Nov. 26, 1968 B. J. ELLIS 3,412,799

HYDRAULIC HOLD-DOWN RELEASE

Filed Aug. 5, 1966 2 Sheets-Sheet 1

Fig. 1

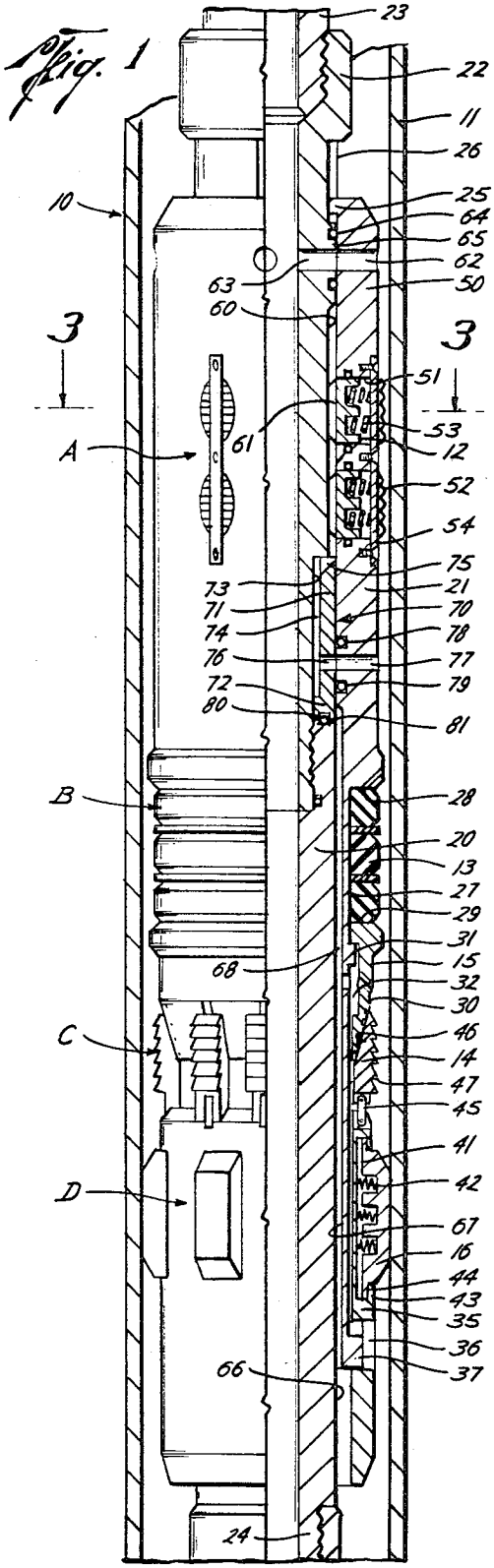
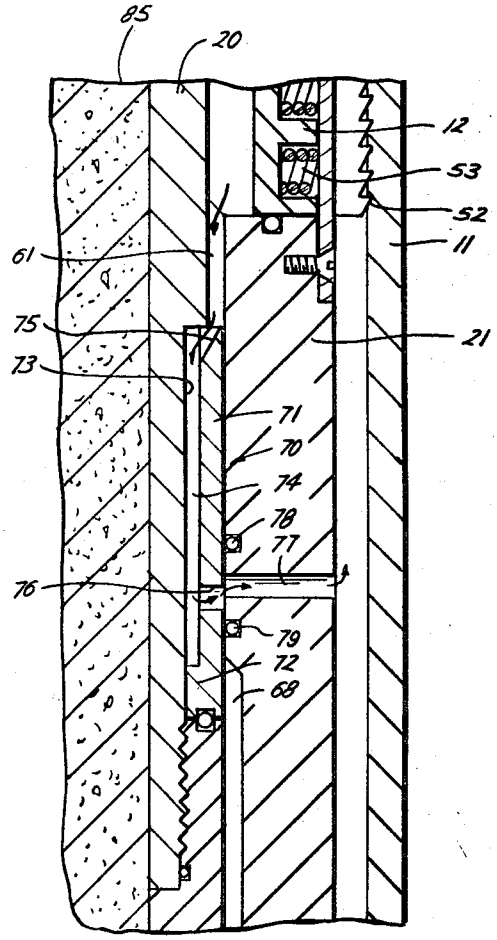


Fig. 4



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Filed Aug. 3, 1966 2 Sheets-Sheet 2

Fig. 2

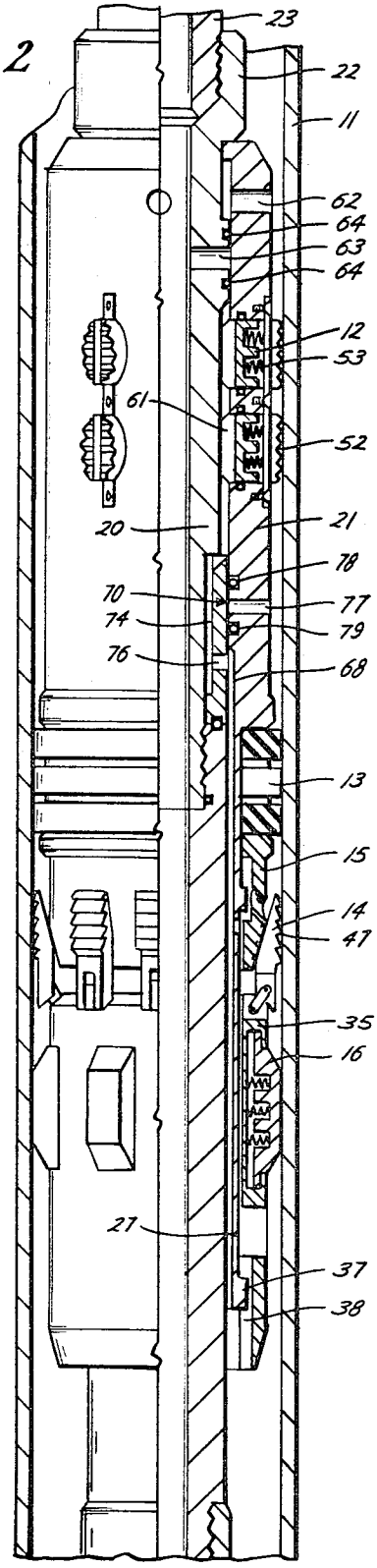


Fig. 3

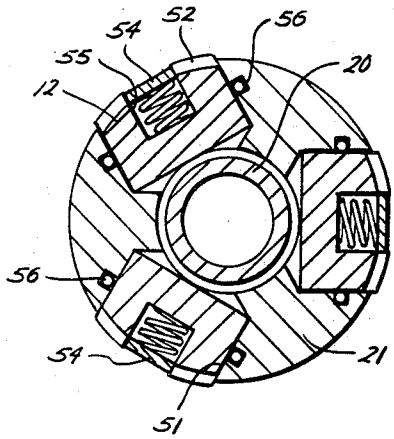
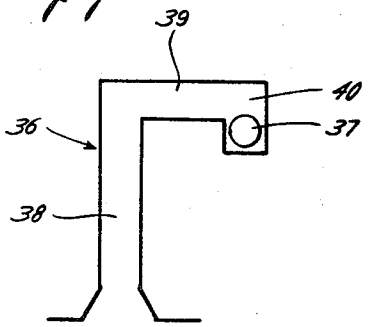


Fig. 5



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HYDRAULIC HOLD-DOWN RELEASE

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10 Claims. (Cl. 166—120)

ABSTRACT OF THE DISCLOSURE

A well packer apparatus having support and hold-down expanding anchors and including a fluid passageway having an upper portion in communication with said hold-down anchors and a lower portion in communication with the well bore below the packer, and valve means for selectively preventing or permitting fluid communication between said passageway portions, as well as fluid communication between said upper passageway portion and the well bore above the packer.

This invention relates generally to subsurface well tools and more specifically to a well packer having hydraulically operable anchoring device and fluid pressure equalizing means.

Well packers for performing well bore pressuring operations such as squeeze cementing or hydraulic fracturing often incorporate hydraulically operated hold-down systems which include gripping pistons adapted to bite into the casing to anchor against upward sliding of the packer. Cement slurry or fracturing fluid is displaced under pressure through a pipe string attached to the packer and into a formation zone. The pressure difference between the squeeze or fracture pressures and the annulus hydrostatic pressure is effective as a force urging the gripping pistons against the casing walls. When the pressure operation is completed, the pressures in the pipe string are released and the gripping pistons returned to their retracted positions so that the packer can be retrieved from the well.

Under certain circumstances, the anomaly of "flash" setting of cement slurry can occur in the pipe string and within the packer bore. That is to say, the cement slurry ingredients are improperly mixed at the surface and will prematurely set up or become hardened when subjected to high temperatures and pressures normally encountered in a well bore. When the cement slurry hardens, squeeze pressures can be trapped behind the gripping pistons so that they will not retract for release of the packer. Moreover, in hydraulic fracturing operations where proping agents such as sand grains are suspended within a gel, the gel can lose viscosity under high temperatures and pressures to the extent that the sand grains can settle within the tubing string and packer bore so as to form a solid plug therein. This anomoly is called "sanding-out" and the fracture fluid pressures can be trapped within the hold-down system to prevent its release when "sanding-out" occurs.

If the hold-down system will not release, the packer must be removed from the well by forcing it upwardly by pull on the pipe string at the earth's surface until the wickers on the gripping piston are stripped or torn off, or by removing the pipe string and attempting to wash over the packer, or by drilling the packing away. Obviously, any of these remedial measures involves loss of valuable rig time and/or damage to valuable equipment.

The leading object of the present invention is to provide a new and improved hydraulic hold-down system in a well packer wherein fluid pressures can be equalized

that have been trapped in the system to prevent its release.

Another object of the present invention is to provide a new and improved hydraulic hold-down mechanism which includes an equalizing valve means operable upon relative movement between parts to equalize any existing pressure differentials across the gripping pistons which are not equalized in a normal fashion.

Another object of the present invention is to provide a new and improved well packer having a fluid bypass and a hold-down mechanism which can be released even though fluid pressures are not equalized in a normal manner when the fluid bypass is open.

Yet another object of the present invention is to provided a new and improved hydraulic hold-down system and pressure equalizing means in a well packer which is effective to anchor and pack off in a well conduit and which is simple and reliable in operation.

These and other objects are attained in accordance with the present invention by providing, in a well packer, inner and outer tubular members movable longitudinally relative to one another. The outer member carries hydraulically operable gripping means for anchoring in a well conduit. Passage means and chamber means are provided between the members through which fluid pressure can act to operate the hydraulically operable means. Port means in the outer member communicate with the well annulus and the valve means can be operated by relative movement between the members to selectively place the port means in communication with the chamber means. Bypass passage means are provided in the members and bypass valve means can be selectively operated to open and close the bypass passage means.

The novel features of the present invention are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood by illustration and example of a preferred embodiment illustrated in the accompanying drawings in which:

FIGURE 1 is a longitudinal partial sectional view of a well packer in accordance with the present invention with parts in relative positions for longitudinal movement within a well bore;

FIGURE 2 is a view similar to FIGURE 1 with parts in relative position for performing a pressure operation in the well bore;

FIGURE 3 is a cross-section taken on line 3—3 of FIGURE 1;

FIGURE 4 is an enlarged fragmentary view of the pressure equalizing means in accordance with the present invention when operated to equalize pressures trapped within the hold-down system; and

FIGURE 5 is a developed plan view of the J-slot and lug mechanism used to control relative movement between parts of the well packer.

Referring to FIGURE 1, a well packer **10** in accordance with the present invention is shown with parts in "running-in" positions or for longitudinal shifting in a well conduit **11**. The well packer includes a hydraulically operable anchor assembly A, including a plurality of gripping pistons **12** for anchoring against upward movement, an expandable packing assembly B including a plurality of packing rings **13** for packing off the cross section of the well bore, a lower anchor assembly C including slips **14** and an expander **15** for anchoring against downward movement, and a control assembly D including drag blocks **16** which frictionally engage the wall of the well conduit **11**.

A generally tubular mandrel **20** is telescopically disposed within a tubular anchor body **21** for sliding movement between extended and contracted positions. The

mandrel **20** extends throughout the full-length of the packer and a threaded box portion **22** at its upper end is adapted for connection with a tubular string **23** which extends to the earth's surface. The lower end of the mandrel has a threaded pin portion **24** to which a section of pipe or another well tool can be connected. Splines **25** and **26** at the upper ends of the anchor body **21** and in the mandrel **20**, respectively, may be provided to co-rotatively and slidably couple the mandrel and anchor body to one another.

The anchor body **21** has a reduced diameter section **27** around which the packing assembly B is mounted. The packing assembly includes a plurality of annular elastomer packing rings **13** made of rubber or rubber-like material. The upper end of the packing assembly engages a downwardly facing annular shoulder or abutment **28** and the lower end engages an upperly facing annular abutment **29** which forms the upper end of the typical expander member **15**. The expander member **15** has downwardly and inwardly inclined outer surfaces **30** thereon and is retained for limited movement relative to the anchor body **21** by an annular flange **31** which engages in an internal recess **32** in the expander member, the bore of the expander being sized for sliding movement on the reduced section **27** of the anchor body.

Movably mounted on the tubular section **27** of the anchor body **21** is the control assembly D including a cage member **35** which carries the plurality of radially directed drag blocks **16** adapted to frictionally engage the well conduit wall. A typical J-slot **36** is formed in the lower end of the cage member **35** and cooperates with a lug **37** extending outwardly from the lower end of the tubular section **27** to permit control of relative movement between the cage member **35** and the anchor body **21**. The J-slot **36**, shown in developed view in FIGURE 5, has a longitudinally extending segment **38**, a horizontal segment **39** and a relatively short vertical segment **40** in which the lug **37** engages when the parts are in a "running-in" position as shown in FIGURE 1.

The cage member **35** has a plurality of circumferentially spaced, radially directed recesses **41** in its periphery, each of which receives a drag block **16**. The drag blocks are urged outwardly by springs **42** into a frictional engagement with the well conduit wall and function to retard movement of the cage member **35** in a well known manner. Outward movement of the drag blocks **16** is limited by co-engaging tangs **43**, **44** on the cage member and the drag blocks, respectively.

The cage member **35** also carries a plurality of slip segments **14** which are movably mounted on the upper end of the cage member by a plurality of links **45**. Each of the slip segments has upwardly and outwardly inclined inner surfaces **46** slidably engaging the inclined surfaces **30** on the expander member **15** in a manner whereby relative movement between the slip segments and the expander member will cause outward shifting of the slip segments to engage the well conduit wall. A conventional tongue and groove connection between each slip segment **14** and the expander member **15** may be provided so that relative movement between the slip segments and the expander member will effect movement of the slip segments to and from the wall of the conduit **11**. Wickers or teeth **47** on the peripheral surfaces of each slip segment **14** are adapted to bite into the conduit wall and anchor the well packer against downward movement therein.

An upper portion **50** of the anchor body **21** has a plurality of radial cylinders or bores **51** therein, each of which receives a movable gripping piston **12** having wickers or teeth **52** on its outer face adapted to anchor the well packer against upward movement when engaged with the well conduit wall. The gripping pistons **12** are pressed inwardly to retracted positions by springs **53** which bear against retainer bars **54** extending across

the faces of the pistons and secured on both sides of the pistons to the anchor body **21** by screws or other suitable fastening means. As shown in FIGURE 3, each bar **54** fits within a diametrical slot **55** in the face of a respective piston to prevent the piston from turning in its cylinder and thereby insuring that the teeth **52** are properly oriented in the direction they will hold. Seal rings **56** encircle each piston **12** and fluidly seal between the pistons and the walls of the cylinders **51**.

The mandrel **20** is formed with an external annular recess **60** behind the gripping pistons **12** to provide a chamber **61**. Fluid pressures developed within the chamber **61** in excess of the hydrostatic fluid pressures in the well annulus will be effective as forces tending to shift the gripping pistons **12** outwardly. When these pressures are equalized, the springs **53** serve to urge the gripping pistons **12** to their retracted positions.

A plurality of radial ports **62** in the anchor body **21** are arranged to register with ports **63** in the mandrel **20** when the mandrel is extended to provide a bypass passageway through which well fluids can bypass as the well packer **10** is shifted up or down in the well conduit. Suitable seal elements **64** are positioned in grooves encircling an annular valve head **65** on the mandrel **20** and function to isolate the ports **62**, **63** from the chamber **61** behind the gripping pistons **12** whether the mandrel **20** is in its extended or retracted position within the anchor body **21**. The upper of the seal elements **64** also isolates the ports **62**, **63** from one another when the mandrel **20** is in its retracted position to seal off fluid flow through the ports.

A lower portion of the mandrel **20** has an outer surface **66** which is laterally spaced from the inner wall surface **67** of the tubular section **21** to provide a fluid pressure communicating space **68** extending from the lower end of the well packer to a location above the packing assembly B. An annular valve means **70** is carried by the mandrel **20** intermediate its ends and adjacent the upper end of the communicating space **68**. The valve means **70**, in the embodiment shown, can take the form of a tubular sleeve valve having an upwardly extending portion **71** and an inwardly extending flange **72** at its lower end. The valve is positioned within an external annular recess **73** in the mandrel **20** and will reciprocate with the mandrel as it is moved between its extended and retracted positions within the anchor body **21**. The flange **72** serves to laterally space the inner wall of the upwardly extending portion **71** from the outer wall of the mandrel recess **73** to provide a fluid passage space **74** therebetween. The passage space **74** is in communication with the chamber **61** behind the gripping pistons **12** through a plurality of angularly cut slots **75** in the top end of the sleeve valve **70**.

A plurality of radially directed ports **76** extend through the wall of the longitudinal portion **71** and are arranged to register with a plurality of radial ports **77** in the anchor body **21** when the parts of the well packer are in "running-in" positions to place the well annulus above the packing assembly B in communication with the passage space **74**. Suitable seal elements **78** and **79** may be received in annular grooves in the anchor body **21** above and below the ports **77** to fluidly seal between the anchor body and the peripheral surfaces of the sleeve valve **70**. Additionally, a seal element **80** can be positioned within opposed grooves in the lower end of the sleeve valve and a mandrel shoulder **81** to fluidly seal therebetween.

Thus, it can be seen that when the parts are in "running-in" positions as shown in FIGURE 1, the chamber **61** behind the gripping pistons **12** is in fluid communication with the well annulus via the slots **75**, the passage space **74**, the sleeve valve ports **76** and the anchor body ports **77** so that fluid pressures within the chamber **61** in the well annulus can be equalized. It can also be seen that when the mandrel **20** is moved to its retracted position within the anchor body **21**, the sleeve valve **70** operates to place the chamber **61** in communication with the communicating

passage 68 between the lower portion 65 of the mandrel 20 and the lower section 27 of the anchor body 21 while closing off the anchor body ports 77. Thus, fluid pressures developed within the mandrel 20 and in the well conduit 11 below the lower end of the mandrel can be communicated through the passage 68 and the sleeve valve 70 into the chamber 61 behind the gripping pistons 12. The longitudinal distance between the lower terminal end of the passage 68 and the gripping pistons 12 provides assurance that any fluid movement therethrough as the gripping pistons 12 are operated during a pressuring operation will not be sufficient to permit fluids such as cement slurry to migrate into the chamber 61 and possibly foul the operation of the gripping pistons.

In the operation, the well packer 10 is assembled as shown on drawings and lowered into the well conduit 11 to a selected setting depth. The lug 37 is in the short segment 40 of the J-slot 36 to prevent relative movement between the cage member 35 and the anchor body 21, so that the slips 14 and the packing rings 13 are retained in retracted positions. The mandrel 20 is in its extended position whereby the sleeve valve 70 is positioned to communicate the chamber 61 with the well annulus so that fluid pressures are equalized across the gripping pistons 12. The bypass ports 62 and 63 are in registry so that ample bypass passage space is provided for well fluids to bypass around and through the packing assembly B. Thus, the well packer can be shifted quickly to the desired setting depth.

The lower one of the bypass seal elemnets 64 and the seal element 79 adjacent the equalizing ports 77 function to completely isolate the gripping pistons 12 from pressure surges within the bore of the mandrel 20 and in the passage space 68 between the mandrel and the anchor body 21 as the packer is lowered into the well. Accordingly, no pressures are developed within the chamber 61 which can pump the gripping pistons outwardly as long as the mandrel 20 is extended. In this manner, the teeth 52 on the gripping pistons will not be dulled or damaged by inadvertent engagement with the well conduit wall.

When setting depth is reached, the well packer is halted. The tubular string 23 is appropriately manipulated to move the lug 37 into the long segment 38 of the J-slot 36, the drag blocks 16 frictionally resisting turning movement of the cage member 35. Then the string 12 can be moved downwardly to move the mandrel 20 and the anchor body 21 relative to the cage member 35 which is held stationary within the well conduit 11 by the frictional engagement of the drag blocks 16 therewith.

As the mandrel 20 is lowered, the anchor body 21 can move downwardly relative to the cage member 35 and the expander member 15 can move downwardly relative to the slips 14 to expand them into anchoring engagement with the conduit wall. The mandrel 20 can move relative to the anchor body 21 until the box portion 22 engages the top of the anchor body, this movement positioning the upper one of the bypass seal elements 64 to close the bypass ports 62 and 63 from one another as shown in FIGURE 2. The sleeve valve 70 is reciprocated downwardly to a position wherein the lateral ports 76 therein are in communication with the passage space 68 between the anchor body 21 and the lower portion of the mandrel 20. Continued downward movement of the anchor body 21 as the weight of the tubular string 12 is applied thereto serves to compress and expand the packing rings 13 into engagement with the conduit wall to seal off the annulus between the tubular string 23 and the well conduit 11.

Fluids under pressure can now be displaced downwardly through the tubular string 23, the bore of the mandrel 20 and into the conduit 11 below the well packer 10. The pressures of the fluids are transmitted through the passage space 68 and past the sleeve valve 70 into the chamber 61 behind the gripping pistons 12. A pressure differential across the pistons sufficient to overcome the force of the springs 53 will move the pistons outwardly into gripping engagement with the conduit wall to anchor the well packer against upward movement.

When a pressure operation is completed, the packer can normally be released by merely moving the mandrel 20 upwardly to open the bypass ports 62, 63. Fluid pressures are equalized within the mandrel bore, the chamber 61 and the well annulus. The springs 53 press the gripping pistons 12 inwardly to retracted positions and the anchor body 21 can be moved upwardly relative to the cage member 35 for retraction of the lower slips 14 and the packing rings 13.

However, under the circumstances of "flash" setting during a cement squeeze or "sanding out" during a fracturing operation, as previously discussed, the bore of the mandrel 20 can become effectively plugged as shown by the numeral 85 so that even though the bypass can be opened, the squeeze or fracture pressures are trapped within and below the packer 10 by the plugging material. When this occurs, gripping pistons 12 will not detract from the conduit wall because the pressure differentials between the higher squeeze or fracture pressures and the hydrostatic pressures in the well annulus continue to be effective as outward forces on the gripping pistons.

The present invention permits the release of the gripping pistons 12 for retrieval of the well packer 10 even under these conditions. As illustrated in FIGURE 4, the plugged mandrel 20 can be moved upwardly relative to the anchor body 21 by an upward pull on the pipe string 23 at the earth's surface. A small amount of upward movement serves to clear the ports 76 in the sleeve valve 70 above the lower seal element 79. The fluid pressures trapped in the chamber 61 behind the gripping pistons 12 can then bleed down and equalize to the lower fluid pressures in the well annulus through the ports 76 and 77. When the pressures are equalized, the springs 53 can cause retraction of the gripping pistons 12 in a normal manner so that the well packer 10 can be retrieved.

A new and improved well packer has been disclosed having means for equalizing fluid pressures that may be trapped within a hydraulic hold-down system when such pressures are not equalized in a normal fashion by opening the fluid bypass valve. Since certain changes and modifications may be made in the embodiment disclosed, without departing from the inventive concepts involved, it is intended that the appended claims cover all such changes and modifications.

I claim:

1. In a well apparatus having inner and outer tubular members telescopically movable between extending and contracted relative positions and hydraulically opearable gripping pistons on said outer member for anchoring in a well conduit, the combination therewith of chamber means communicating with said pistons, passage means between said members, port means in said outer member, and equalizing valve means on one of said members selectively operated by telescoping movement of said members for communicating said passage means and chamber means while closing said port means in one of said positions, and for communicating said port means and chamber means while closing said passage means in the other of said positions.

2. The apparatus of claim 1 wherein said equalizing valve means comprises sleeve means on said inner member, flow means in said sleeve means arranged to alternatively register with said port means and said passage means, and seal means between said sleeve means and said outer member.

3. The apparatus of claim 2 wherein said sleeve means is a tubular member having a larger bore than the adjacent outer diameter of said inner member to provide a passage space therebetween, and wherein said flow means are ports extending laterally through the wall of said tubular member.

4. The apparatus of claim 1 further including bypass means in said members, and bypass valve means for selectively opening and closing said bypass means.

5. The apparatus of claim 4 wherein said equalizing valve means comprises sleeve means on said inner member, flow means in said sleeve means arranged to alternatively register with said port means and said passage means, and seal means between said sleeve means and said outer member.

6. In a well packer for use in a well bore, the combination comprising: inner and outer members telescopically movable between extended and contracted relative positions; packing means carried by said members for sealing off a well bore; hydraulically operable gripping members on said outer member for anchoring against movement in a well conduit; fluid passage means between said members, said passage means having an upper portion in communication with said gripping members, and a lower portion in communication with the well bore below said packing means; valve means between said members for blocking fluid communication between said passage portions in one of said relative positions, and for communicating said passage portions with one another in the other of said relative position; and means for communicating said upper portion with the well bore above said packing means in said one position.

7. In a well apparatus having inner and outer tubular members and hydraulically operable gripping pistons on said outer member for anchoring in a well conduit, the combination comprising passage and chamber means between said members through which fluid pressure can act to operate said hydraulically operable gripping pistons, port means in said outer member, valve means for selectively placing said port means in communication with said chamber means, bypass means in said members, bypass valve means for selectively opening and closing said hypass means, and seal means between said members for isolating said chamber means from the pressures of fluids in said bypass means.

8. A well packer comprising: concentric tubular members relatively movable between extending and contracted positions; anchor means and packing means for respectively anchoring said members against downward movement in a well conduit and packing off the annulus between said members and the surrounding well conduit wall; hydraulically operable gripping means on said members for anchoring against upward movement in the well conduit; passage means and chamber means between said members through which fluid pressures can act to operate said hydraulically operable means; port means in the outer of said members; equalizing valve means actuated by relative movement of said members for selectively placing said port means in communication with said chamber means; bypass means in said members for bypassing well fluids through said packing means; and bypass valve means for selectively opening and closing said bypass means.

9. The well packer of claim 8 wherein said equalizing valve means includes sleeve means on the inner of said members, flow means in said sleeve means arranged to registed with said port means when said member means are contracted, and seal means between said sleeve means and outer of said members above and below said port means.

10. The well packer of claim 8 wherein said bypass valve means includes seal means for isolating said chamber means from fluids passing through said bypass means.

References Cited

UNITED STATES PATENTS

2,880,805	4/1959	Nelson et al.	166—212 X
3,189,095	6/1965	De Rochemont	166—120
3,233,675	2/1966	Tamplen et al.	166—134 X
3,277,965	10/1966	Grimmer	166—120
3,283,819	11/1966	Tausch	166—120
3,338,308	8/1967	Elliston et al.	166—134 X

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