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PRESSURE-RESPONSIVE ANCHOR FOR WELL PACKING APPARATUS

Filed June 11, 1964 6 Sheets-Sheet 1

Fig. 1

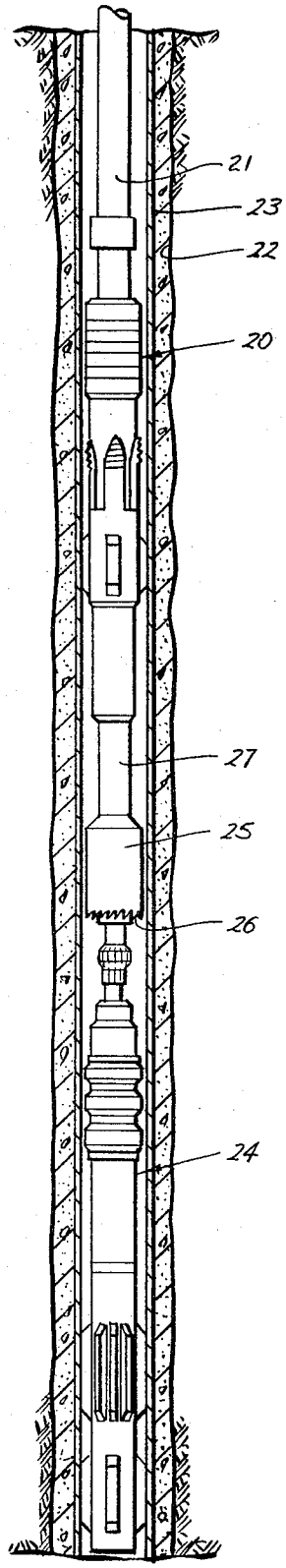
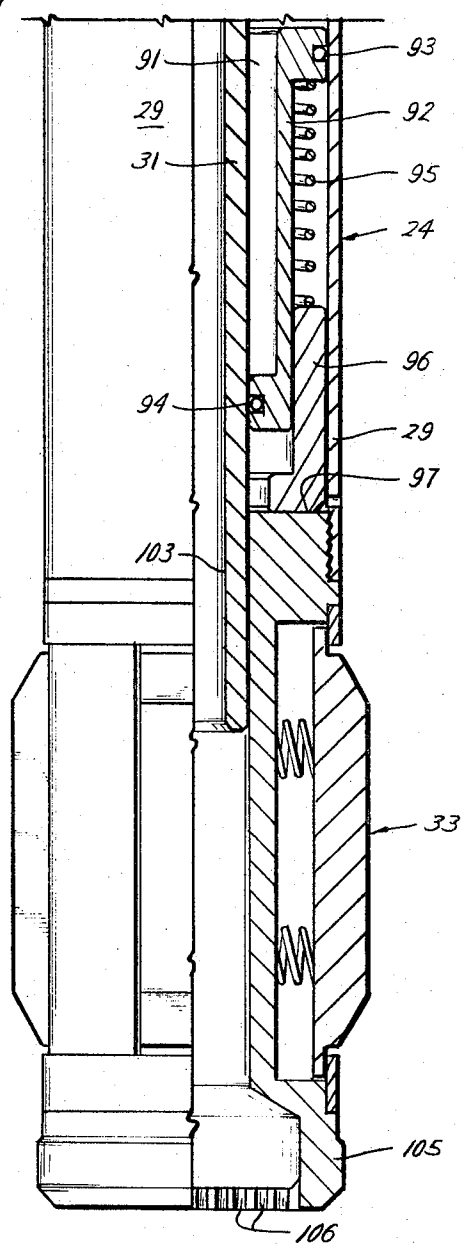


Fig. 2E



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PRESSURE-RESPONSIVE ANCHOR FOR WELL PACKING APPARATUS

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Fig. 2A

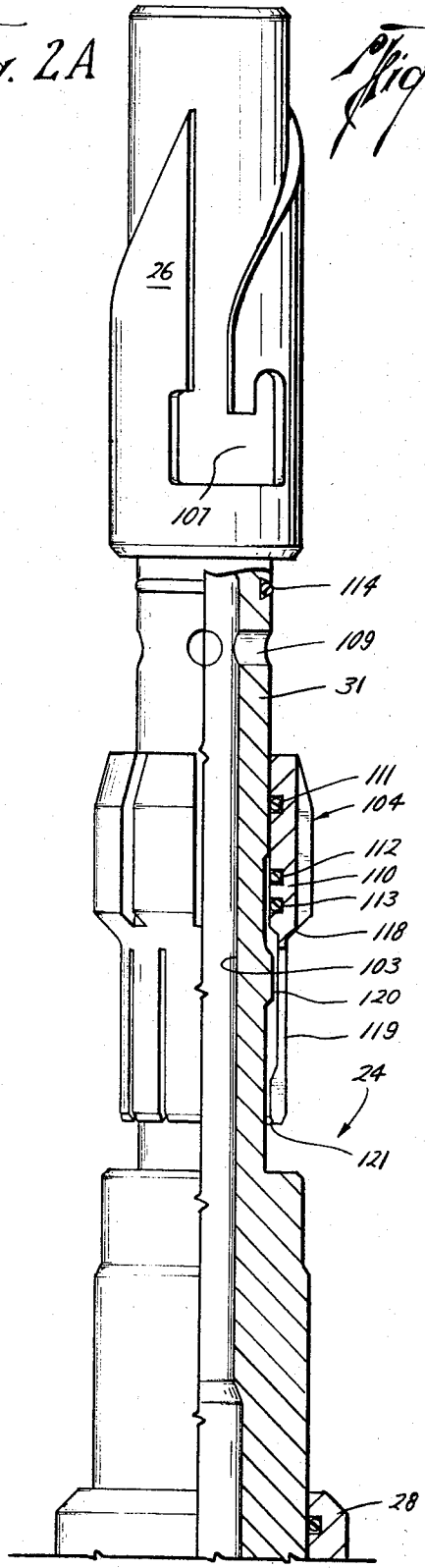
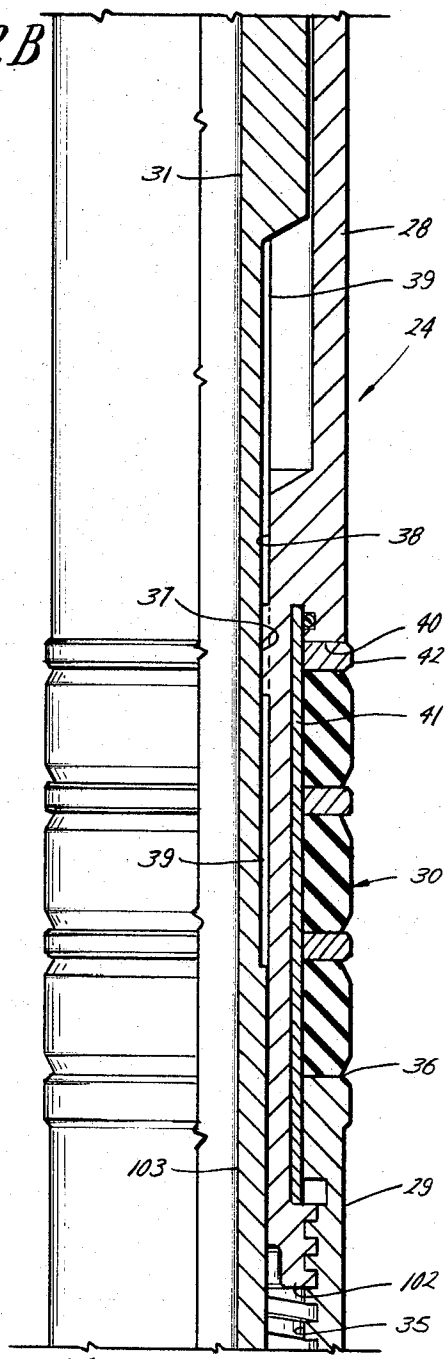


Fig. 2B



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PRESSURE-RESPONSIVE ANCHOR FOR WELL PACKING APPARATUS

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Fig. 2C

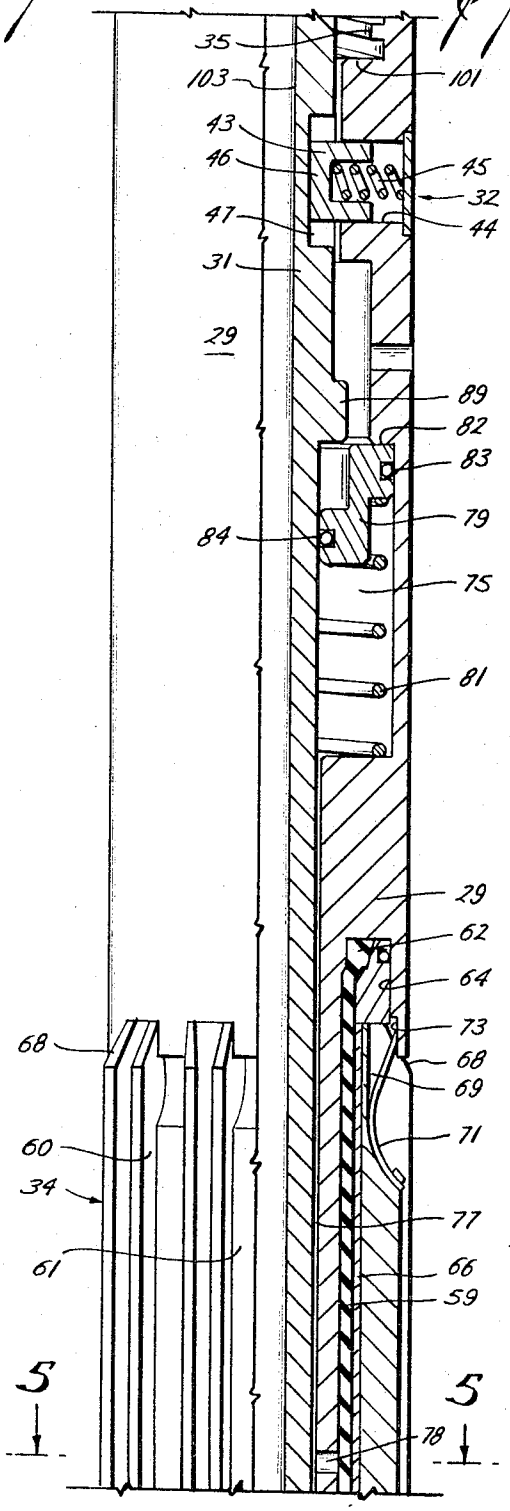
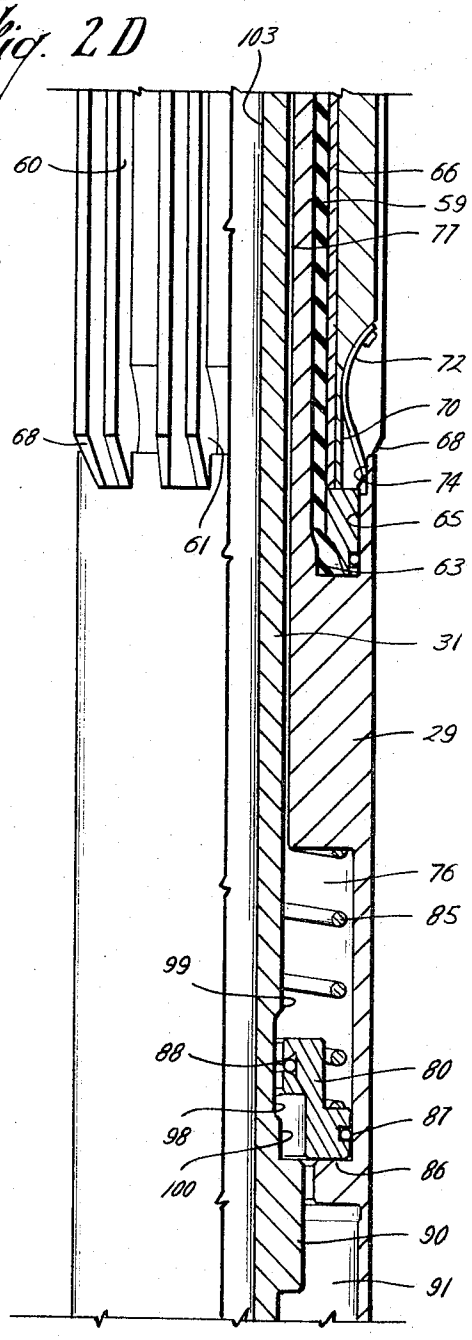


Fig. 2D



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PRESSURE-RESPONSIVE ANCHOR FOR WELL PACKING APPARATUS

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Fig. 3

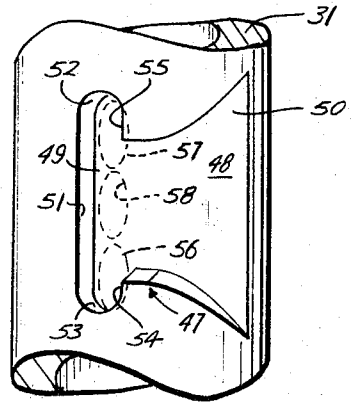

Fig. 4

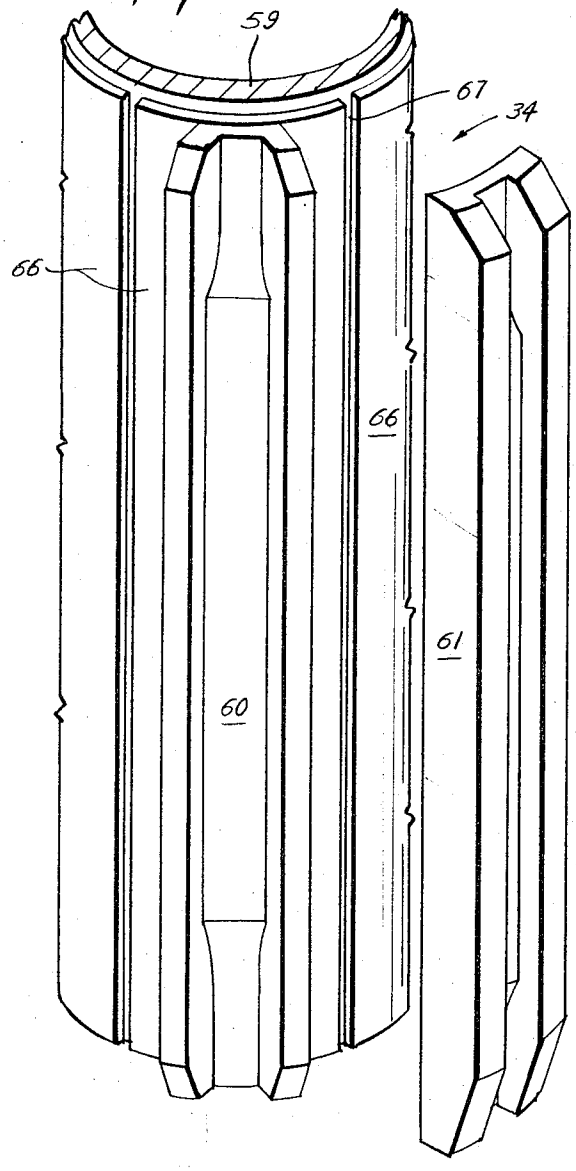

Fig. 10

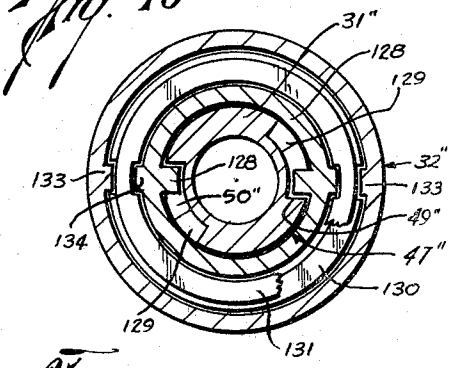

Fig. 5

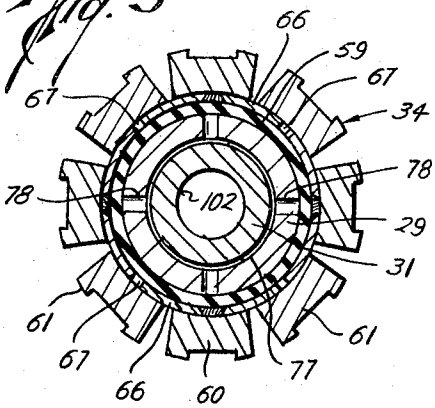

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Fig. 6

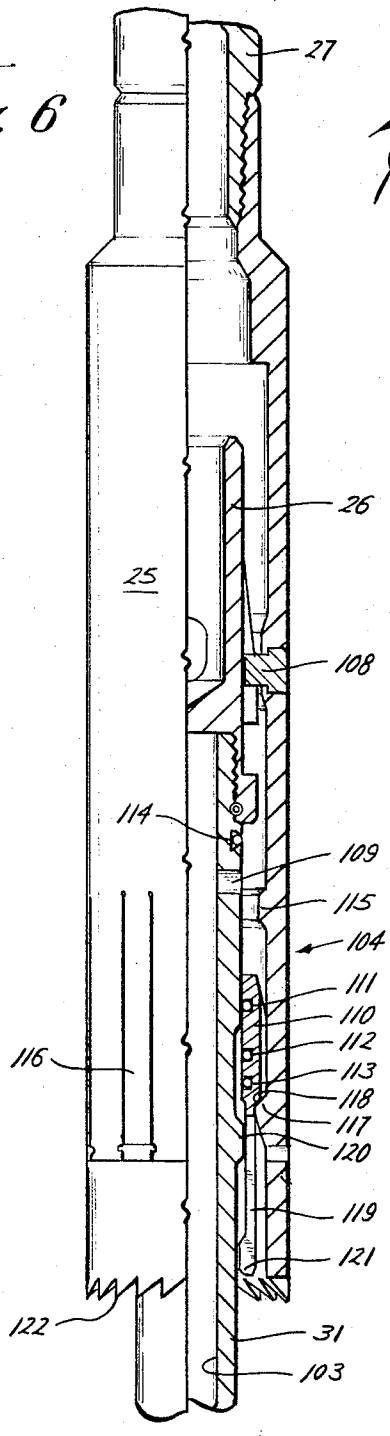
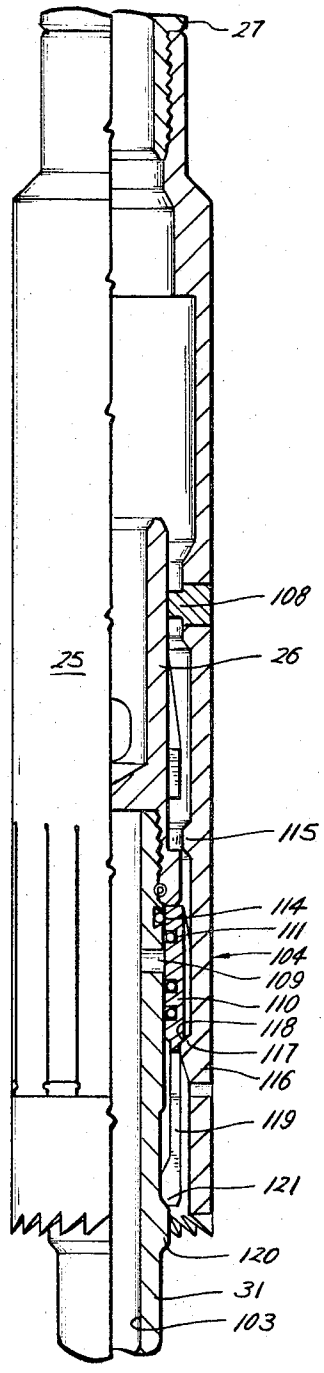


Fig. 7



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PRESSURE-RESPONSIVE ANCHOR FOR WELL PACKING APPARATUS

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Fig. 8

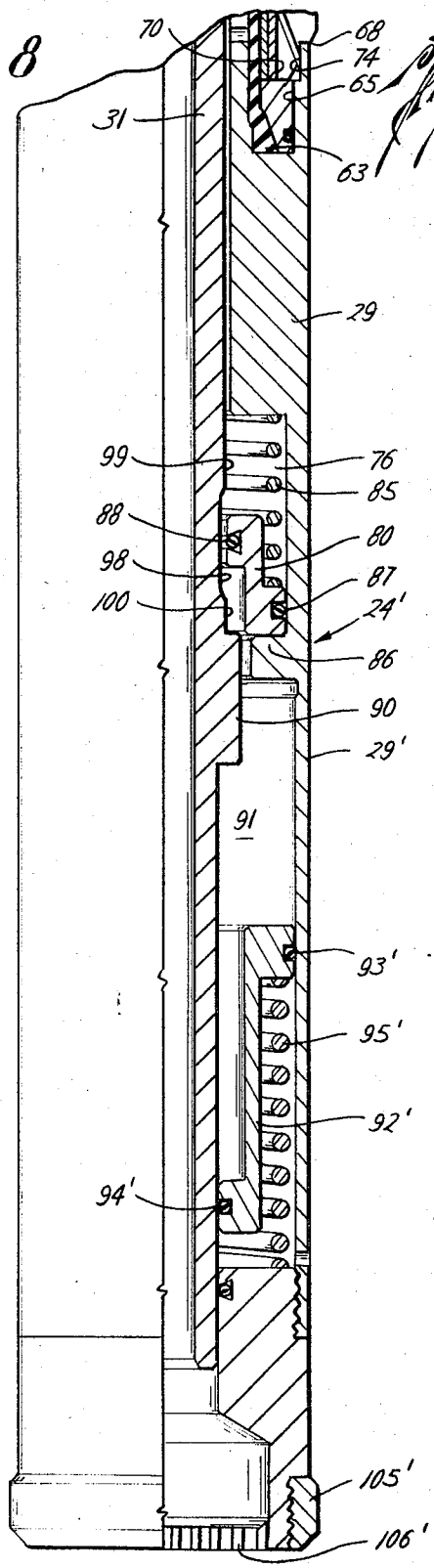
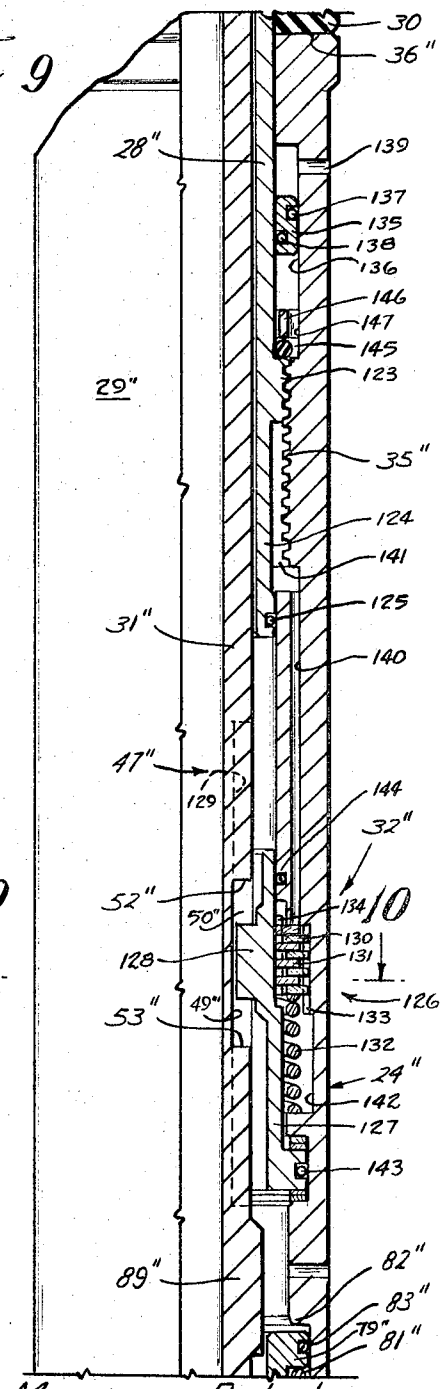


Fig. 9



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United States Patent Office

3,305,021

Patented Feb. 21, 1967

3,305,021

PRESSURE-RESPONSIVE ANCHOR FOR WELL PACKING APPARATUS

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Filed June 11, 1964, Ser. No. 374,535
21 Claims. (Cl. 166—122)

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 against hydraulic pressure in the well acting on the plug or packer from either direction 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 and 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 retrievable bridge plug can be dependently coupled beneath the full-opening packer. Such a bridge plug permits pack-off zones of selected length in the well bore for selective treatment of different formation intervals with only one trip in the well.

It will be appreciated that such packers and bridge plugs must be capable of withstanding high pressures acting from either direction. Furthermore, during the course of typical completion operations, both types of such packing apparatus can be subjected to high pressures acting alternately from both above and below the apparatus. Accordingly, it is necessary to securely anchor such packing apparatus 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 and secure the apparatus against shifting.

Retrievable bridge plugs in the past have generally employed cup-type packers which, have particular limitations in that the cups (1) sometimes become defective while in service within a well bore, (2) they are not capable of effective sealing where a low pressure differential exists and can break down with high pressures that are sometimes present in a well bore, and (3) a fluid bypass must be provided through the tool body.

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 the fluid in the well.

It is an additional object of the present invention to provide new and improved retrievable bridge plugs which employ expandable and retractable elastomeric annular packing elements rather than cup-type packers.

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

It is still another object of the present invention to provide retrievable bridge plugs having annular packing elements which are expanded into sealing engagement by rotative motion of an actuator.

Packing apparatus arranged in accordance with the present invention includes selectively operable wall-engaging means operated by a self-contained hydraulic system which, in response to the pressure of fluids in a well, is adapted to press the wall-engaging means into anchoring engagement with a force proportionately related to this fluid pressure. After the packing element and wall-engaging means are selectively extended, the hydraulic system responds to a pressure differential across the apparatus to maintain the apparatus anchored against the casing with an anchoring force which is proportional to this pressure 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–2E are detailed cross-sectional views in succession 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 an isometric view showing particular details of a friction anchor employed with the present invention;

FIG. 5 is a cross-sectional view taken along the line 5—5 of FIG. 2C;

FIG. 6 is a view showing the upper end of the bridge plug of FIG. 2 with its equalizing valve open;

FIG. 7 is a view similar to FIG. 6, but with the equalizing valve closed;

FIG. 8 is a partial view of an alternate embodiment of a bridge plug;

FIG. 9 is a partial view of another alternate embodiment of a bridge plug;

FIG. 10 is a cross-sectional view taken along the line 10—10 of FIG. 9.

As seen in FIG. 1, a typical full-bore packer **20** with a conventional hold-down (not shown) on its mandrel is dependently connected from a tubing string **21** and positioned within a well bore **22** having a casing **23** set therein. A retrievable bridge plug **24** is shown sealingly and anchoringly engaged with the casing **23**. An overshot **25** dependently connected beneath the well packer **20** is releasably coupled to a fishing neck **26** on the bridge plug **24**. This releasable coupling allows the bridge plug **24** to be set at the lower limit of a particular formation interval and the packer **20** subsequently set at any point thereabove irrespective of the length of the tubing sub **27** connecting the packer to the bridge plug.

Turning now to FIGS. 2A–2E, the retrievable bridge plug **24** depicted in FIG. 1 is constructed in accordance with the principles of the present invention and includes a rotatable tubular sleeve member **28** (FIG. 2B) having one end telescopically arranged within and threadedly engaged with a tubular housing member **29** (FIGS. 2B–

2E). Elastomeric packing means **30** (FIG. 2B) mounted around the tubular sleeve **28** are arranged to be foreshortened and expanded outwardly into sealing engagement whenever the tubular sleeve **28** is rotated in one direction relative to the housing **29**. Rotation of the tubular sleeve **28** in the opposite direction will, of course, allow the elastomeric packing means **30** to relax and return to their normal position.

An actuating body member or index mandrel **31** (FIGS. 2A–2E) is slidably engaged and co-rotatively secured within the tubular sleeve **28** and extended on into the housing **29**. Normally engaged latch means **32** (FIG. 2C) releasably latch the mandrel to the housing **29** to prevent the mandrel **31** from shifting longitudinally until the mandrel has first been rotated a predetermined amount as it screws the tubular sleeve **28** inwardly into the housing to foreshorten the packing means **30**. The members **28, 29** and **31** are, of course, made in separate sections which are arranged with threaded connections where needed to facilitate manufacture and assembly. These threaded connections are not shown, however, for purposes of greater clarity.

The housing **29** is initially restrained against rotation by a set of conventional spring-biased drag blocks **33** (FIG. 2E) mounted around the housing and arranged to be continuously biased outwardly against the casing. As is customary, the force exerted by these blocks is not sufficient to prevent the bridge plug **24** from being longitudinally shifted through the casing. Once the bridge plug **24** has been brought to rest, however, the static frictional drag imposed by the drag blocks **33** will be sufficient to effectively hold the housing **29** fixed as the index mandrel **31** is rotated therein.

A hydraulically-actuated, radially-expansible, friction anchor **34** (FIGS. 2C–2D) mounted on the housing **29** is adapted to be pressed against the casing whenever the mandrel **31** shifts longitudinally in either direction with respect to the housing to anchor the bridge plug **24** relative to the casing.

The lower end of the rotatable tubular sleeve member **28** is threadedly engaged and received within particularly arranged right-hand threads **35** (FIGS. 2B–2C) around the upper end **36** of the housing **29**. The sleeve member **28** is provided with a series of inwardly projecting, longitudinal splines **37** (FIG. 2B) spaced around its inner bore **38** which are cooperatively and slidably received within a series of substantially elongated, complementary, longitudinal spline grooves **39** formed around the periphery of the index mandrel **31**. As will be subsequently described, once the latch means **32** (FIG. 2C) has been released from the mandrel, these splines **37** and their longer mating grooves **39** allow the mandrel **31** to freely shift longitudinally with respect to the sleeve member **28** but prevent these members **28, 31** from rotating relative to one another.

The elastomeric packing means **30** (FIG. 2B) are mounted around the tubular sleeve **28** and disposed between the upper end **36** of the housing and a downwardly facing annular shoulder **40** provided around the upper end of the sleeve. A tubular guard **41** loosely disposed around the tubular sleeve **28** and inside of the packing means **30** allows the sleeve to rotate freely within the packing element. Thus, as the tubular sleeve **28** is being screwed downwardly into the housing **29** to foreshorten the packing means **30**, no torque is applied against the internal circumferential surfaces of the packing means. For similar reasons, a freely swiveling annular ring **42** around the upper end of the packing means **30** allows the sleeve **28** to rotate without twisting the upper end of the packing means.

The releasable latching means **32** (FIG. 2C) normally holds the index mandrel **31** fixed longitudinally with respect to the housing **29**, but is so arranged that it is selectively released by torquing the mandrel **31** in a clockwise direction as the packing means **30** is being foreshortened. The latching means **32** is comprised of a reciprocable lug member **43** which is slidably received within an inwardly directed lateral bore or recess **44** provided in a central portion of the housing **29**. A spring member **45** biases the lug **43** inwardly so that its inner end **46** is engaged within a T-shaped groove **47** in the periphery of the mandrel **31** whenever this groove is in juxtaposition with the end of the lug.

As shown in detail in FIG. 3, the T-shaped groove **47** has a flat bottom **48** cut along a plane including a chord of the circular cross-section of the mandrel **31**. The groove **47** has an elongated portion **49** extending longitudinally along the mandrel **31** and a branch portion **50** extending to the right and perpendicularly away from the center of the longitudinal groove portion **49**. As shown isometrically in FIG. 3, the elongated groove portion **49** provides a continuous shoulder **51** along its left side, opposed semicircular shoulders **52, 53** at each end, and short shoulders **54, 55** along its right side on opposite sides of the branch portion **50**. The branch portion **50** diverges as it extends away from the elongated groove portion **49** with the flat bottom **48** being terminated and slightly rounded-off where it intersects and merges into the outer surface of the mandrel **31**.

It will be understood that so long as the inner end **46** of the spring-loaded lug **43** is within the longitudinal groove portion **49**, the mandrel **31** can shift only a very limited distance longitudinally. Left-hand rotation of the index mandrel **31** relative to the housing **29** is, of course, prevented by the end **46** of the lug **43** engaging the straight shoulder **51** of the longitudinal slot portion **49**. Moreover, as the bridge plug **24** is being raised or lowered within the casing, it will be appreciated that the end **46** of the lug **43** will be respectively shifted into the positions **56, 57** shown by dashed lines in FIG. 3. Thus, so long as there is either an upward or downward force on the mandrel **31**, shoulder **54** or shoulder **55** will prevent the mandrel from being rotated to the right as well. The mandrel **31**, therefore, must first be shifted in such a manner that the lug end **46** is substantially in a neutral position **58** before it can be torqued to the right for setting of the bridge plug **24**.

Accordingly, when the lug end **46** is placed in the neutral position **58**, clockwise rotation of the index mandrel **31** will rotate the flat surface **48** from under the lug end to gradually urge the spring-loaded lug **43** back into its recess **44**. Continued rotation of the mandrel **31** in this direction will, of course, depress the spring-loaded lug **43** and free the mandrel **31** as the packing means **30** is being set. Once the spring-loaded lug **43** is disengaged from the T-groove **47**, the index mandrel **31** is then free to shift longitudinally relative to the housing **29** as well as to the sleeve member **28**.

Mounted around the housing **29** is an expansible anchor assembly **34** (FIGS. 2C–2D) with parts thereof being shown in detail in FIGS. 5 and 6. This assembly **34** includes an elastomeric sleeve **59** encircling the housing **29** with a plurality of elongated casing-contacting members **60, 61** uniformly mounted around the periphery of the sleeve. The upper **62** and lower **63** ends of the elastomeric sleeve **58** are enlarged and sealingly secured within peripheral recesses **64, 65** provided in the housing **29**.

Each of the casing-engaging members **60, 61** are elongated and have a thick, arcuate cross-section (FIGS. 4 and 5). Alternate ones **60** of these casing-engaging members are centrally aligned and mounted along the outer convex surface of relatively thin, elongated, arcuate backing members **66**. A sufficient number of these mounted members **60** are disposed uniformly around the periphery of the elastomeric sleeve **59** so that the backing members **66** substantially encompass the sleeve. The remaining unmounted casing-engaging members **61** are alternately disposed between the mounted casing-engaging members **60** in such a manner that the unmounted members **61** will

straddle adjacent backing members **66** and cover the gap **67** therebetween.

The ends of the casing-engaging members **60, 61** are beveled, as at **68**, for reception within opposed annular recesses **64, 65** around the housing **29** at opposite ends of the members (FIGS. 2C–2D). A longitudinal slot **69, 70** cut into each of the members **60, 61** receives one end of arcuate leaf springs **71, 72** which normally bias the casing-engaging members radially inwardly. The opposite ends of these leaf springs **71, 72** are received within the annular housing recesses **64, 65** and engaged against inwardly directed shoulders **73, 74** formed therein. It will be appreciated that although the casing-engaging members **60, 61** are moved radially outwardly against springs **71, 72** whenever the elastomeric sleeve **59** is inflated, the beveled end portions **68** of the casing-engaging members will engage and be stopped by the inwardly directed shoulders **73, 74** of recesses **64, 65** in the housing at opposite ends of the members **60, 61**.

Turning now to the hydraulic system of the present invention, the housing **29** is formed in such a manner as to provide an annular chamber **75** (FIG. 2C) above the upper end of the anchor **34** and a similar annular chamber **76** (FIG. 2D) below the lower end of the anchor. An annular clearance space **77** between the index mandrel **31** and housing **29** provides fluid communication from the upper chamber **75** to the lower chamber **76**. A plurality of radial ports **78** through the housing **29** adjacent the elastomeric sleeve **59** provide fluid communication from this clearance space **77** into the sealed space underneath the elastomeric sleeve.

The upper end of the upper annular chamber **75** and the lower end of the lower annular chamber **76** are respectively closed by annular piston members **79, 80** which are slidably mounted relative to both the housing **29** and the index mandrel **31**. The upper slidable piston member **79** (FIG. 2C) is biased upwardly by a spring **81** which normally urges this piston member **79** against a downwardly directed shoulder **82** formed in the housing at the upper end of the upper chamber **75**. Annular grooves around the outer and inner surfaces, respectively, of the upper piston member receive O-rings **83, 84** which fluidly seal the slidable piston member **79** relative to the housing **29** as well as to the index mandrel **31**.

In a similar manner, the lower slidable piston member **80** (FIG. 2D) is biased downwardly by a spring **85** so that the lower piston member normally rests against an upwardly directed shoulder **86** formed in the housing **29** at the lower end of the lower chamber **76**. Similarly, external and internal annular grooves around the piston member **80** receive O-rings **87, 88** to fluidly seal the slidable piston member **80** relative to both the housing **29** and the index mandrel **31**.

A shoulder **89** (FIG. 2C) located on the mandrel **31** a short distance above the upper slidable piston **79** is so arranged that whenever the mandrel **31** shifts downwardly, the shoulder will engage upper piston **79** and force the piston downwardly. Similarly, a second shoulder **90** (FIG. 2D) is provided on the mandrel to engage and shift lower piston member **80** upwardly whenever the mandrel **31** shifts in that direction.

It will be appreciated that with a suitable fluid in the above-described hydraulic system, longitudinal shifting of the mandrel **31** in either direction will expand the elastomeric sleeve **59** of the anchor **34** and press the casing-engaging members **60, 61** against the casing. Thus, as the tubular sleeve **28** (FIG. 2B) is being rotated downwardly by the mandrel **31** to set the packing means **30**, the upper piston **79** (FIG. 2C) will be engaged and forced downwardly by the mandrel shoulder **89**. Downward shifting of this piston **79** will, of course, cause the anchor **34** to be extended into anchoring engagement with the casing.

A compensating chamber **91** (FIGS. 2D–2E) is provided in the housing **29** beneath the lower piston member **80** to ensure that the hydraulic system remains full as well as to compensate for thermal expansion of the hydraulic fluid. The lower end of this compensating chamber **91** is closed by a slidable annular compensating piston member **92** (FIG. 2E) having O-rings **93, 94** around its outer and inner surfaces, respectively, which fluidly seal the compensating piston relative to the housing **29** and mandrel **31**. A relatively light spring **95** underneath the compensating piston holds it off of an annular spacer member **96** which, in turn, rests on an upwardly facing housing shoulder **97**. The spring **95** will contract and expand in accordance with thermal expansion of the hydraulic fluid and continuously bias the compensating piston **92** against the hydraulic fluid.

Selectively controlled fluid communication is provided between the compensating chamber **91** and the remainder of the hydraulic system through an annular clearance space formed by a reduced-diameter portion **98** (FIG. 2D) around the index mandrel **31**. This reduced-diameter portion **98** is arranged to be in juxtaposition with the lower piston **80** whenever the mandrel **31** is in its previously described latched position. Whenever the mandrel **31** is shifted only a slight distance longitudinally, however, the inner sealing member **88** around the inner bore of lower piston member **80** fluidly seals the piston to the mandrel at either **99** or **100**, depending upon the direction in which the mandrel shifts.

Turning now to the operation of the bridge plug **24**, whenever the bridge plug has been positioned at the depth in the well bore where it is desired to set the packing element **30**, the tubing string **21** is manipulated properly to shift the locking lug end **46** to its neutral position **58**. The tubing **21** and index mandrel **31** are then rotated to the right. This rotation allows the bottom **48** of the T-shaped groove **47** to cam the locking lug **43** (FIG. 2C) back into its recess **44** thereby freeing the mandrel **31** from the housing **29**. The housing **29** is, of course, secured against this rotation since the drag blocks **33** hold the housing fixed relative to the casing. Accordingly, right-hand rotation of the mandrel **31** frees it from the housing **29** as it simultaneously (in view of splines **37** and grooves **39**) begins to screw the sleeve **28** downwardly into the housing along the threads **35** (FIG. 2B).

As the sleeve **28** is screwed downwardly, it will be appreciated that the downwardly facing shoulder **40** around the upper end of the sleeve advances toward the upper end **36** of the housing **29** to foreshorten the packing means **30**. The pitch of the threads **35** is appropriately selected so that approximately only three-quarters of a revolution is required to advance the sleeve **28** a sufficient distance to fully displace the packing means **30** into sealing engagement with the casing. An upwardly directed housing shoulder **101** (FIG. 2C) is arranged to be engaged by the lower end **102** (FIG. 2B) of the sleeve **28** and halt further advancement of the sleeve whenever it has rotated approximately three-quarters of a revolution which otherwise might allow the lug **43** to snap back into the T-shaped groove **47** and relatch the mandrel.

It will be further appreciated that when the mandrel **31** moves downwardly only a slight distance with respect to the housing **29**, the reduced-diameter portion **98** (FIG. 2D) of the mandrel is shifted out of juxtaposition with the lower slidable piston member **80**. When this reduced diameter portion **98** shifts a slight distance downwardly relative to the lower slidable piston member **80**, O-ring **88** sealingly engages the periphery of the mandrel at **99** to trap all hydraulic fluid in the system above the lower slidable piston member. It will also be noted that continued downward travel of the mandrel **31** will soon bring the upper shoulder **89** (FIG. 2C) projecting outwardly from the mandrel into engagement with the upper piston member **79** and begin to shift it downwardly. Thus, with the lower piston **80** engaged against shoulder **86** and sealed at **99** around the mandrel **31**, as shoulder **89** continues to advance the upper slidable pis-

ton member **79** downwardly in the housing **29** toward the lower piston **80**, a hydraulic pressure is developed in the system. This developed hydraulic pressure expands the elastomeric sleeve **59** and extends the casing-engaging members **60**, **61** (FIGS. 2C–2D) of the anchor **34** outwardly into tight engagement with the well casing. It will be understood, of course, that due to the relative incompressibility of hydraulic fluids, a considerable hydraulic pressure will be developed within the hydraulic system and, moreover, that this pressure will be imposed against the substantial surface area of the elastomeric sleeve member **59**. Thus, the casing-engaging members **60**, **61** will be pressed against the casing with a considerable force, which force will be sufficient to anchor the bridge plug **24** against substantial longitudinal directed forces.

It will be appreciated, therefore, that after the bridge plug is set, should the pressure in the well bore above the bridge plug **24** be greater than the pressure below, the pressure differential will act on the effective cross-sectional area of the index mandrel **31** and shift the mandrel further downwardly. Downward shifting of the mandrel **31** accordingly drives the upper slidable piston member **79** further downwardly, which action will, of course, further increase the hydraulic pressure within the system to press the casing-engaging members **60**, **61** of the anchor **34** even more tightly against the well casing.

Should, perchance, the pressure in the well bore below the bridge plug **24** become greater than that thereabove, the mandrel **31** will similarly be shifted upwardly. As the mandrel **31** shifts upwardly, the upper slidable piston member **79** will, of course, be returned to its initial position against shoulder **82** by spring **81** and the hydraulic pressure will be momentarily reduced. As the mandrel **31** continues to travel upwardly, however, the lower slidable piston member **80** (FIG. 2D) is quickly resealed by O-ring **88** around the mandrel **31**, but now at **100** on the opposite side of reduced-diameter portion **98**. The lower outwardly-extending upwardly-directed shoulder **90** on the mandrel will then engage the lower slidable piston member **80** and begin shifting it upwardly against spring **85**. This upward movement will, of course, again increase the hydraulic pressure within the fluid-filled system to maintain the casing-engaging members **60**, **61** tightly pressed against the well casing.

Accordingly, it will be appreciated that well pressure acting on the bridge plug **24** from either longitudinal direction will proportionately increase the hydraulic pressure which correspondingly forces the casing-engaging members **60**, **61** even more tightly against the well casing. Furthermore, the bridge plug **24** will remain anchoringly engaged so long as the pressure seals in the hydraulic system remain effective.

It should be noted that once latching means **32** releases, the mandrel **31** is relatively free to shift longitudinally in either direction with respect to the tubular sleeve member **28** (FIG. 2B) in view of the difference in lengths of the splines **37** and the spline grooves **39**. Thus, the mandrel can shift upwardly a considerable distance within the tubular sleeve **28** without imposing an upward force against the sleeve which might otherwise tend to rotate the sleeve upwardly along threads **35**.

As seen in FIGS. 2A–2E, the mandrel **31** is provided with a central axial bore **103** which is selectively opened and closed by an equalizing valve **104** (FIG. 2A). Thus, whenever the bridge plug **24** is being traversed through a fluid-filled well bore, the equalizing valve **104** is left open to allow well fluids to also flow freely through the mandrel bore **103** rather than all of the well fluid being forced through the confined annular space between the casing and retracted packing means **30**. The housing **29** is terminated at its lower end with a "junk pusher" **105** (FIG. 2E) having ports **106** therein which allow well fluids to enter the central bore **103** of the index mandrel.

The equalizing valve **104** (FIG. 2A) is arranged to be selectively closed after the bridge plug **24** has been set into anchoring and sealing engagement with the well casing. Then, whenever the bridge plug **24** is to be released, the valve **104** is first reopened to equalize the well pressure across the bridge plug.

The fishing neck **26** is arranged for receiving the overshot **25** which may be dependently coupled to either the packer **20** or tubing string **21**. Matched J-slots **107** on opposite sides of the fishing neck **26** receive cooperatively-arranged J-pins **108** on the overshot **25**. When the overshot **25** is lowered over the fishing neck **26**, the J-pins **108** will readily enter the open upper end of the J-slots **107**. The pins are lockingly engaged in the lower end of the slots by a concerted application of left-hand torque and a slight upward pull on the tubing **21**. Conversely, the overshot **25** is disengaged from the fishing neck **26** by lowering the tubing **21** slightly, torquing it to the right, and then pulling upwardly. A shoulder in the open portion of J-slots **107** will allow the bridge plug **24** to be set also by pulling up on the mandrel **31** while rotating to screw the sleeve **28** downwardly.

As seen in FIGS. 6 and 7, the fishing neck **26** closes off the upper end of the longitudinal bore **103** extending through the index mandrel **31**. A group of lateral equalizing ports **109** are provided around the upper end of the mandrel **31** immediately below the fishing neck **26**. Fluid communication through these ports **109** is selectively controlled by an annular valve member **110** which is slidably disposed around the mandrel **31** immediately below the equalizing ports. O-rings **111–114** are arranged around the inner surface of the valve member **110** and outer surface of the mandrel **31**, respectively, to close the ports **109** whenever the equalizing valve member **110** is shifted upwardly to its closed position (FIG. 7). This slidable member **110** is cooperatively arranged to be longitudinally shifted by particular manipulation of the running overshot **25** so that the equalizing ports **109** are uncovered whenever the overshot is engaged over the fishing neck **26** (FIG. 6) and covered whenever the overshot is removed (FIG. 7).

A shoulder **115** projecting inwardly from the central portion of the overshot **25** is arranged to engage the upper end of sliding valve member **110** and shift the valve member downwardly to its open position as the overshot is being coupled onto the fishing neck **26**. Whenever the overshot **25** is removed by torquing it to the right and picking up, a group of resilient fingers **116** spaced around the lower portion of the overshot **25** are arranged with inwardly projected shoulders **117** to engage a shoulder **118** on the sliding valve member **110** and pull it upwardly to close the equalizing ports **109**. A similar group of depending resilient fingers **119** around the lower end of the slidable valve member **110** are cooperatively arranged to be cammed outwardly as they pass over an annular shoulder **120** around the index mandrel **31** and then retracted after clearing the shoulder. Thus, the lower ends **121** of these fingers **119** will engage the upwardly facing portion of the annular shoulder **120** and hold the slidable valve member **110** in its uppermost or port-closing position after the overshot **25** has been removed.

Conversely, whenever the running overshot **25** is reengaged over the fishing neck **26**, the resilient fingers **116** of the overshot **25** will engage the top of the valve member **110** and shift it downwardly to reopen the equalizing ports **109**. Serrated teeth **122** are provided around the lower end of the overshot **25** for cutting through any debris that may have fallen on top of the bridge plug **24** while it was set in place.

Accordingly, whenever the mandrel **31** has been rotated sufficiently to set the packing means **30** into sealing engagement with the casing, the overshot **25** will then be disengaged from the fishing neck **26** and the tool **20** moved on up the well bore. As has been already explained, removal of the overshot **25** will shift the slidable valve member **110** upwardly and close the equalizing ports

109 so as to completely block fluid communication from one side of the bridge plug 24 to the other.

Whenever it is desired to release and retrieve the bridge plug 24, the overshot 25 is dropped over and re-engaged with the fishing neck 26. Once the overshot 25 reaches its engaging position, J-pins 108 will re-enter the upper end of the J-slots 107 on the fishing neck 26. As the J-pins 108 re-enter the closed portion of the slots, the slidable valve member 110 is again shifted downwardly to re-open the equalizing ports 109. Thus, pressure will be equalized across the bridge plug 24 which will enable it to be retracted and easily removed.

Retraction of the bridge plug 24 is simply done by rotating the mandrel 31 to the left, which action returns the tubular sleeve member 28 upwardly along the threads 35 in the housing 29, thereby relaxing the packing means 30 and allowing it to reassume its normal configuration.

It will also be appreciated that whenever the tubular sleeve 28 has been screwed back upwardly to its initial starting position, the mandrel 31 will be angularly re-aligned relative to the housing 29 and the inwardly projecting locking lug member 43 will again be substantially aligned with the longitudinal groove portion 29 of the T-groove 47 in the outer surface of the mandrel 31. Thus, if the lug 43 has not already relatched, the operator needs only to shift the tubing 21 and mandrel 31 upwardly and downwardly slightly until the lug end 46 re-enters the T-groove 47. The operator cannot observe the operation of this lug, of course, but inasmuch as the anchor 34 remains engaged with the casing so long as the mandrel 31 is not locked, the bridge plug 24 cannot be moved until the lug end 46 has re-entered the T-groove 47.

As an added feature, it will be noted in FIG. 2E that should annular spacer member 96 be reversed end-for-end, the compensating piston 92 will be shifted upwardly a substantial distance. It will be understood, of course, that such reversal will accordingly displace more fluid into the hydraulic system proper, which will naturally inflate the elastomeric sleeve 59 a corresponding amount. Accordingly, by properly proportioning the dimensions of the hydraulic system, one particular model of the bridge plug 24 may be successfully operated in various sizes of casing having widely differing internal diameters. By pre-inflating the elastomeric sleeve 59 in this manner, the casing-engaging members 60, 61 will consequently be moved closer to the casing before the mandrel 31 is actuated. Thus, it is made certain that the members 60, 61 will engage the casing before the mandrel 31 has been shifted its full extent thereby ensuring that additional longitudinal shifting of the mandrel will serve to press the members more tightly against the casing.

Turning now to FIG. 8, an alternate embodiment 24' of the bridge plug of the present invention is partially shown. This alternate embodiment is substantially the same as that already described with the sole exception that the drag blocks 33 have been eliminated and the friction anchor 34 itself is utilized to develop the initial drag for holding the housing 29 relatively fixed to the casing as the bridge plug 24' is being set.

In this modification, the annular spacer member 96 (FIG. 2E) is no longer required and spring 95 is replaced with a substantially heavier spring 95' (FIG. 9). This heavier spring 95' is made sufficiently strong that it will bias the compensating piston 92' upwardly to develop and maintain a slight pressure within the hydraulic system. The hydraulic pressure so developed is sufficient to maintain the casing-engaging members 60, 61 against the casing. Thus, the anchor 34 will also serve to initially restrain the housing 29' from turning in the same manner as the drag blocks 33 did in the previously described embodiment.

It will be understood, of course, that since the casing-engaging members are maintained in engagement with the casing, it is not necessary to bias these members 60, 61 inwardly. Thus, the arcuate springs 71, 72 are not required in this alternate embodiment as shown in FIG. 8. During operation of the bridge plug 24', whenever the mandrel 31 is freed from the releasable latch means 32 and shifts, the reduced diameter portion 98 around the periphery of the mandrel 31 is moved out of alignment with O-ring 88 which allows the lower slidable piston member 80 to be fluidly sealed around the index mandrel as has been previously described. Shifting of the mandrel in either direction will develop a still greater hydraulic pressure to press the anchor 34 into anchoring engagement with a force proportional to the pressure differential across the bridge plug 24'.

Referring now to FIG. 9, a partial view is shown of an alternate embodiment 24'' of the bridge plug of the present invention. In this alternate embodiment 24'', the latch means 32 and the threads 35 previously described in conjunction with the embodiments of FIGS. 2 and 8 have been modified to allow the tubular sleeve 28 to make at least a full revolution to fore-shorten the packing means 30. Aside from these modifications to be described, the bridge plug 24'' is arranged as already described either with the drag blocks 33 (FIG. 2) or without them (FIG. 8).

In FIG. 9, the lower portion of the packing means 30 is seen resting upon the upper end of the housing 29''. In the same manner as previously described, the tubular sleeve member 28'' has its lower end telescopically arranged within and has threads 123 threadedly engaged with internal right-hand threads 35'' around the upper end of the housing 29''. An extension 124 of the sleeve 28'' has an annular groove receiving an O-ring 125 for fluidly sealing the extension relative to the housing 29''.

In the same manner as previously described, the mandrel 31'' is telescoped through the tubular sleeve 28'' and co-rotatively secured thereto by longitudinal splines (not shown) cooperatively and slidably received within elongated longitudinal spline grooves (not shown). The mandrel 31'' is selectively secured against longitudinal shifting by a releasable latching means 32''. This latching means 32'' normally prevents the index mandrel 31'' from either rotating or shifting longitudinally with respect to the housing 29''. Upon application of right-hand torque to the mandrel 31'', the mandrel is initially secured against rotation relative to the housing 29'' until the torque reaches a predetermined magnitude. When the torque reaches this pre-determined level, the mandrel 31'' is then freed for both rotation and longitudinal shifting with respect to the housing 29''.

As seen in FIGS. 9 and 10, the latching means 32'' is comprised of a clutch mechanism 126 which releasably secures the housing 29'' to an annular member 127 having inwardly projecting lugs 128 cooperatively received in T-shaped grooves 47'' formed in opposite sides of the mandrel 31''. Each of these grooves 47'' are similar to that already described and illustrated in FIG. 3 with the exception that instead of diverging outwardly until its bottom merges into the outer surface of the mandrel, the branch portion 50'' of the groove 47'' opens into an enclosed, greatly elongated, longitudinal groove portion 129. The long groove portion 129 is parallel to the shorter groove portion 49'' and extends above and below the shorter groove portion. All groove portions 49'', 50'' and 129 are of equal depth so it will be appreciated that the lug members 128 will always be confined within one of these groove portions. Thus, when the mandrel 31'' is secured, the lugs 128 will be within their respective shorter groove portions 49''; and, when the mandrel is released, the lugs 128 will be within their respective greatly elongated groove portions 129.

The clutch mechanism 126 is comprised of alternately disposed, flat, annular clutch plates 130, 131 urged into engagement with one another by a clutch spring 132. One set 130 of the clutch plates is secured against rotation relative to the housing 29'' by longitudinal housing splines 133 which are cooperatively received in radial notches

or grooves on the outer edge of these plates **130**. The other set **131** of the clutch plates is secured in a similar manner to the outside of the annular member **127** by longitudinal splines **134** along the outer surface of that member.

Thus, depending upon the strength of the clutch spring **132**, the contiguous plates **130**, **131** will be frictionally secured one to the other until sufficient torque is applied through the mandrel **31''** to overcome the frictional force. Then, the clutch plates **130** secured to the housing **29''** will remain stationary as the clutch plates **131** secured to the annular member **127** slidably rotate therebetween.

Accordingly, when the mandrel **31''** is first rotated, the frictionally engaged clutch plates **130**, **131** will initially restrain the annular member **127**. This will allow the mandrel **31''** to rotate the groove portions **49''** away from the momentarily-fixed lugs **128** and rotate the greatly elongated groove portions **129** into alignment with the lugs. Once the lugs **128** engage the straight sides of groove portions **129**, the mandrel **31''** will, of course, be momentarily halted since the annular member **127** is still secured by the clutch plates **130**, **131** to the fixed housing **29''**. Continued application of torque to the mandrel **31''**, however, will soon increase the torsional force to a magnitude sufficient to overcome the frictional restraint provided by the clutch plates **130**, **131**. At this time, the annular member **127** begins to rotate with respect to the housing **29''** and the mandrel **31''** is now free to shift longitudinally in either direction with respect to both the housing **29''** and annular member **127**.

Once the mandrel **31''** begins to rotate to the right, the tubular sleeve member **28''** begins rotating (because of the splines co-rotatively securing it to the mandrel) downwardly along threads **35''** to begin foreshortening the packing means **30**. It will be realized, however, that now in contrast to the other two embodiments, the mandrel may rotate a full turn or more without becoming re-secured. Thus, where it is necessary to displace the packing means **30** outwardly an extra amount, the mandrel **31''** may be rotated several turns to ensure that the packing means is fully displaced.

As an added feature, a slidable annular piston **135** is placed in an annular clearance space **136** in the upper end of the housing **29''** and fluidly sealed by O-rings **137**, **138** to the housing and tubular sleeve **28''**. A port **139** through the housing **29''** above the piston **135** allows the pressure of fluids in the well bore beneath the packing means **30** to act on the upper face of the piston. A fluid passage **140** in the housing **29''** connects the annular clearance space **141** around the threads **35''** to the space **142** enclosing the clutch plates **130**, **131**. A sealed hydraulic chamber is provided between the piston **135** by an O-ring **143** which fluidly seals the annular member **127** to the housing **29''**. This sealed chamber is filled with a suitable hydraulic fluid to lubricate the threads **35''**, **123** as well as the clutch plates **130**, **131**. An O-ring **144** around the upper end of the annular member **127** as well as the O-ring **125** around the sleeve extension **124** fluidly seal the intermediate portions of the sealed hydraulic chamber. Thus, it will be realized that when the packing means **30** is sealingly engaged with a casing, any pressure acting upwardly on the bridge plug **24''** that might tend to jam the threads **35''**, **123** will be substantially counterbalanced since the balancing piston **135** will develop the same pressure in the fluid-filled, sealed, hydraulic chamber between the piston and O-ring **143**.

An additional feature is provided by disposing an O-ring **145** loosely around the sleeve **28''** above its threads **123**. Whenever the sleeve **28''** is returned to its uppermost position, it will be brought to rest by the O-ring **145** engaging an inwardly projecting stop or shoulder **146**. A passage **147** through the shoulder **146** ensures free fluid communication between the piston **135** and remainder of the sealed hydraulic chamber.

Except as already discussed, the bridge plug **24''**, of course, operates in the same manner as those shown in FIGS. 2 and 8. It will be appreciated, of course, that when the packing means **30** is to be retracted, the mandrel **31''** is torqued to the left which returns the sleeve **28''** back up threads **35''**. Then, by holding the left-hand torque, the lugs **128** will re-enter the short groove portions **49''** whenever the mandrel **31''** is shifted to re-align the lugs with groove portions **50''**.

Accordingly, it will be appreciated that each of the bridge plugs described herein provide new and amproved packing apparatus having hydraulically-actuated wall-engaging members which are pressed into anchoring engagement by a longitudinally directed force on the shiftable mandrel. It will be realized, of course, that such a longitudinally directed force may be imposed either by a pressure differential acting from either above or below the bridge plug or by engaging the mandrel with a member lowered into the well and manipulating the mandrel in either longitudinal direction.

Moreover, the force directed against the shiftable mandrel will be proportionately related to the anchoring force securing the bridge plug within the well. It will be realized as well that the developed anchoring force will be independent of the force applied to foreshorten the packing means and displace it into sealing engagement.

Furthermore, it has been shown how each of the bridge plugs employ conventional annular packing means which are sealingly engaged by a rotative motion.

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: a housing; a rotatable tubular member threadedly engaged with said housing, said tubular member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said tubular member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said tubular member; anchoring means for securing said well packer within the well bore including outwardly-extendible wall-engaging means operatively mounted on said housing; a body member slidably disposed within the bore of said tubular member and arranged to shift longitudinally therein; and hydraulic means responsive to shifting of said body member for pressing said wall-engaging means into anchoring engagement to anchor said well packer with a force proportionately related to the distance said body member shifts.

2. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing; a rotatable tubular member threadedly engaged with said housing, said tubular member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said tubular member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said tubular member; anchoring means for securing said well packer within the well bore including outwardly-extendible wall-engaging means operatively mounted on said housing and fluidly sealed relative thereto to provide a fluid-tight space therebetween, said wall-engaging means being arranged and adapted to extend upon application of hydraulic pressure in said fluid-tight space; a body member slidably disposed within the bore of said tubular member and arranged to shift longitudinally therein; 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 and anchor said well packer with a force proportionately related to the distance said body member shifts.

3. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member disposed in said housing bore and threadly engaged with said housing, said tubular member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said tubular member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said tubular member; anchoring means for securing said well packer within the well bore including outwardly-extendible wall-engaging means operatively mounted on said housing and fluidly sealed relative thereto to provide a fluid-tight space therebetween, said wall-engaging means being arranged and adapted to extend upon application of hydraulic pressure in said fluid-tight space; a body member slidably disposed within said tubular member and housing bore and operatively arranged to shift longitudinally therein in response to a pressure differential between fluids in the well bore above and below said well packer; 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 and anchor said well packer with a force proportionately related to the pressure differential.

4. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said tubular member haxing a fixed shoulder longitudinally spaced from said housing; packing means mounted around said tubular member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said tubular member; anchoring means for securing said well packer within the well bore including outwardly-extendible wall-engaging means mounted on said housing and fluidly sealed relative thereto to provide a fluid-tight space therebetween, said wall-engaging means being adapted to extend upon application of hydraulic pressure in said fluid-tight space and press said wall-engaging means into anchoring engagement with the well bore; a rotatable body member slidably disposed within said tubular member and housing and arranged to shift longitudinally therein in response to fluid pressure in a well bore; and hydraulic means responsive to shifting of said body member for developing a hydraulic pressure to extend said wall-engaging means including a piston member slidably disposed in said housing bore and adapted to be engaged by said body member and advanced along said bore thereby whenever said body member shifts in one direction, first means fluidly sealing said housing 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 housing 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 fluid.

5. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said tubular member having a flange longitudinally spaced from said housing; packing means mounted around said tubular member intermediate said flange and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said tubular member; anchoring means for securing said well packer within 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 expand upon application of hydraulic pressure in said fluid-tight space and press said wall-engaging means into anchoring engagement with the well bore; a rotatable body member slidably disposed within said tubular member and housing and arranged to shift longitudinally therein in response to fluid pressure in a well bore; hydraulic means responsive to shifting of said body member for developing a hydraulic pressure to inflate said elastomeric sleeve including a piston member slidably disposed in said housing bore and adapted to be engaged by said body member and advanced along said bore thereby whenever said body member shifts in one direction, first means fluidly sealing said housing 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 housing 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 fluid; and releasable latching means securing said body member against longitudinal shifting, said latching means being responsive to rotation of said tubular member to free said body member for longitudinal shifting and responsive to rotation of said tubular member in the opposite direction to resecure said body member against longitudinal shifting.

6. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said tubular member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said tubular member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said tubular member; first anchoring means for securing said housing against rotation relative to the well bore including first wall-engaging means operatively mounted around said housing and spring means for biasing said first wall-engaging means into engagement with the well bore; second anchoring means for selectively securing said well packer against longitudinal displacement within the well bore including an inflatable elastomeric sleeve sealingly mounted around said housing to provide a fluid-tight space therebetween and second wall-engaging means mounted around said elastomeric sleeve, said elastomeric sleeve being adapted to expand upon application of hydraulic pressure in said fluid-tight space to press said second wall-engaging means into anchoring engagement with the well bore; a rotatable body member slidably disposed within said tubular member and housing and arranged to shift longitudinally therein in response to fluid pressure in a well bore; and hydraulic means responsive to shifting of said body member for developing a hydraulic pressure to inflate said elastomeric sleeve including a piston member slidably disposed in said housing bore and adapted to be engaged by said body member and advanced along said bore thereby whenever said body member shifts in one direction, first means fluidly sealing said housing 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 housing 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 fluid.

7. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said tubu-

lar member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said tubular member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said tubular member; anchoring means for securing said well packer within 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 expand upon application of hydraulic pressure in said fluid-tight space and press said wall-engaging means into anchoring engagement with the well bore; a rotatable body member slidably disposed within said tubular member and housing and arranged to shift longitudinally therein in response to fluid pressure in a well bore; hydraulic means responsive to shifting of said body member for developing a hydraulic pressure to inflate said elastomeric sleeve including a piston member slidably disposed in said housing bore and adapted to be engaged by said body member and advanced along said bore thereby whenever said body member shifts in one direction, first means fluidly sealing said housing 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 housing 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 fluid; and means for maintaining pressure in said fluid-tight chamber and space to inflate said elastomeric sleeve for securing said housing against rotation relative to said body member.

8. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said tubular member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said tubular member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said tubular member; anchoring means for securing said well packer within 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 expand upon application of hydraulic pressure in said fluid-tight space and press said wall-engaging means into anchoring engagement with the well bore; a rotatable body member slidably disposed within said tubular member and housing and arranged to shift longitudinally therein in response to fluid pressure in a well bore; hydraulic means responsive to shifting of said body member for developing a hydraulic pressure to inflate said elastomeric sleeve including first and second piston members slidably disposed in said housing bore and spaced apart, means fluidly sealing said piston members 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, 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.

9. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said tubular member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said tubular member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said tubular member; anchoring means for securing said well packer within 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 expand upon application of hydraulic pressure in said fluid-tight space and press said wall-engaging means into anchoring engagement with the well bore; a rotatable body member slidably disposed within said tubular member and housing and arranged to shift longitudinally therein in response to fluid pressure in a well bore; hydraulic means responsive to shifting of said body member for developing a hydraulic pressure to inflate said elastomeric sleeve including first and second piston members slidably disposed in said housing bore and spaced apart, means fluidly sealing said piston member 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, 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; means for maintaining pressure in said fluid-tight chamber and space to inflate said elastomeric sleeve for securing said housing against rotation relative to said body member; and releasable latching means securing said body member against longitudinal shifting, said latching means being responsive to rotation of said body member for expanding said packing means to free said body member for longitudinal shifting.

10. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said tubular member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said tubular member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said tubular member; first anchoring means for securing said housing against rotation relative to the well bore including first wall-engaging means operatively mounted around said housing and spring means for biasing said first wall-engaging means into engagement with the well bore; second anchoring means for selectively securing said well packer against longitudinal displacement within the well bore including an inflatable elastomeric sleeve sealingly mounted around said housing to provide a fluid-tight space therebetween and second wall-engaging means mounted around said elastomeric sleeve, said elastomeric sleeve being adapted to expand upon application of hydraulic pressure in said fluid-tight space to press said second wall-engaging means into anchoring engagement with the well bore; a rotatable body member slidably disposed within said tubular member and housing and arranged to shift longitudinally therein in response to fluid pressure in a well bore; hydraulic means responsive to shifting of said body member for developing a hydraulic pressure to inflate said elastomeric sleeve including first and second piston members slidably disposed in said housing bore and spaced apart, means fluidly sealing said piston members 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, first means for advancing said first pis-

ton 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; and releasable latching means securing said body member against longitudinal shifting, said latching means being responsive to rotation of said body member for expanding said packing means to free said body member for longitudinal shifting.

11. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said tubular member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said tubular member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said tubular member; first anchoring means for securing said housing against rotation relative to the well bore including first wall-engaging means operatively mounted around said housing and spring means for biasing said first wall-engaging means into engagement with the well bore; second anchoring means for selectively securing said well packer against longitudinal displacement within the well bore including an inflatable elastomeric sleeve sealingly mounted around said housing to provide a fluid-tight space therebetween and second wall-engaging means mounted around said elastomeric sleeve, said elastomeric sleeve being adapted to expand upon application of hydraulic pressure in said fluid-tight space to press said second wall-engaging means into anchoring engagement with the well bore; a rotatable body member slidably disposed within said tubular member and housing bore and arranged to shift longitudinally therein in response to fluid pressure in a well bore; hydraulic means responsive to shifting of said body member for developing a hydraulic pressure to inflate said elastomeric sleeve 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, means fluidly sealing said piston members 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, biasing means normally urging said piston members against said stop means, 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; and releasable latching means securing said body member against longitudinal shifting, said latching means being responsive to rotation of said body member for expanding said packing means to free said body member for longitudinal shifting and responsive to rotation of said body member in the opposite direction to resecure said body member against longitudinal shifting.

12. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said tubular member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said tubular member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said tubular member; anchoring means for securing said well packer within 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 expand upon application of hydraulic pressure in said fluid-tight space and press said wall-engaging means into anchoring engagement with the well bore; a rotatable body member slidably disposed within said tubular member and housing bore and arranged to shift longitudinally therein in response to fluid pressure in a well bore; hydraulic means responsive to shifting of said body member for developing a hydraulic pressure to inflate said elastomeric sleeve 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, means fluidly sealing said piston members 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, biasing means normally urging said piston members against said stop means, 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; and releasable latching means securing said body member against longitudinal shifting, said latching means being responsive to rotation of said body member for expanding said packing means to free said body member for longitudinal shifting.

13. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said tubular member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said tubular member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said tubular member; anchoring means for securing said well packer within 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 expand upon application of hydraulic pressure in said fluid-tight space to press said wall-engaging means into anchoring engagement with the well bore; a rotatable body member slidably disposed within said tubular member and housing bore and arranged to shift longitudinally therein in response to fluid pressure in a well bore; hydraulic means responsive to shifting of said body member for developing a hydraulic pressure to inflate said elastomeric sleeve 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, means fluidly sealing said piston members 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, biasing means normally urging said piston members against said stop means, 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; means for maintaining pressure in said fluid-tight chamber and space for inflating said elastomeric sleeve to press said wall-engaging means

into engagement with the well bore and secure said housing against rotation relative to said body member; and releasable latching means securing said body member against longitudinal shifting, said latching means being responsive to rotation of said body member for expanding said packing means to free said body member for longitudinal shifting and responsive to rotation of said body member in the opposite direction to resecure said body member against longitudinal shifting.

14. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said tubular member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said tubular member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said tubular member; 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; actuating means for rotating said tubular member to expand said packing means into sealing engagement with the well bore including a rotatable body member slidably disposed within said tubular member and housing bore and arranged to shift therein in response to fluid pressure in a well bore; means co-rotatively securing said tubular member to said body member and limiting longitudinal shifting of said body member; 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 rotation relative to said body member including first means fluidly sealing-off a portion of said housing bore, a piston member slidably disposed in said housing bore and longitudinally displaced from said first sealing means, biasing means normally urging said piston member toward said first sealing means, second means fluidly sealing said piston member providing a fluid-tight chamber in said housing bore intermediate said first sealing means and piston member, and conduit 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 means for inflating said elastomeric sleeve to press said wall-engaging means into anchoring engagement with the well bore with a force proportional to fluid pressure in the well bore including means on said body member adapted to engage and advance said piston member whenever said body member is shifted toward said first sealing means to develop a hydraulic pressure in said fluid-filled space.

15. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing; a rotatable member threadedly engaged with said housing, said rotatable member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said rotatable member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said rotatable member; anchoring means for securing said well packer within the well bore including extendible wall-engaging means operatively mounted on said housing; and means responsive to torque of a predetermined magnitude for releasably connecting said rotatable member to said housing.

16. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing; a rotatable member threadedly engaged with said housing, said rotatable member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said rotatable member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said rotatable member; anchoring means for securing said well packer within the well bore including extendible wall-engaging means operatively mounted on said housing; and means responsive to torque of a predetermined magnitude for releasably connecting said rotatable member to said housing including first clutch means secured to said housing, second clutch means operatively engaged with said first clutch means and connected to said rotatable member and means biasing said clutch means into engagement with one another.

17. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing; a rotatable member threadedly engaged with said housing, said rotatable member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said rotatable member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said rotatable member; anchoring means for securing said well packer within the well bore including outward-extendible wall-engaging means operatively mounted on said housing; means responsive to torque of a predetermined magnitude for releasably connecting said rotatable member to said housing; and hydraulic means operable upon release of said rotatable member and responsive to a pressure differential across said well packer of well fluids above and below said packer for pressing said wall-engaging means into anchoring engagement with a force proportionately related to this pressure differential.

18. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said rotatable member having a fixed shoulder longitudinally spaced from said housing; a packing means mounted around said rotatable member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said rotatable member; a body member slidably disposed in said rotatable member and co-rotatively secured thereto and arranged to shift longitudinally therein; anchoring means for securing said well packer within the well bore including outwardly-extendible wall-engaging means operatively mounted on said housing; means responsive to torque of a predetermined magnitude for releasably coupling said body member to said housing; and hydraulic means operable upon release of said body member and responsive to shifting of said body member for pressing said wall-engaging means into anchoring engagement to anchor said well packer with a force proportionately related to the distance said body member shifts.

19. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said rotatable member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said rotatable member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said rotatable member; a body member slidably disposed in said rotatable member and co-rotatively secured thereto and arranged to shift longitudinally therein; anchoring means for securing said well packer within the well bore including outwardly-extendible wall-engaging means operatively mounted on said housing 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; means responsive to torque of a predetermined magnitude for releasably coupling said body member to said housing; and hydraulic means operable upon release of said body member and responsive to shifting of said body member for applying a hydraulic pressure into said fluid-tight space to press said wall-engaging means into anchoring engagement to anchor said well packer with a force proportionately related to the distance said body member shifts.

20. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said rotatable member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said rotatable member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said rotatable member; a body member slidably disposed in said rotatable member and co-rotatively secured thereto and arranged to shift longitudinally therein; anchoring means for securing said well packer within the well bore including outwardly-extendible wall-engaging means operatively mounted on said housing 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; means responsive to torque of a predetermined magnitude for releasably coupling said body member to said housing including first clutch means secured to said housing, second clutch means operatively engaged with said first clutch means and connected to said body member and means biasing said clutch means into engagement with one another; and hydraulic means operable upon release of said body member and responsive to shifting of said body member for applying a hydraulic pressure into said fluid-tight space to press said wall-engaging means into anchoring engagement to anchor said well packer with a force proportionately related to the distance said body member shifts.

21. A well packer sized and adapted for reception in a well bore for packing-off the well bore, comprising: a housing having a central longitudinal bore; a rotatable tubular member threadedly engaged with said housing, said rotatable member having a fixed shoulder longitudinally spaced from said housing; packing means mounted around said rotatable member intermediate said shoulder and said housing, said packing means being adapted for expansion into sealing engagement with the well bore upon rotation of said rotatable member; a body member slidably disposed in said rotatable member and co-rotatively secured thereto and arranged to shift longitudinally therein; anchoring means for securing said well packer within the well bore including outwardly-extendible wall-engaging means operatively mounted on said housing 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; means responsive to torque of a predetermined magnitude for releasably coupling said body member to said housing including stop means on said body member providing first and second longitudinally extending paths of different lengths angularly spaced-apart and joined together at one adjacent point, an annular member disposed around said body member and having an inwardly-projecting member slidably received in said stop means, first clutch means in said housing bore secured to said housing, second clutch means operatively engaged with said first clutch means and secured to annular member and means biasing said clutch means into engagement with one another; and hydraulic means operable upon release of said body member and responsive to shifting of said body member for applying a hydraulic pressure into said fluid-tight space to press said wall-engaging means into anchoring engagement to anchor said well packer with a force proportionately related to the distance said body member shifts.

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