Feb. 28, 1967 M. P. LEBOURG 3,306,361

DOUBLE SET HYDRAULIC ANCHOR

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Fig. 1

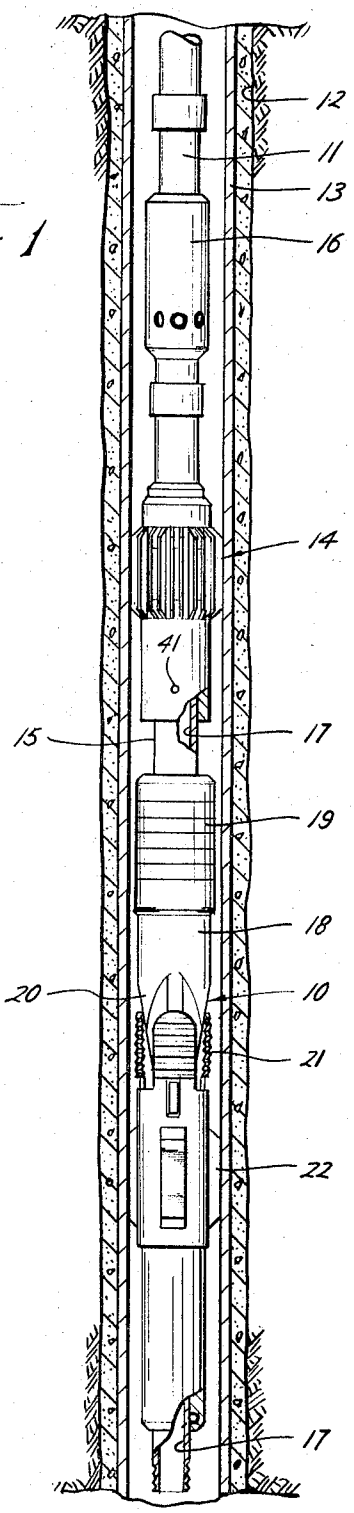


Fig. 3

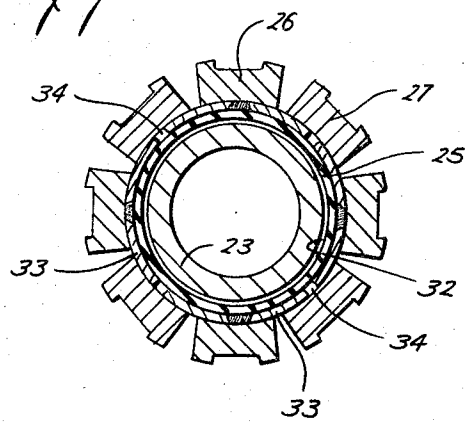
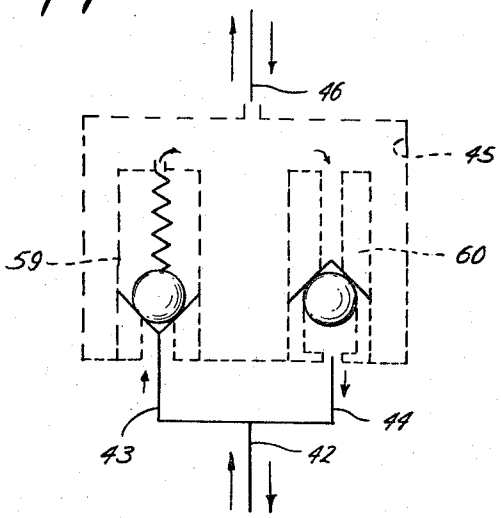


Fig. 4



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DOUBLE SET HYDRAULIC ANCHOR

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Fig. 2

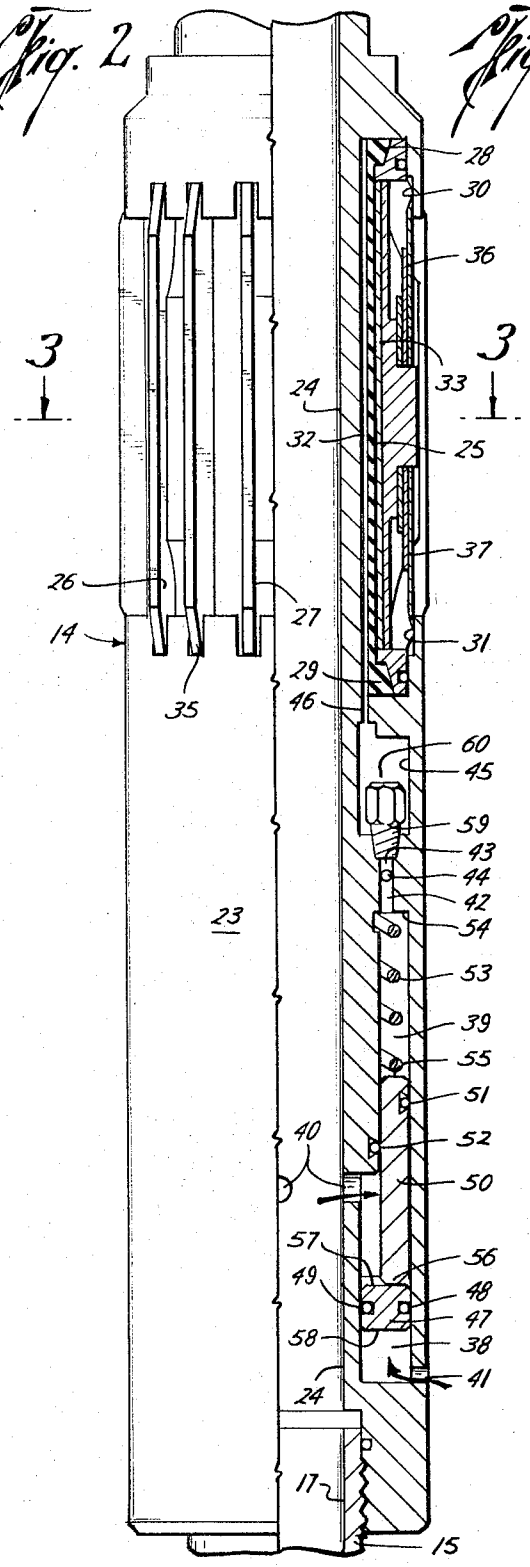
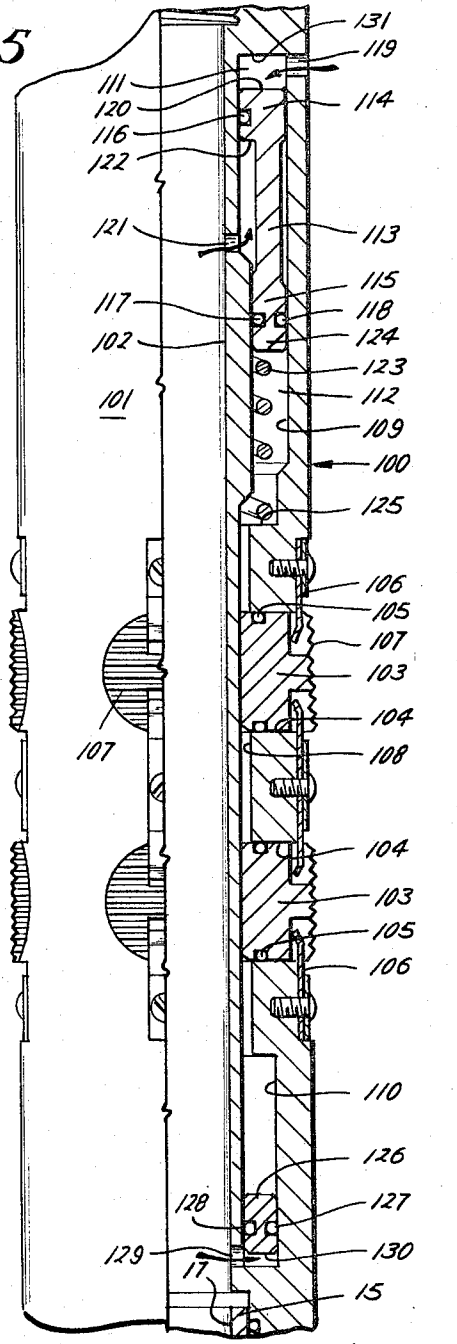


Fig. 5



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DOUBLE SET HYDRAULIC ANCHOR

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Filed June 11, 1964, Ser. No. 374,430
13 Claims. (Cl. 166—122)

This invention relates to apparatus adapted for anchoring a well tool in place within a well bore; and, more particularly, to hydraulically actuated anchors which, when set in place, will be secured against hydraulic pressures in the well acting 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 full-bore packer and introduced into the formation being treated through perforations appropriately located in the casing.

It will be appreciated that such full-bore packers must be capable of withstanding high pressures acting from either direction. Furthermore, during the course of typical completion operations, the packer can be subjected to high pressures acting alternately from both and above and below the packer. Accordingly, it is necessary to securely anchor the packer against movement in either longitudinal direction.

Heretofore, extendible slip members have typically been employed to anchor such packers against 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.

Accordingly, it is an object of the present invention to provide new and improved anchoring apparatus for well packers, which apparatus has 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 an additional object of the present invention to provide new and improved well tool anchors which will anchor the tools in response to a pressure differential acting from either direction.

Anchoring apparatus arranged in accordance with the present invention includes a selectively operable hydraulic system responsive to fluid pressure in a well and adapted to maintain wall-engaging means in anchoring engagement with a force proportionately related to a fluid pressure differential across the apparatus.

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 having an anchor thereon employing principles of the present invention and depicted as they would appear within a well bore;

FIG. 2 is a detailed cross-sectional view of an embodiment of an anchor;

FIG. 3 is a cross-sectional view taken along the line 3—3 of FIG. 2;

FIG. 4 is a schematic representation of a portion of the anchor shown in FIG. 2; and

FIG. 5 is a view of an alternate embodiment of an anchor.

As seen in FIG. 1, a typical full-bore packer **10** is dependently connected in a tubing string **11** and positioned within a well bore **12** having a casing **13** set therein. An anchor **14** incorporating principles of the present invention is serially coupled between the upper end of the tubular body member or mandrel **15** of the full-bore packer **10** and the lower end of a conventionally arranged bypass valve **16**, which is in turn connected to the lower end of the tubing string **11**. As is conventional in the art, such a bypass valve **16** is opened whenever the full-bore packer **10** is being shifted within a fluid-filled well to divert some of the fluids through the central bore **17** of the mandrel **15** and bypass valve before returning to the annulus of the well bore **12**. Whenever the packer **10** has been set in position, the bypass valve **16** is of course closed to prevent fluid communication through the mandrel bore **17** of the sealingly engaged packer **10**.

The typical full-bore packer **10** illustrated in FIG. 1 includes a rotatable tubular body member or mandrel **15** slidably disposed within and extended through a tubular housing member **18**. Elastomeric packing means **19** are mounted around the upper portion of the housing **18** intermediate an outwardly directed shoulder on the mandrel **15** and a slidably disposed slip bowl **20**. Normally retracted slip members **21** are operatively mounted around the upper end of the housing **18** and cooperatively engaged with the slip bowl **20** in the well-known manner. Conventional drag blocks **22** are provided to secure the housing **18** to the casing **13** as the mandrel **15** is manipulated relative to the housing to extend the packing means **19** and slips **21** against the casing. Conventionally arranged J-slots and J-pins (not shown) selectively latch the mandrel **15** relative to the housing **18** to keep the packer **10** retracted.

Accordingly, when the packer **10** is to be set, the tubing string **11** is picked up slightly and then manipulated in a particular manner to free the mandrel **15** for downward travel. As the mandrel **15** is lowered, the drag blocks **22** restrain the housing **18** as the downward movement of the mandrel successively drives the slip bowl **20** downwardly to extend the slips **21** and foreshorten the packing means **19** in the well-known manner. By the time the mandrel **15** has reached its lower limit of travel, the slips **21** will be engaged against the casing **13** and the packing means **19** displaced into sealing engagement therewith. It will be appreciated, of course, that once set, the slips **21** will then prevent the full-bore packer **10** from moving further downwardly within the casing **13**.

As seen in FIG. 1, the hydraulic anchor **14** is dependently coupled in the tubing string **11** to the upper end of the packer mandrel **15**. A self-contained hydraulic system therein is adapted to operatively actuate the anchor **14** in response to a pressure differential across the packing means **19**. Thus, whenever the bypass valve **16** is closed after the packing means **19** has been set, the anchor **14** will be anchoringly engaged to secure the mandrel **15** in its lower position as well as to prevent the packer **10** from shifting upwardly.

Turning now to FIG. 2, the anchor **14** includes a tubular housing **23** having a longitudinal bore **24** of a uniform diameter extending therethrough. This longitudinal bore **24** is of course in fluid communication at all times with the central bore **17** of the packer mandrel **15**. Mounted around the anchor housing **23** is an expansible elastomeric sleeve **25** encircling the housing with a plurality of elongated casing-engaging members **26, 27** being mounted uniformly around the periphery of the sleeve. The enlarged upper **28** and lower **29** ends of the elastomeric sleeve **25** are sealingly secured within opposed peripheral recesses **30, 31** around the housing **23** to provide a fluid-tight space **32** between the sleeve and housing.

Each of the casing-engaging members **26**, **27** is elongated and has a thick, arcuate, cross-section (FIG. 3). Alternate ones **26** of these casing-engaging members are centrally aligned and mounted along the outer convex surface of relatively thin, elongated, arcuate backing members **33**. A sufficient number of these mounted members **26** are disposed uniformly around the periphery of the elastomeric sleeve **25** that the backing members **33** substantially encompass the sleeve. The remaining unmounted casing-engaging members **27** are alternately disposed between the mounted casing-engaging members **26** in such a manner that the unmounted members **27** straddle adjacent backing members **33** and cover the gap **34** therebetween.

The ends of the casing-engaging members **26**, **27** are beveled, as at **35** (FIG. 2), for reception within the opposed annular housing recesses **30**, **31**. Springs **36**, **37** operatively engaged at opposite ends of the members **26**, **27** bias the members inwardly. It will be appreciated, therefore, that although the casing-engaging members **26**, **27** will be moved radially outwardly against springs **36**, **37** whenever the elastomeric sleeve **25** is inflated, the beveled ends of the members cannot escape from the housing recesses **30**, **31**.

Turning now to the hydraulic system of the anchor **14**, the housing **23** is formed in such a manner as to provide a first annular chamber **38** of a particular cross-sectional area in the housing and a second annular chamber **39** of a smaller cross-sectional area immediately thereabove and in coaxial alignment therewith. Radial ports **40** at the junction of the annular chambers **38**, **39** provide fluid communication therefrom to the inner bore **24** of the anchor **23**. A second group of ports **41** is provided to establish fluid communication from outside of the housing **23** into the lower portion of the lower annular chamber **38**. A fluid passage **42** within the housing **23** extending from the upper portion of the upper annular chamber **39** is divided into separate branches **43**, **44** (FIG. 4), each of which lead into a valve chamber **45** thereabove. A second fluid passage **46** leads from the valve chamber **45** to the fluid-tight space **32** beneath the elastomeric sleeve **25**.

A complementarily formed annular piston member **47** is slidably disposed within the lower annular chamber **38** and fluidly sealed therein with respect to the housing **23** by O-rings **48**, **49**. An elongated tubular piston member **50** is complementarily fitted and slidably disposed within the upper annular chamber **39** and fluidly sealed therein relative to the housing **23** by O-rings **51**, **52**. A compression spring **53** within the upper piston chamber **39** is engaged between a downwardly directed housing shoulder **54** and the upper face **55** of the tubular piston member **50**. This spring **53** biases the tubular piston member **50** downwardly so that its lower face **56** will normally rest upon the upper face **57** of the annular piston member **47** and urge that piston downwardly as well until its lower face **58** comes to rest on the bottom of chamber **38**.

It will be appreciated that when the upper piston chamber **39**, valve chamber **45**, fluid passages **42–44**, **46** and the fluid-tight space **32** are filled with a suitable hydraulic fluid, a hydraulic pressure will be developed within this system whenever the tubular piston member **50** is advanced further upwardly into the upper piston chamber **39** as shown in FIG. 2. Furthermore, whenever a hydraulic pressure is so developed, the elastomeric sleeve **25** will be inflated and press the casing-engaging members **26**, **27** against the casing.

Whenever the packer **10** and its cooperatively arranged anchor **14** are positioned in a fluid-filled well bore and the packing means **19** set, the pressure of the fluids above the packing means will be transmitted through the outer fluid ports **41** through the anchor housing **23** against the lower face **58** of the annular piston member **47** as well as act on the outside of the elastomeric sleeve **25**. The

pressure from below the packing means **19** will be transmitted through the open mandrel bore **17** into the inner bore **24** of the anchor **14** and be directed through inner ports **40** simultaneously against the upper face **57** of the annular piston member **47** and the lower face **56** of the tubular piston member **50**. Thus, it will be appreciated that the piston members **47**, **50** will shift within their respective chambers **38**, **39** in response to a pressure differential across the engaged packing means **19**.

To illustrate the operation of the anchor **14** and its hydraulic system, assume first that the pressure of the fluids in the well below the set packing means **19** is greater than the pressure of the fluids thereabove. In this instance, the pressure that is communicated through the mandrel bore **17** to within the inner bore **24** of the anchor **14** will be greater than that outside of the anchor. The annular piston member **47** will be driven downwardly since the pressure acting on its upper face **57** is greater than that acting on its lower face **58**. This greater pressure acting on the lower face **56** of the tubular piston member **50** of course advances the piston further upwardly into the upper piston chamber **39** to displace fluid upwardly and develop a hydraulic pressure within the fluid-filled hydraulic system. The pressure so developed will of course be substantially equal to the greater pressure within the anchor's inner bore **24**. Since the hydraulic pressure inside of the sleeve **25** is greater than the pressure of the fluids in the well bore outside of the elastomeric sleeve, the sleeve will be inflated. It will be appreciated, therefore, that the wall-engaging members **26**, **27** will be pressed against the casing with a force proportionately related to the pressure differential across the set packing means **19** of the fluids in the well.

Should, however, the conditions within the well be reversed and the pressure of the fluids in the well above the packing means **19** instead be greater than that of those below, this higher fluid pressure will act through the outer ports **41** to shift the annular piston member **47** upwardly. Since the lower face **56** of the tubular piston member **50** normally rests on the annular piston **47**, as the annular piston member **47** is shifted upwardly, the tubular piston is advanced upwardly to develop pressure within the fluid-filled hydraulic system. The pressure so developed, however, will be proportionately greater than the pressure of the fluids in the well bore above the packing means **19** as determined by the ratio of the effective cross-sectional area of the annular piston member **47** divided by the effective cross-sectional area of the tubular piston member **50**. It is, of course, necessary in this instance that the developed hydraulic pressure be greater than the pressure of the fluids above the packing means **19** inasmuch as this latter pressure is not only the actuating pressure but is also being applied against the outside of the elastomeric sleeve **25**. Thus, the casing-engaging members **26**, **27** will again be pressed against the casing with a force proportionately related to the pressure differential across the set packing means **19** of the fluids in the well.

In either of the two above-described conditions, it will be realized that the casing-engaging members **26**, **27** will remain engaged with the casing only so long as the packing means **19** is set to maintain a pressure differential on opposite sides thereof. Thus, whenever the packing means **19** is released, the pressure differential will no longer exist and the anchor **14** will automatically retract as the spring **53** returns the tubular piston member **50** to its initial position as the sleeve **25** deflates.

Whenever the retracted full-bore packer **10** is being moved through a fluid-filled well bore, it is not at all unusual for the restriction to passage of fluids around the packer to create a slight pressure differential between the outside of the packer and its mandrel bore **17**. For example, as the package **10** is being pulled upwardly, the fluid pressure outside of the anchor **14** above the packing means **19** will be somewhat greater than that

below the packing means and in the mandrel bore **17**. This pressure differential could of course become sufficiently great that both piston members **47**, **50** would shift upwardly and extend the casing-engaging members **26**, **27** against the casing to retard, if not prevent, the packer **10** from moving further.

Accordingly, to prevent premature actuation of the anchor **14**, a conventional spring-loaded, normally-closed, check valve **59** (FIGS. 2A and 4) is connected in series between the upper piston chamber **39** and the fluid-tight space **32** beneath the elastomeric sleeve **25**. The valve **59** is disposed in the valve chamber **45** with its inlet connected to one **43** of the branch portions of the lower fluid passage **42** and its outlet open to the valve chamber. This valve **59** is biased to remain closed until the pressure in the upper piston chamber **39** exceeds that in the fluid-tight space **32** by a predetermined differential. Thus, the elastomeric sleeve **25** will not be inflated until a substantial hydraulic pressure is developed in the upper piston chamber **39**.

The other conventional check valve **60** (behind valve **59** in FIG. 2) disposed within the valve chamber **45** has its inlet open to the valve chamber and its outlet connected to the other branch portion **44** of the lower fluid passage **42**. Although it is in parallel with the spring-loaded valve **59**, this check valve **60** operates in the opposite direction and opens only when the pressure in the valve chamber **45** exceeds that in the lower fluid passage **42**. Thus, this valve **60** opens only to allow hydraulic fluid to return to the upper piston chamber **39** as the elastomeric sleeve **25** contracts and the tubular piston member **50** returns to its normal position.

Thus, whenever the tubular piston **50** inadvertently shifts upwardly in response to a pressure differential across the packing means **19** as the retracted packer **10** is moved through a well bore, the hydraulic presssure so developed is insufficient to overcome the bias holding the spring-loaded valve **59** closed. The other valve **60** of course remains closed as well.

When the packing means **19** is set, the hydraulic pressure developed in the upper piston chamber **39** must of course be sufficient to overcome the bias and open the valve **59** before hydraulic pressure can build-up in the remainder of the system. When, however, the spring-loaded valve **59** does open, the pressure in the valve chamber **45** will of course be lower than that in the upper piston chamber **39** by an amount proportionate to the bias on the valve. Thus, the pressure differential will hold the other check valve **60** closed so long as the tubular piston **50** is being urged upwardly into the upper piston chamber **39**. This other check valve **60** will of course open whenever the hydraulic pressure within the upper piston chamber **39** drops below that in the valve chamber **45**. Thus, whenever the packing means **19** is released and the pressure of the fluids in the well is equalized across the packing means, the elastomeric sleeve **25** will contract and displace hydraulic fluids downwardly through the opened check valve **60** and back into the upper piston chamber **39** as the spring **53** returns the tubular piston **50** to its normal position.

Turning now to FIG. 5, the anchor **100** includes a tubular housing **101** having a central axial bore **102** of uniform diameter extending therethrough. At a central portion of the housing **101** a plurality of outwardly facing piston members **103** are operatively mounted within radial bores **104** and fluidly sealed therein by O-rings **105**. Leaf springs **106** fastened to the housing **101** are arranged to retain the piston members **103** and to bias the piston members inwardly whenever they are extended. The outer face of each piston member **103** is serrated to provide casing-engaging teeth or wickers **107**.

The inner end of each of the radial bores **104** opens to a fluid-tight space **108** which extends above and below the casing-engaging piston members **103**. At the open upper end of this fluid-tight space **108**, an annular chamber **109** is formed in the housing **101**. Similarly, at the open lower end of the fluid-tight space **108**, a second annular chamber **110** is formed in the housing **101**.

The upper annular chamber **109** is formed into an enlarged upper portion **111** and a lower portion **112** of a smaller cross-sectional area. An annular piston member **113** having an enlarged upper portion **114** and a reduced diameter lower portion **115** is complementarily formed and slidably disposed within the upper annular chamber **109** and fluidly sealed therein by O-rings **116–118**. An outer port **119** through the housing **101** provides fluid communication from the exterior of the anchor **100** to the upper face **120** of the enlarged piston portion **114**. An inner port **121** provides fluid communication from the inner bore **102** of the housing **101** to the lower face **122** of the enlarged portion **114** of the annular piston member **113**. A compression spring **123** is disposed between the lower end **124** of the piston member **113** and an upwardly directed housing shoulder **125**.

A complementarily formed annular piston member **126** is slidably disposed within the lower annular chamber **110** and fluidly sealed therein by O-rings **127**, **128** mounted around its outer and inner surfaces. An inner port **129** provides fluid communication from the inner bore **102** of the housing **101** to the lower face **130** of the annular piston member **126**.

Thus, it will be appreciated that with the upper annular chamber **109**, the lower annular chamber **110**, the fluid-tight space **108** and that portion of the bores **104** beneath the casing-engaging piston members **103** being filled with a suitable hydraulic fluid, a hydraulic pressure will be developed within the system whenever either piston member **113**, **126** is advanced toward the casing-engaging members **103**. It is to be understoood, of course, that whenever such a hydraulic pressure is so developed, the casing-engaging piston members **103** will be forced outwardly to press the casing-engaging teeth **107** against the casing.

To illustrate the operation of the anchor **100** and its hydraulic system, assume first that the pressure of the fluids in the well beneath the set packing means therebelow is greater than the pressure of the fluids thereabove. Thus, the greater pressure transmitted through the central bore **17** of the packer body member or mandrel **15** to within the inner bore **102** of the anchor **100** will act through the inner port **121** to drive the upper piston member **113** upwardly until its upper face **120** engages a downwardly directed housing shoulder **131**. At the same time, however, this greater pressure is acting through the inner port **129** on the lower face **130** of the lower piston member **126** to drive this piston upwardly to develop a hydraulic pressure within the fluid-filled hydraulic system. This pressure so developed will of course be equal to the fluid pressure within the inner bore **102** of the anchor. This developed hydraulic pressure is, however, greater than the pressure of the fluids above the packing means outside of the piston members **103** so that the casing-engaging members will be driven outwardly and pressed against the casing with a force proportionately related to the pressure differential across the set packing means.

Where the conditions within the well are reversed and the pressure of the fluids above the set packing means is greater than that therebelow, the higher pressure is now outside of the anchor **100** and will act through outer port **119** to drive the upper piston member **113** downwardly. As this piston member **113** is driven downwardly, it will also develop a pressure within the fluid-filled hydraulic system. This developed pressure, however, will be proportionately greater than the pressure of the fluids in the well above the packing means as determined by the ratio of the effective cross-sectional area of the enlarged portion **114** divided by that of the reduced portion **115** of the upper piston member **113**. It is necessary, of course, that this developed hydraulic pressure be greater than that of the fluids above the packing means since this latter pressure is simultaneously imposed against the outer faces **107**

of the casing-engaging members **103**. Thus, by developing this greater hydraulic pressure, the casing-engaging piston members **103** will again be pressed outwardly into engagement against the casing with a force proportionately related to the pressure differential across the set packing means.

It will be understood, of course, that whenever the anchor **100** and the full-bore packer are being shifted in either direction through the fluid-filled well bore, the leaf springs **106** can be made sufficiently strong to prevent the casing-engaging piston member **103** from inadvertently extending. Furthermore, it will be appreciated that as the anchor **100** is being pulled upwardly through a fluid-filled well bore, any tendency of well fluids acting through the outer port **119** to shift the upper piston **113** and develop a slight hydraulic pressure will be resisted by the compression spring **123**.

It will be realized that either the anchor **14** or anchor **100** will be effective as an anchor for well tools in other situations so long as a fluid pressure differential exists. For example, by placing a choke in the central bore of either of the anchors **14, 100** the passage of fluids through the bore would create a pressure differential which could be utilized for acutating the anchor.

Thus, it will be appreciated that the present invention provides new and improved anchors for securing well tools within a well bore. These anchors will be effective to prevent a well tool from being shifted within a well bore by extreme pressure differentials acting against it from either direction. Furthermore, the anchoring forces applied by the new and improved anchors will be proportionately related to the pressure differential acting on the tool.

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 including: means for packing-off a well bore; anchoring means on said well packer including extendible fluid-actuated wall-engaging means for engaging the wall of a well bore; and hydraulic means selectively responsive to a fluid pressure differential in a well bore either above or below said packing-off means for developing an actuating pressure to extend and press said wall-engaging means into anchoring engagement with a force proportionate to this pressure differential to anchor said well packer.

2. A well packer sized and adapted for reception in a well bore including: means for packing-off a well bore; means responsive to hydraulic pressure for anchoring said well packer relative to the wall of a well bore; and means for applying hydraulic pressure to said anchoring means in response to a pressure differential acting from either above or below said packing-off means for anchoring said well packer to the well bore with a force dependent upon said differential pressure across said packing-off means.

3. In a well packer sized and adapted for reception in a well bore: a tubular housing; packing means operatively mounted on said housing and adapted for expansion into sealing engagement with a well bore; means for selectively expanding said packing means including a body member operatively arranged within said housing; anchoring means adapted to secure said packer against longitudinal movement relative to the well bore whenever said packing means is sealingly engaged including outwardly-extendible wall-engaging means on said body member responsive to hydraulic pressure to press said wall-engaging means into anchoring engagement with the well bore; and hydraulic means responsive to a pressure differential acting from either above or below said packing means for applying a hydraulic pressure to press said wall-engaging means into anchoring engagement with a force proportionate to this pressure differential.

4. In a well packer sized and adapted for reception in a well bore; a tubular housing; packing means operatively mounted on said housing and adapted for expansion into sealing engagement with a well bore; means for selectively expanding said packing means including a body member having a radial bore and being operatively arranged within said housing; anchoring means adapted to secure said packer against longitudinal movement relative to the well bore whenever said packing means is sealingly engaged including a piston member slidably disposed in said radial bore and fluidly sealed therein to provide a fluid-tight space therein, said piston member being adapted to move outwardly, upon application of hydraulic pressure in said fluid-tight space, into anchoring engagement with the well bore; and hydraulic means responsive to a pressure differential acting from either above or below said packing means for applying a hydraulic pressure in said fluid-tight space to press said piston member into anchoring engagement with a force proportionate to this pressure differential.

5. In a well packer sized and adapted for reception in a well bore: a tubular housing; packing means operatively mounted on said housing and adapted for expansion into sealing engagement with a well bore; means for selectively expanding said packing means including a body member operatively arranged within said housing; anchoring means adapted to secure said packer against longitudinal movement relative to the well bore whenever said packing means is sealingly engaged including an inflatable sleeve sealingly mounted around said body member to provide a fluid-tight space therebetween and wall-engaging means mounted around said sleeve, said sleeve being adapted to inflate, upon application of hydraulic pressure in said fluid-tight space, to press said wall-engaging means into anchoring engagement with the well bore; and hydraulic means responsive to a pressure differential acting from either above or below said packing means for applying a hydraulic pressure in said fluid-tight space to press said wall-engaging means into anchoring engagement with a force proportionate to this pressure differential.

6. The packer of claim **5** wherein said wall-engaging means comprise: a plurality of elongated and arcuate rigid backing members circumferentially spaced around said sleeve to substantially enclose it except at gaps between adjacent longitudinal edges of said backing members; first elongated wall-engaging members mounted on each of said backing members and extending longitudinally thereon substantially the full length of said backing members; second elongated wall-engaging members disposed between adjacent ones of said first wall-engaging members and extending substantially the full length of said backing members to cover said gaps; and abutment means on said body member at each end of said wall-engaging members for limiting them to substantially lateral movement; and piston means between said sleeve and each of said abutment means and movable longitudinally toward the ends of said wall-engaging members in response to said hydraulic pressure for covering the portions of said sleeve between said ends and said abutment means.

7. In a well packer sized and adapted for reception in a well bore: a tubular housing; packing means operatively mounted on said housing and adapted for expansion into sealing engagement with a well bore; means for selectively expanding said packing means including a body member having a chamber therein and being operatively arranged within said housing; anchoring means adapted to secure said packer against longitudinal movement relative to the well bore whenever said packing means is sealingly engaged including outwardly-extendible wall-engaging means mounted on said body member and fluidly sealed relative thereto to provide a fluid-tight space therebetween, said wall-engaging means being adapted to extend, upon appli-

cation of hydraulic pressure in said fluid-tight space, into anchoring engagement with the well bore; and hydraulic means responsive to a pressure differential across said packing means 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 this pressure differential including a piston member slidably disposed within said chamber and adapted to shift therein in response to this pressure differential; means fluidly sealing said piston member within said chamber for fluidly isolating a portion of said chamber; and passage means providing fluid communication between said isolated chamber portion and said fluid-tight space, all being filled with a hydraulic fluid.

8. In a well packer sized and adapted for reception in a well bore: a tubular housing; packing means operatively mounted on said housing and adapted for expansion into sealing engagement with a well bore; means for selectively expanding said packing means including a body member having a cylindrical chamber therein and being operatively arranged within said housing; anchoring means adapted to secure said packer against longitudinal movement relative to the well bore whenever said packing means is sealingly engaged including outwardly-extendible wall-engaging means mounted on said body member 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, into anchoring engagement with the well bore; and hydraulic means responsive to a pressure differential acting from either above or below said packing means 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 this pressure differential including first and second piston members slidably disposed within said chamber and adapted to shift therein in response to this pressure differential; first and second means respectively fluidly sealing said piston members within said chamber for fluidly isolating separate portions of said chamber; first passage means providing fluid communication from the well bore at a point longitudinally displaced in one direction from said packing means to said chamber adjacent one end of said first piston member; second passage means providing fluid communication from the well bore at a point longitudinally displaced in the other direction from said packing means to said chamber adjacent one end of said second piston member; and third passage means providing fluid communication from said chamber adjacent the other ends of said piston members to said fluid-tight space, all being filled with a hydraulic fluid.

9. In a well packer sized and adapted for reception in a well bore: a tubular housing; packing means operatively mounted on said housing and adapted for expansion into sealing engagement with a well bore; means for selectively expanding said packing means including a body member having a cylindrical chamber therein and being operatively arranged within said housing; anchoring means adapted to secure said packer against longitudinal movement relative to the well bore whenever said packing means is sealingly engaged including outwardly-extendible wall-engaging means mounted on said body member 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, into anchoring engagement with the well bore; and hydraulic means responsive to a pressure differential acting from either above or below said packing means 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 this pressure differential including first and second piston members slidably disposed within said chamber and adapted to shift therein in response to this pressure differential, said first piston member being adapted to engage and shift said second piston member whenever said first piston member shifts toward said second piston member; first and second means respectively fluidly sealing said piston members within said chamber for fluidly isolating separate portions of said chamber; first and second passage means respectively providing fluid communication from the well bore at points separated from one another by said packing means to said chamber on opposite sides of said first piston member; and third passage means providing fluid communication from said chamber at a point adjacent the other end of said second piston member to said fluid-tight space, all being filled with a hydraulic fluid.

10. In a well packer sized and adapted for reception in a well bore: a tubular housing; packing means operatively mounted on said housing and adapted for expansion into sealing engagement with a well bore; means for selectively expanding said packing means including a body member having a cylindrical chamber with a first portion of a greater cross-sectional area than the remaining portion of said chamber, said body member being operatively arranged within said housing; anchoring means adapted to secure said packer against longitudinal movement relative to the well bore whenever said packing means is sealingly engaged including outwardly-extendible wall-engaging means mounted on said body member 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 ir said fluid-tight space, into anchoring engagement with the well bore: and hydraulic means responsive to a pressure differential acting from either above or below said packing means foi applying a hydraulic pressure in said fluid-tight space to press said wall-engaging means into anchoring engagement with a force proportionately related to this pressure differential including a first piston member slidably disposed in said first chamber portion; a second piston member slidably disposed in said remaining chamber portion; said first piston member being adapted to engage and shift said second piston whenever said first piston member shifts toward said second piston member; first and second means respectively fluidly sealing said piston members relative to said chamber; first and second passage means respectively providing fluid communication from the well bore at points separated from one another by said packing means to said chamber on opposite sides of said first piston member; and third passage means providing fluid communication from said remaining chamber portion at a point separated from said first chamber portion by said second piston member to said fluid-tight space, said remaining chamber portion, fluid-tight space and third passage means being filled with a hydraulic fluid.

11. In a well packer sized and adapted for reception in a well bore: a tubular housing; packing means operatively mounted around said housing and adapted for expansion into sealing engagement with a well bore; slip members movably mounted on said housing adjacent one end of said packing means and operatively arranged and adapted for outward extension into anchoring engagement with a well bore to secure said packer against longitudinal movement in one direction relative to the well bore; means for selectively extending said slip members and expanding said packing means including a body member engaged with the other end of said packing means, said body member having a cylindrical chamber therein with a first portion of a greater cross-sectional area than the remaining portion of said chamber, said body member being operatively arranged within said packing means and extending into said housing; an inflatable elastomeric sleeve sealingly mounted around said body member to provide a fluid-tight space therebetween at a point longitudinally displaced in one direction from said other end of said packing means; wall-engaging means operatively 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 anchoring engagement with the well bore and secure said packer against longitudinal movement in the opposite direction; and hydraulic means responsive to a pressure differential acting from either above or below said packing means for applying hydraulic pressure in said fluid-tight space to press said wall-engaging means into anchoring engagement with a force proportionately related to this pressure differential including; first and second slidable piston members respectively disposed in said first and remaining chamber portions; said second piston member being adapted to be engaged by said first piston member and shifted thereby whenever said first piston member shifts toward said second piston member; first and second means respectively fluidly sealing said piston members within said chamber; first passage means providing fluid communication between the well bore from a point longitudinally displaced in said one direction from said packing means to said first chamber portion at a point separated from said remaining chamber portion by said first piston member; second passage means providing fluid communication between the well bore from a point longitudinally displaced in the opposite direction from said packing means to said chamber at a point intermediate said piston members; and third passage means providing fluid communication from said remaining chamber portion at a point separated from said first chamber portion by said second piston member into said fluid-tight space, said remaining chamber portion, fluid-tight space and third passage means being filled with a hydraulic fluid.

12. As a sub-combination, an anchor comprising: a housing; a resilient sleeve disposed around said housing and sealingly secured at each end thereof to said housing to provide an enclosed space between said sleeve and housing; a plurality of elongated and arcuate rigid backing members circumferentially spaced around said sleeve and having adjacent longitudinal edges; first wall-engaging members mounted on each of said backing members; second elongated wall-engaging members disposed between adjacent ones of said first wall-engaging members and covering said adjacent longitudinal edges of their associated backing members; and abutment means on said housing at each end of said members for limiting said members to substantially lateral movements.

13. As a sub-combination, an anchor comprising: a housing; an elasotmeric sleeve disposed around said housing and secured at each end thereof to said housing to provide an enclosed space between said sleeve and housing; means on each end of said sleeve for fluidly sealing said sleeve ends to said housing and preventing outward distortion of said sleeve ends; a plurality of elongated and arcuate rigid backing members between said end-sealing means and circumferentially spaced around said sleeve to substantially enclose said sleeve except at gaps between adjacent longitudinal edges of said backing members; first elongated wall-engaging members mounted on each of said backing members; second elongated wall-engaging members disposed between adjacent ones of said first wall-engaging members and covering said gaps; and abutment means on said housing at each end of said members for limiting said members to substantially lateral movements.

References Cited by the Examiner

UNITED STATES PATENTS

2,370,832	3/1945	Baker	166—120
2,603,163	7/1952	Nixon	166—212
2,881,841	4/1959	Page	166—212
2,925,128	2/1960	Page	166—121
2,970,651	2/1961	Roberts	166—212
3,008,523	11/1961	Clark et al.	166—134 X
3,211,227	10/1965	Mott	166—120
3,233,675	2/1966	Tamplen et al.	166—120

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