 into the elongated slot 209, the inner end 225 of the valve member 217 will be cammed outwardly by the peripheral surface of the mandrel adjacent to the flat 224. Thus, once the mandrel 201 has been rotated to bring the lug 207 into the elongated slot 209, the valve member 217 will be shifted to its outermost position and sealed by O-rings 221 and 222 to block fluid communication between port 223 and axial passage 218.

Turning now to the hydraulic system of the friction anchor 212, the housing 202 is formed in such a manner as to provide an annular chamber 228 (FIG. 6B) above the upper end of the anchor. A similar annular chamber 229 is also formed below the lower end of the anchor 212. The annular clearance space 230 between the mandrel 201 and housing 202 at this point provides fluid communication between the upper chamber 228 and lower chamber 229. A plurality of radial ports 231 through the housing 202 adjacent the elastomeric sleeve 232 provide fluid communication from this clearance 230 into the sealed space 233 underneath the elastomeric sleeve.

The upper end of the upper annular chamber 228 and lower end of the lower annular chamber 229 are respectively closed by annular piston members 234 and 235 which are slidably mounted therein and fluidly sealed by O-rings 236–239 to both the housing 202 and the mandrel 201. The upper slidable piston member 234 is free to move downwardly in the upper chamber until reaching an upwardly directed housing shoulder 240 therein. The lower slidable piston member 235 is normally biased downwardly by a spring 241 against an upwardly directed shoulder 242 formed in the housing 202 at the lower end of the lower chamber 229.

A mandrel shoulder 243 a short distance above the upper slidable piston 234 is suitably arranged to engage the upper piston and force it downwardly whenever the mandrel 201 shifts downwardly. Similarly, a second mandrel shoulder 244 is arranged below the piston 235 to engage and shift the lower piston member upwardly whenever the mandrel 201 shifts in that direction.

It will be appreciated, therefore, that with a suitable fluid in the above-described hydraulic system, longitudinal shifting of the mandrel 201 in either direction will expand the elastomeric sleeve 232 of the anchor 212 and press the casing-engaging members 245 and 246 against the casing. A compensating chamber 247 is formed in the housing 202 beneath the lower piston member 235 to maintain a supply of fluid in the hydraulic system as well as to compensate for

thermal expansion of the fluid. The lower end of this compensating chamber **247** is closed by a slidable annular compensating piston member **248** having O-rings **249** and **250** around its inner and outer surfaces to fluidly seal the compensating piston relative to the housing **202** and the mandrel **201**.

For reasons that will subsequently become apparent, a sleeve **251** is slidably disposed in the lower end of the housing **202** and releasably secured thereto by a frangible shear pin **252** or the like to hold an upper shoulder **253** of the sleeve a short distance below the compensating piston **248**. A compression spring **254** is mounted around the sleeve **251** and is confined between an upwardly directed housing shoulder **255** and a downwardly directed shoulder on sleeve **251**. An annular piston member **256** having a reduced-diameter upper portion **257** and an enlarged-diameter lower portion **258** is slidably disposed within the housing **202** below the shear pin **252**. O-rings **259** and **260**, respectively, around the enlarged and reduced portions **258** and **257** of the piston **256** are spaced from one another and fluidly seal the piston relative to the housing **202** to define an enclosed, sealed space **261** therebetween.

Selectively controlled fluid communication is provided between the compensating chamber **247** and the remainder of the hydraulic system through a housing passage **262** and an annular clearance space formed by a reduced-diameter portion **263** around the mandrel **201**. This reduced-diameter portion **263** is arranged to be in juxtaposition with the lower piston **235** whenever the mandrel **201** is in its intermediate position as determined by the mandrel lug **207** being confined within the shorter slot **210**. When, however, the mandrel **201** is so manipulated to shift the lug **207** into the longer slot **209** and the mandrel is shifted longitudinally only a slight distance in either direction, the inner O-ring **238** within the lower piston member **235** fluidly seals the piston to the mandrel at either **264** or **265**, depending upon the direction in which the mandrel has been shifted.

Accordingly, it will be seen that so long as the mandrel **201** is in a "neutral" or intermediate position (as determined by the lug **207** being within the short slot **210**), the mandrel is substantially restrained from shifting longitudinally in either direction. Thus, so long as the mandrel **201** is in this intermediate position, the upper and lower piston members **234** and **235** will be substantially in the positions illustrated in FIG. 6 and the mandrel shoulders **243** and **244** will be separated therefrom. With the mandrel **201** in this intermediate position, there will also be fluid communication between the compensating chamber **247** by way of the reduced-diameter mandrel portion **263** to permit free communication of the hydraulic fluid from the compensating chamber into the remainder of the hydraulic system.

Turning now to the operation of the bridge plug **200**, it will be realized that to shift the mandrel lug **207** within the slot system **208**, means must be provided to hold the housing **202** fixed relative to the mandrel **201**. Moreover, after the bridge plug **200** has been set, the housing **202** must remain anchored to the casing with a minimum holding force either when the mandrel **201** is not sufficiently displaced to shift one of the pistons **234** and **235** or as it is shifting through its intermediate position to one of the other positions. It will be recognized, of course, that were the lower spring **254** always engaged with the compensating piston **248**, the compensating piston would be urged upwardly to develop a pressure in the hydraulic system that was proportionately related to the spring force. Thus, by selecting a suitable spring rate for the spring **254**, a predetermined hydraulic pressure would be developed to maintain the wall-engaging members **245** and **246** engaged against the casing with a holding force that is adequate to accomplish the above-described functions.

Although this approach is successful in some operations, it has been found difficult in other instances to shift a bridge plug arranged in this manner downwardly in the well bore before it has reached a depth where the tubing string has sufficient weight to overcome the above-mentioned holding force. Inasmuch as the minimum holding force may well be in the order of a few thousands of pounds, it will be recognized that, in some instances, several hundreds of feet of tubing will be required before the weight of the assembled tubing string will freely shift the bridge plug downwardly.

Accordingly, in the bridge plug **200** depicted in FIGS. 6A and 6B, means are provided for initially removing the spring bias from the compensating piston **248** until such time that the bridge plug has reached a predetermined depth in a well bore. To accomplish this, the retainer sleeve **251** is secured at its lower end to the housing **202** by the shear pin **252** to depress the spring **254** below the compensating piston **248**. By spacing the retainer sleeve **251** below the compensating piston **248**, the compensating piston is free to move downwardly to accommodate thermal expansion of the hydraulic fluid within the system as the bridge plug **200** is lowered into warmer environments.

To release the retainer sleeve **251**, the stepped piston **256** immediately below the shear pin **252** is appropriately arranged to move upwardly and into engagement with the lower end of the retainer sleeve in response to the hydrostatic pressure of fluids in the well bore. It will be appreciated that as the bridge plug **200** is assembled at the surface, the space **261** between O-rings **259** and **260** will be at atmospheric pressure. Thus, as the hydrostatic pressure increases during the descent of the bridge plug **200**, it will act upon the effective cross-sectional area between O-rings **259** and **260** to urge the piston member **256** upwardly against the lower end of the retainer sleeve **251** with a force proportionately related to the hydrostatic pressure. Then, whenever the bridge plug **200** has reached a depth at which the hydrostatic pressure is sufficient to enable the piston **256** to shear the pin **252**, the retainer sleeve **251** will be released from the housing **202** and be carried upwardly by the compensating spring **254** until its upper end engages the compensating piston **248** immediately below the O-ring **250**. Once the compensating spring **254** has been released, it will be appreciated that it will urge the compensating piston **248** upwardly with a predetermined force calculated to develop sufficient hydraulic pressure within the system to move the casing-engaging members **245** and **246** outwardly against the casing with a desired holding force.

Once the bridge plug **200** has been positioned at the depth at which it is to be set, it is halted and the overshot (not shown) removed as previously described. As the overshot is removed, the mandrel **201** is shifted upwardly relative to the housing **202** to first sealingly engage the O-ring **238** within the lower piston **235** at **264** on the mandrel and, thereafter, bring lower mandrel shoulder **244** against the lower piston and shift it upwardly. As the lower piston **235** is shifted upwardly, it will be appreciated that a hydraulic pressure will be developed within the hydraulic system to expand the casing-engaging members **245** and **246** against the casing with still greater force. Thus, it will be appreciated that the bridge plug **200** will function similarly to those previously described.

Accordingly, it will be appreciated that the present invention provides new and improved packing apparatus having hydraulically actuated wall-engaging members. These members are arranged to be pressed into anchoring engagement with a well casing with a force proportionately related to whatever pressure differential is acting across the packing apparatus. Furthermore, this new and improved well-packing apparatus is capable of being releasably anchored in a packed-off condition to resist extreme pressure differentials acting from either longitudinal direction.

While particular embodiments of the present invention have been shown and described, it is apparent that changes

and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. A well packer sized and adapted for reception in a well bore for packing-off the well bore comprising: an outer tubular member; a body member slidably disposed within said outer member and operatively arranged to shift longitudinally relative thereto in response to a differential of fluid pressure above and below said members in a well bore; packing means operatively mounted on one of said members and arranged for expansion into sealing engagement with the well bore; anchoring means for securing said packer against movement relative to the well bore including outwardly-extendible wall-engaging means mounted on said outer member and fluidly sealed relative thereto to provide a fluid-tight space therebetween, said wall-engaging means being adapted for extension into engagement with the well bore upon application of hydraulic pressure in said fluid-tight space; and hydraulic means responsive to shifting of said body member for applying a hydraulic pressure in said fluid-tight space to press said wall-engaging means into anchoring engagement with a force proportionately related to said pressure differential.

2. A well packer sized and adapted for reception in a well bore for packing-off the well bore comprising: an outer tubular member; a body member slidably disposed within the bore of said outer member and operatively arranged to be shifted longitudinally relative thereto in response to a differential of fluid pressure above and below said members in a well bore; packing means operatively mounted on one of said members and arranged for expansion into sealing engagement with the well bore; anchoring means for securing said packer against movement relative to the well bore including outwardly-extendible wall-engaging means mounted on said outer member and fluidly sealed relative thereto to provide a fluid-tight space therebetween, said wall-engaging means being adapted for extension into engagement with the well bore upon application of hydraulic pressure in said fluid-tight space; and hydraulic means responsive to shifting of said body member for applying a hydraulic pressure in said fluid-tight space to press said wall-engaging means into anchoring engagement with a force proportionately related to said pressure differential including a piston member slidably disposed in said tubular member bore and adapted to be advanced along said bore by said body member whenever said body member shifts in one direction, first means fluidly sealing said tubular member bore at a point longitudinally spaced from said piston member in said one direction, second means fluidly sealing said piston member for providing a fluid-tight chamber in said tubular member bore intermediate said piston member and said longitudinally displaced point, and passage means providing fluid communication between said fluid-tight chamber and said fluid-tight space, said fluid-tight chamber and space being filled with a hydraulic fluid.

3. A well packer sized and adapted for reception in a well bore for packing-off the well bore comprising: an outer tubular member; a body member slidably disposed within the bore of said outer member and operatively arranged to be shifted longitudinally relative thereto in response to a differential of fluid pressure above and below said members in a well bore; packing means operatively mounted on one of said members and arranged for expansion into sealing engagement with the well bore; anchoring means for securing said packer against movement relative to the well bore including outwardly-extendible wall-engaging means mounted on said outer member and fluidly sealed relative thereto to provide a fluid-tight space therebetween, said wall-engaging means being adapted for extension into engagement with the well bore upon application of hydraulic pressure in said fluid-tight space; and hydraulic means responsive to shifting of said body member for applying a hydraulic pressure in said fluid-tight space to press said wall-engaging means into anchoring engagement with a force proportionately related to said pressure differential including first and second piston members slidably disposed in said tubular member bore and spaced apart, first and second means respectively fluidly sealing said piston members for providing a fluid-tight chamber in said tubular member bore between said piston members, passage means providing fluid communication between said fluid-tight chamber and said fluid-tight space, said fluid-tight chamber and space being filled with fluid, first means for advancing said first piston member toward said second piston member whenever said body member shifts in one direction and second means for advancing said second piston member toward said first piston member whenever said body member shifts in the opposite direction.

4. A well packer sized and adapted for reception in a well bore for packing-off the well bore comprising: an outer tubular member; a body member slidably disposed within the bore of said outer member and operatively arranged to be shifted longitudinally relative thereto in response to a differential of fluid pressure above and below said members in a well bore; packing means operatively mounted on one of said members and arranged for expansion into sealing engagement with the well bore; anchoring means for securing said packer against movement relative to the well bore including outwardly-extendible wall-engaging means mounted on said outer member and fluidly sealed relative thereto to provide a fluid-tight space therebetween, said wall-engaging means being adapted for extension into engagement with the well bore upon application of hydraulic pressure in said fluid-tight space; and hydraulic means responsive to shifting of said body member for applying a hydraulic pressure in said fluid-tight space to press said wall-engaging means into anchoring engagement with a force proportionately related to said pressure differential including first and second annular piston members slidably disposed around said body member and slidably received within said tubular member bore, said piston members being spaced apart, first and second means respectively fluidly sealing said piston members for providing a fluid-tight chamber in said tubular member bore between said piston members, passage means providing fluid communication between said fluid-tight chamber and said fluid-tight space, said fluid-tight chamber and space being filled with fluid, stop means limiting retrogression of said piston members, first means on said body member for advancing said first piston member toward said second piston member whenever said body member shifts in one direction and second means on said body member for advancing said second piston member toward said first piston member whenever said body member shifts in the opposite direction.

5. A well packer sized and adapted for reception in a well bore comprising: packing means adapted for expansion into sealing engagement with the well bore; a housing having a longitudinal bore; a body member slidably disposed within said housing bore and operatively arranged to shift longitudinally relative thereto in response to a differential of fluid pressure above and below said packing means in a well bore; anchoring means for securing said packer relative to the well bore including an inflatable elastomeric sleeve sealingly mounted around said housing to provide a fluid-tight space therebetween and wall-engaging means mounted around said elastomeric sleeve, said elastomeric sleeve being adapted to inflate upon application of hydraulic pressure in said fluid-tight space to press said wall-engaging means into engagement with the well bore; and hydraulic means for inflating said elastomeric sleeve to press said wall-engaging means into anchoring engage-

ment with a force proportionately related to said pressure differential including first and second annular piston members slidably disposed around said body member and slidably received within said housing bore, said piston members being spaced apart, first and second means respectively fluidly sealing said piston members for providing a fluid-tight chamber in said housing bore between said piston members, passage means providing fluid communication between said fluid-tight chamber and said fluid-tight space, said fluid-tight chamber and space being filled with fluid, stop means limiting retrogression of said piston members, first means on said body member for advancing said first piston member toward said second piston member whenever said body member shifts in one direction and second means on said body member for advancing said second piston member toward said first piston member whenever said body member shifts in the opposite direction.

6. A well packer sized and adapted for reception in a well bore comprising: packing means adapted for expansion into sealing engagement with the well bore; a housing having a longitudinal bore; a body member slidably disposed within said housing bore and operatively arranged to shift longitudinally relative thereto in response to a differential of fluid pressure above and below said packing means in a well bore; anchoring means for securing said well packer relative to the well bore including an inflatable elastomeric sleeve sealingly mounted around said housing to provide a fluid-tight space therebetween and wall-engaging means mounted around said elastomeric sleeve, said elastomeric sleeve being adapted to inflate upon application of hydraulic pressure in said fluid-tight space to press said wall-engaging means into engagement with the well bore; hydraulic means for inflating said elastomeric sleeve to press said wall-engaging means into engagement with the well bore with sufficient force to secure said housing against movement relative to said body member including first and second annular piston members slidably disposed around said body member and slidably received within said housing bore, said piston members being spaced apart, first and second means respectively fluidly sealing said piston members for providing a fluid-tight chamber in said housing bore between said piston members, passage means providing fluid communication between said fluid-tight chamber and said fluid-tight space, said fluid-tight chamber and space being filled with fluid; and biasing means normally urging said piston members toward one another; and means for inflating said elastomeric sleeve to press said wall-engaging means into anchoring engagement with the well bore with a force proportionately related to said pressure differential including stop means limiting retrogression of said piston members. first means on said body member for advancing said first piston member toward said second piston member whenever said body member shifts in one direction and second means on said body member for advancing said second piston member toward said first piston member whenever said body member shifts in the opposite direction.

7. A well packer sized and adapted for reception in a well bore for packing-off the well bore comprising: an outer tubular member; a body member slidably disposed within the bore of said outer member and operatively arranged to shift longitudinally relative thereto in response to a differential of fluid pressure above and below said members in a well bore; packing means operatively mounted on one of said members and arranged for expansion into sealing engagement with the well bore; anchoring means for securing said packer relative to the well bore including outwardly-extendible wall-engaging means mounted on said outer member and fluidly sealed relative thereto to provide a fluid-tight space therebetween, said wall-engaging means being adapted for extension into engagement with the well bore upon application of hydraulic pressure in said fluid-tight space; hydraulic means for applying a hydraulic pressure in said fluid-tight space to press said wall-engaging means into engagement with the well bore with sufficient force to secure said outer member against movement relative to said body member including a piston member slidably disposed in said tubular member bore, first means fluidly sealing said tubular member bore at a point longitudinally spaced from said piston member in one direction, second means fluidly sealing said piston member for providing a fluid-tight chamber in said tubular member bore intermediate said piston member and said longitudinally displaced point, passage means providing fluid communication between said fluid-tight chamber and said fluid-tight space, said fluid-tight chamber and space being filled with a hydraulic fluid, and biasing means normally urging said piston member toward said first sealing means; and means for applying a hydraulic pressure in said fluid-tight space to press said wall-engaging means into anchoring engagement with the well bore with a force proportionately related to said pressure differential including means on said body member for advancing said piston member toward said first sealing means whenever said body member shifts in said one direction.

8. A well packer sized and adapted for reception in a well bore for packing-off the well bore comprising: an outer tubular member; a body member slidably disposed within said outer member and operatively arranged to shift longitudinally relative thereto in alternate directions from a normal intermediate position; packing means operatively mounted on one of said members and arranged for expansion into sealing engagement with the well bore; anchoring means for securing said packer against movement relative to the well bore including outwardly-extendible wall-engaging means mounted on said outer member and fluidly sealed relative thereto to provide a fluid-tight space therebetween, said wall-engaging means being adapted for extension into engagement with the well bore upon application of hydraulic pressure in said fluid-tight space; and hydraulic means responsive to shifting of said body member for applying a hydraulic pressure in said fluid-tight space to press said wall-engaging means into anchoring engagement with a force proportionately related to the distance beyond said intermediate position which said body member shifts in either of said alternate directions.

9. A well packer sized and adapted for reception in a well bore for packing-off the well bore comprising: an outer tubular member; a body member slidably disposed within the bore of said outer member and operatively arranged to be shifted longitudinally relative thereto; packing means operatively mounted on one of said members and arranged for expansion into sealing engagement with the well bore; anchoring means for securing said packer against movement relative to the well bore including outwardly-extendible wall-engaging means mounted on said outer member and fluidly sealed relative thereto to provide a fluid-tight space therebetween, said wall-engaging means being adapted for extension into engagement with the well bore upon application of hydraulic pressure in said fluid-tight space; and hydraulic means responsive to shifting of said body member for applying a hydraulic pressure in said fluid-tight space to press said wall-engaging means into anchoring engagement with a force proportionately related to the distance said body member shifts including first and second piston members slidably disposed in said tubular member bore and spaced apart, first and second means respectively fluidly sealing said piston members for providing a fluid-tight chamber in said tubular member bore between said piston members, passage means providing fluid communication between said fluid-tight chamber and said fluid-tight space, said fluid-tight chamber and space being filled with fluid, first means for advancing said

first piston member toward said second piston member whenever said body member shifts in one direction and second means for advancing said second piston member toward said first piston member whenever said body member shifts in the opposite direction.

10. A well tool sized and adapted for reception in a well bore comprising: an outer tubular member; a body member slidably disposed within said outer member and operatively arranged to shift longitudinally relative thereto in alternate directions from a normal intermediate position; anchoring means for securing said tool against movement relative to the well bore including outwardly-extendible wall-engaging means mounted on said outer member and fluidly sealed relative thereto to provide a fluid-tight space therebetween, said wall-engaging means being adapted for extension into engagement with the well bore upon application of hydraulic pressure in said fluid-tight space; and hydraulic means responsive to shifting of said body member for applying a hydraulic pressure in said fluid-tight space to press said wall-engaging means into anchoring engagement with a force proportionately related to the distance beyond said intermediate position which said body member shifts in either of said alternate directions.

11. A well tool sized and adapted for reception in a well bore comprising: an outer tubular member; a body member slidably disposed within the bore of said outer member and operatively arranged to be shifted longitudinally relative thereto; anchoring means for securing said tool against movement relative to the well bore including outwardly-extendible wall-engaging means mounted on said outer member and fluidly sealed relative thereto to provide a fluid-tight space therebetween, said wall-engaging means being adapted for extension into engagement with the well bore upon application of hydraulic pressure in said fluid-tight space; and hydraulic means responsive to shifting of said body member for applying a hydraulic pressure in said fluid-tight space to press said wall-engaging means into anchoring engagement with a force proportionately related to the distance said body member shifts including first and second piston members slidably disposed in said tubular member bore and spaced apart, first and second means respectively fluidly sealing said piston members for providing a fluid-tight chamber in said tubular member bore between said piston members, passage means providing fluid communication between said fluid-tight chamber and said fluid-tight space, said fluid-tight chamber and space being filled with fluid, first means for advancing said first piston member toward said second piston member whenever said body member shifts in one direction and second means for advancing said second piston member toward said first piston member whenever said body member shifts in the opposite direction.

12. A packer sized and adapted for reception in a well bore comprising: telescoping mandrel and housing members movable longitudinally relative to one another between alternate positions above and below a normal intermediate position, pack-off means on one of said members, hydraulically actuatable wall-engaging means on said housing member, means for hydraulically applying pressure to said wall-engaging means, and means responsive to selective positioning of said members in either of said alternate positions for actuating said hydraulic means.

13. A packer sized for reception in a well bore comprising: telescoping mandrel and housing members movable longitudinally relative to one another between alternate positions above and below a normal intermediate position, said mandrel having a passage therethrough; pack-off means on one of said members; hydraulically actuatable wall-engaging means on said housing member; means for applying hydraulic pressure to said wall-engaging means; means responsive to selective positioning of said members in either of said alternate positions for actuating said hydraulic means; and means for selectively closing said passage.

14. A packer sized for reception in a well bore comprising: telescoping mandrel and housing members movable longitudinally relative to one another between alternate positions above and below a normal intermediate position, pack-off means on said housing member; hydraulically actuatable wall-engaging means on said housing member, hydraulic means for applying pressure to said wall-engaging means; and means responsive to positioning of said mandrel in either of said alternate positions relative to said housing member for actuating said hydraulic means.

15. A packer for use in a well bore comprising: telescoping mandrel and housing members movable longitudinally relative to one another between alternate positions above and below a normal intermediate position, pack-off means on one of said members; pressure-responsive wall-engaging means on said housing member; fluid-pressure means for applying pressure to said wall-engaging means to anchor said housing member to a well bore; and means responsive to selective positioning of said members in either of said alternate positions for actuating said fluid-pressure means.

16. A packer for use in a well bore comprising: telescoping mandrel and housing members movable longitudinally relative to one another between alternate positions above and below a normal intermediate position, pack-off means on said housing member, pressure-responsive wall-engaging means on said housing member, fluid-pressure means for applying pressure to said wall-engaging means to anchor said housing member to a well bore, and means responsive to selective positioning of said mandrel in either of said alternate positions relative to said housing member for actuating said fluid-pressure means.

17. A packer for use in a well conduit comprising: telescoping mandrel and housing members movable longitudinally relative to one another between alternate positions above and below a normal intermediate position; conduit pack-off means on said housing member; pressure-responsive wall-engaging means on said housing member; fluid-pressure means between said members in communication with said wall-engaging means for operating said wall-engaging means; and means responsive to shifting of said mandrel to either of said alternate positions relative to said housing member for actuating said fluid-pressure means.

18. A packer for use in a well bore comprising: telescoping mandrel and housing members, said members being relatively movable between upper, lower and intermediate positions; pack-off means on one of said members; hydraulically actuatable wall-engaging means on said housing member, hydraulic means for applying pressure to said wall-engaging means; and means responsive to positioning of said members in upper and lower positions for actuating said hydraulic means.

19. A packer for use in a well bore comprising: telescoping mandrel and housing members, said members being relatively movable between upper, lower and intermediate positions; conduit pack-off means on one of said members; hydraulically actuatable wall-engaging means on said housing member; hydraulic means for applying pressure to said wall-engaging means; means responsive to positioning of said members in upper and lower positions for actuating said hydraulic means; and means for releasably holding said members in said intermediate position.

20. A packer for use in a well bore comprising: telescoping mandrel and housing members, said mandrel having a passage therethrough; a pack-off means on one of said members, said members being relatively movable between upper, lower and intermediate positions; hydraulically actuatable wall-engaging means on said housing member; hydraulic means for applying pressure to said wall-engaging means; means responsive to positioning of said

members in upper and lower positions for actuating said hydraulic means; means for releasably holding said members in said intermediate position; and means for selectively closing said passage.

21. A packer for use in a well bore comprising: inner and outer telescoping members, oppositely facing cup packers on said outer member, segmented, expandable elements mounted on said outer member and having outer surfaces for frictionally engaging a well bore; an expandable fluid-tight sleeve on said body adjacent said elements for expanding said elements into engagement with a well bore, said members having a space therebetween in fluid communication with said sleeve, first and second slidable piston means in said space and defining a closed chamber, a fluid in said closed chamber, means for limiting motion of said pistons in a direction away from one another, and means on said inner member for selectively engaging and moving one or the other of said piston means to apply pressure to said sleeve and expand said elements.

22. A packer for use in a well bore comprising: inner and outer telescoping members, pack-off means on said outer member, expandable elements mounted on said outer member and having outer surfaces for engaging a well bore; an expandable fluid-tight sleeve on said body adjacent said elements for expanding said elements into engagement with a well bore, said members having a space therebetween in fluid communication with said sleeve, first and second slidable piston means in said space and defining a closed chamber, a fluid in said closed chamber, means for limiting motion of said pistons in a direction away from one another, and means on said inner member for selectively engaging and moving one or the other of said piston means to apply pressure to said sleeve and expand said elements.

23. A retrievable bridge plug sized and adapted for reception in a well bore comprising: telescoping inner and outer members, said members being relatively movable between upper, lower and intermediate locations, said members having a space therebetween and sealing means between said members; pack-off means on one of said members; hydraulically actuatable wall-engaging means on said outer member and having fluid communication to said space; upper and lower slidable piston means in said space; a fluid in said space whereby said piston means may apply pressure to said wall-engaging means, means on one of said members selectively cooperating with one or the other of said pistons in said upper and lower locations to apply pressure; means for releasably holding said members in said intermediate location; passage means through said inner member; and valve means for selectively closing said passage.

24. A retrievable bridge plug sized and adapted for reception in a well bore comprising: telescoping inner and outer members, said members being relatively movable between upper, lower and intermediate locations, said members having a space therebetween and sealing means between said members; pack-off means on one of said members; hydraulically actuatable wall-engaging means on said outer member and having fluid communication to said space; upper and lower slidable piston means in said space; a fluid in said space whereby said piston means may apply pressure to said wall-engaging means, means on one of said members selectively cooperating with one or the other of said pistons in said upper and lower locations to apply pressure; means for releasably holding said members in said intermediate location; passage means through said inner member; and valve means for selectively closing said passage, said inner member having a release connection permitting separation of said bridge plug from a lowering-in tool.

References Cited by the Examiner

UNITED STATES PATENTS

2,638,168	5/1953	Parks	166—120
2,880,805	4/1959	Nelson et al.	166—120
2,925,128	2/1960	Page	166—121
3,164,210	1/1965	Lewis	166—121
3,233,675	2/1966	Tamplen et al.	166—120
3,253,656	5/1966	Brown	166—129

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