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HOLD-DOWN FOR WELL PACKERS

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Fig. 1

Fig. 2

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In the drawings:

Fig. 1 is a vertical mid-sectional view of a hold-down apparatus embodying the invention, the parts being shown in the positions normally occupied as the device is lowered into a well.

Fig. 2 is a similar mid-sectional view with the hold-down means shown in anchoring position.

Figs. 3 and 4 are transverse sectional views, the planes of the sections being indicated by the lines 3--3 and 4--4 respectively, of Fig. 1.

Fig. 5 is a vertical mid-sectional view, similar to Fig. 1, showing the mandrel moved to a position releasing position.

Fig. 6 is a vertical mid-sectional view similar to Fig. 5, showing the mandrel moved to a position for displacing the anchoring means to releasing position.

Fig. 7 is a view similar to Fig. 1, illustrating a slightly modified form of construction.

Fig. 8 is a view illustrating in elevation, and on a smaller scale, the application of the hold-down device of the present invention for setting a packer of a different conventional structure within a well casing.

In terms of broad inclusion, the hold-down device of the present invention comprises a hollow mandrel attachable to a string of operating pipe by which the device may be lowered into a well. A cylinder mounted over the mandrel is provided with a windowed wall portion forming a chamber around the mandrel. A piston within the chamber is axially movable relative to both the cylinder and the mandrel, and is operable to displace slips radially through the windows in the cylinder wall for effecting anchoring engagement with the well bore or casing. A packer connected to the lower end of the cylinder is arranged to be expanded into packing engagement with the well bore or casing by fluid pressure introduced through the mandrel into the well below the packer. Provision is made for directing fluid pressure from the mandrel into the piston chamber above the piston for displacing the piston downwardly, and thereby moving the slips radially outwardly to anchoring position. The fluid pressure directed upwardly against the packer is transmitted by the downward pressure against the piston for resisting displacement of the packer. Passages are provided in the mandrel for operation in association with a packing gland positioned near the top of the cylinder for releasing the fluid pressure applied to the piston, and to provide communication between the piston chamber and the well.

The invention also contemplates a structure permitting the hold-down mechanism to be disengaged and separated from the packer, including means for displacing the piston to effect release of the anchoring slips.

In terms of greater detail, the hold-down device of the present invention, designated in general by the reference numeral 10, comprises a cylinder body 12 mounted over a mandrel 14 arranged to be connected to the lower end of a string of operating pipe 18 by which the device and associated apparatus may be lowered into a well casing 20. The mandrel may be attached to the pipe 18 by any suitable coupling or sub 16.

An upper head member 22 is threaded or otherwise secured to the upper end of the body 12, and is recessed at its upper end as at 24, and is internally threaded, as at 21, to receive and to seat a stuffing gland 26 compressed into sealing engagement between the head member 22 and the mandrel 14, by means of a gland nut 28. The head member 22 is counterbored from the end opposite the stuffing gland to provide an annular passage 30 surrounding the mandrel, and to form an annular abutment 32 against which the packing 26 is compressed by the nut 28.

The packing is compressed sufficiently to prevent escape of fluid introduced under pressure from the mandrel 14.
into the passage 30 through ports 23 and 25 formed through the wall of the mandrel in axially spaced relation as indicated in the drawings.

A plurality of segmental anchoring slips 34 are mounted in connection with the mandrel 14 for movement radially through windows 36 formed in the wall of the tubular body 12. The slips 34 are slidable connected to a piston 42, preferably by a dovetailed tongue and groove connection 37, as indicated in Fig. 3 of the drawings. The tongues and grooves engage along matching tapered wedge faces 38 and 40 by which movement of the piston in an axial direction along the mandrel 14 is translated to a radial movement of the slips 34 through the windows 36.

The piston 42 is movable axially relative to the body 12 and the mandrel 14 within the annular piston chamber 44 provided between the tubular body 13 and the mandrel 14 below the cylinder head member 22. Sealing means, such as O-rings 46, are seated in suitable grooves formed in the inner and outer walls of the piston 42 in sealing engagement with the inner surface of the tubular body 12 and the outer surface of the mandrel 14. The inclination of the tapered wedge faces 38 and 40 is designed to effect radial movement of the slips 34 from a normal position entirely within the outer circumference of the tubular body 12, as indicated in Fig. 1, to an outwardly extending position in anchoring engagement with the well casing 29, as indicated in Fig. 2 of the drawings.

A lower cylinder head 48 is threaded or otherwise secured upon the lower end of the tubular body 12. The lower cylinder head 48 is recessed at 49 to receive a sleeve nut 52 threaded onto the lower end of the mandrel 14, and provided with splines 54 interengagable with splines 56 upon the inner surface of the cylinder head 48. The upper edge of the sleeve nut 54 forms a shoulder 50, positioned externally of the mandrel 14 and movable thereby into engagement with the lower end 51 of the piston 42, for imparting displacing force thereagainst, as hereinafter more fully explained. Also, the splines 54 and 56 are circumferentially spaced and relatively movable through a limited range of circumferential movement for imparting a jarring action and relative rotative movement when and if such movement is desired.

The sleeve nut 52 is provided with a downwardly disposed extension 57 extending downwardly through a reduced extension 60 formed upon the lower end of the lower cylinder head 48. The extension 57 has an axial passage in communication with the hollow mandrel 14. A suitable O-ring 58 or other sealing means is provided in the head 48 for effecting sealing engagement with the reduced extension 57 within the extension 60 while preventing the escape of fluid pressure therebetween.

The lower end of the head extension 60 is threaded into a packer mounting member 62. The packer may be of any conventional construction, as for example, a cup type packer 64 of the general character indicated in Fig. 1 of the drawings, the packer mounting member 62 is provided with a flanged head portion 66 having an annular sleeve portion 67 depending therefrom. A reduced extension 68 projects downwardly from the mounting member 62 through the packer 64.

The packer 64 is preferably of a type provided with a packer 70 having upwardly converging walls against which fluid pressure may be directed to expand the packer against the extension 68 and the inner surface of the well casing 20. Where substantial pressure must be encountered as the packer is lowered into a well, appropriate means may be provided for holding the cup in collapsed condition until the desired level is reached in a well, which point the holding means is released by a suitable shifting of the mandrel or other appropriate means. Since such packers and release means are well known in the art, a detailed disclosure thereof is herein unnecessary.

The hold-down device is assembled as a unit with the sleeve nut 52 seated in its lowermost position in the lower cylinder head 48, and with the piston 42 in its normal raised position as limited by the lower end of the upper cylinder head 22 when tightly screwed into the tubular body 12. The ports 23 and 25 are so positioned in the mandrel 14 that, when the unit is thus assembled, the ports open into the passage 30 at a point immediately below the packing 26, and the ports 25 open into the passage 30 in the shoulder 43 formed in the piston 42. In assembling the piston onto the mandrel 14, the normal position of the piston may be fixed by a shoulder 45 formed on the mandrel at a point such that it will normally be disposed in substantially the same plane as the shoulder 43 formed by the lower end of the cylinder head 22. The piston 42 is normally held against movement along the sealing rings 46 against the mandrel and the cylinder body. When in this position, the dovetail connection of the piston with the slips 34 causes the slips 34 to engage only to their recessed positions shown in Fig. 1. Force adequate to move the packer and hold-down unit, together with any equipment attached below the packer, may be applied through the string of pipe 18, operating against the lower cylinder head 48 through the sleeve nut 52 without displacing the piston 42 or the slips 34.

When the packer 64 and hold-down unit 16 have been lowered to the desired level, fluid is pumped down the string of pipe 18 to and through the mandrel 14. The fluid passes downwardly through the packer mounting member 62 and is directed into the well at a point below the packer, the packer being expanded into sealing engagement with the surrounding casing, or the surrounding well bore if it is not cased. At the same time, fluid pressure is directed from the mandrel 14 through the ports 23 and 25 into the passage 30, and exerts a downward pressure against the piston 42. This pressure forces the piston 42 downwardly within the chamber 44, and the axial movement of the piston is translated to a radial movement of the anchor slips 34 by reason of the interengaging wedge faces 38 and 40.

The pressure applied to the upper face of the piston 42 is substantially the same as the pressure pumped into the well below the packer, and hence the slips are forced against the casing by a pressure which is in hydrostatic balance with the pressure below the packer. As the pressure below the casing is increased, the pressure against the piston 42 is correspondingly increased, and the slips are held in effective anchoring engagement with the casing (or well bore). The outer faces of the slips are preferably serrated, so as to bite against the surrounding casing and effectively resist upward displacement regardless of the pressure below the packer. The fluid pumped into the well through the pipe 18 may be the mixture used for squeeze cementing, or for squeeze acidizing, or it may be any liquid available, or required for a particular purpose.

In some operations, it is desirable to hold the packer in a set position within a well, and thereafter to perform various operations above the level of the packer. This may be readily accomplished by the device of the present invention by moving the mandrel 14 upwardly to position the ports 23 above the stuffing gland 26, as illustrated in Fig. 5 of the drawings. Pressure effective through the ports 25 will continue to resist upward movement of the piston 42 from its operative hold-down position where it will ordinarily be firmly set. In this position, the mandrel is in communication with the well above the hold-down unit; and the line of pipe may now be flushed out to the level of the hold-down unit through the ports 23. The flushing fluid in turn may be displaced by another liquid
to be introduced into the well above the packer for any desired purpose. When it is desired to release and withdraw the hold-down unit, the mandrel 14 may be moved axially upwardly to cause the shoulder 50 to strike against the lower face 51 of the piston 42 with sufficient force to displace the piston upwardly to the slip withdrawing position shown in Fig. 6 of the drawings. The pressure from the passage 30 is relieved through the mandrel and passages 23 into the well at a point above the hold-down unit. This permits the hold-down unit to be withdrawn bodily from the well without impairment of its usefulness for future operations of a similar kind.

At times it is desirable to leave the packer itself in position, and to disconnect and remove the hold-down unit without disturbing the position of the packer. This may be accomplished by rotating the string of pipe 18, and of course the mandrel 14 attached thereto, to unscrew the assembly at a desired point. The interengaging splines 54 and 56 may be caused to transmit rotary movement from the mandrel 14 to the sleeve nut 52 in either direction. The splines are spaced to permit the nut to be moved within the lower cylinder head 48 through a short arc to strike the companion splines and thereby jar loose the desired threaded joint. Separation at a desired point may be insured by providing locking means of any conventional character at joints other than the one at which it is planned to make the break. Alternatively, an appropriate use of right and left hand threads may be utilized to insure separation in response to rotation of the string of pipe 18 in a desired direction after the anchor has been firmly set in place.

In some cases, it is desirable to provide means for resisting displacement of the packer and/or the hold-down unit from a desired position while the mandrel 14 is moved to position the packer 43 and 44 in the relationship to the packer gland 26. In Fig. 7 of the drawings I have illustrated a modified arrangement of the hold-down unit of my invention wherein the upper end of the upper cylinder head 22 is externally threaded to engage a box 69 upon the lower end of a sleeve 70, which is mounted over the mandrel 14 between the cylinder head 22 and the lower end of the pipe 18 to which the mandrel is connected. Springs 71 are mounted upon the sleeve 70 to frictionally engage the casing 20. Engagement of the springs 71 with the casing 20 insures that the hold-down cylinder will be held in its normal uppermost position while the unit is being lowered into the well. Casing 20 also serves to hold the cylinder against upward movement with the mandrel when it is raised to communicate with the well through the ports 23 at a level above the packer gland 26. Openings 73 are provided in the box 69 in communication with the well above the hold-down unit.

In Fig. 8 I have illustrated, more or less diagrammatically, an arrangement wherein the hold-down unit of the present invention is attached by a suitable sub or coupling 72 to a packer, designated in general by the numeral 74, of a different structural form. In this arrangement a plurality of expandable packing elements 76 is provided, and a plurality of anchor slips 78 is mounted upon the lower end of the packer 74 to aid in positioning the packer at a desired level in a well. As illustrated, wiper springs 80 are mounted upon a downwardly extending mandrel 82 coupled to the hold-down unit 10 by the coupling 72. The slips 78 and wiper springs 80 are normally held in a retracted position from which they are releasable by manipulation of the mandrel 82, in accordance with conventional practice, to frictionally engage the casing and position the packer preparatory to the introduction of fluid pressure for compressing the packer to its packing condition. Other types of packer may of course be substituted and used in accordance with conventional practice. In any case, the packer may be effectively held down by the device of the present invention in the manner above described.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A hold-down for well apparatus arranged to be lowered into a well casing by a string of operating pipe comprising a tubular mandrel attachable to the string of pipe, a cylinder mounted over the mandrel for limited axial movement relative thereto and provided with a windowed wall portion spaced from the mandrel and forming a chamber around the mandrel intermediate the windows of the cylinder, a piston with which a chamber slidingly movable relative to the mandrel and forming a movable wall of the chamber, slips mounted upon the piston for radial displacement through the cylinder wall windows by axial movement of the piston, sealing means engaged between the mandrel and end portions of the cylinder, longitudinally spaced parts formed in the mandrel adjacent the sealing means at the upper end of the cylinder, the uppermost of said ports being adapted to be disposed within or without the cylinder by longitudinal movement of the mandrel relative to the cylinder to optionally provide communication between the string of pipe and the chamber formed by the piston or between the string of pipe and both the chamber and the well casing above the cylinder.

2. A hold-down for well apparatus lowered into a well casing by a string of operating pipe comprising a tubular mandrel, a cylinder mounted over the mandrel and provided with upper and lower head fittings and a windowed cylinder body connecting the head fittings, said body having its inner surface spaced from the mandrel to form a chamber, a pressure-sealed piston within the chamber axially movable relative to the mandrel and cylinder and forming a movable wall of the chamber, slips slidably connected to the piston and movable through the windows of the cylinder body, including wedge surfaces upon the piston and the slides for moving the slides radially in response to axial movement of the piston relative to the mandrel and cylinder, a packer connected to the lower end of the cylinder and expandable by hydrostatic pressure below the packer, and means for directing hydrostatic pressure through the string of pipe into the chamber for moving the slips into locking engagement with the casing.

3. A hold-down for well apparatus lowered into a well casing by a string of operating pipe comprising a tubular mandrel, a cylinder mounted over the mandrel and provided with upper and lower head fittings and a windowed cylinder body connecting the head fittings, said body having its inner surface spaced from the mandrel to form a chamber, a pressure-sealed piston within the chamber axially movable relative to the mandrel and cylinder and forming a lower movable wall of the chamber, slips slidably connected to the piston and movable through the windows of the cylinder body, interengaging wedge surfaces upon the piston and the slips for moving the slips radially in response to axial movement of the piston relative to the mandrel and cylinder, a packer connected to the lower end of the cylinder and expandable by hydrostatic pressure below the packer, and means for directing substantially balanced hydrostatic pressure from the string into the chamber and into the well below the packer.

4. A hold-down for well apparatus arranged to be lowered into a well by a string of operating pipe comprising a tubular mandrel attachable to the string of pipe, a cylinder mounted over the mandrel for limited axial movement relative thereto and having a windowed wall portion spaced from the mandrel and forming a chamber around the mandrel, a pressure-sealed piston within the chamber slidingly movable relative to the mandrel and forming a movable wall of the chamber, slips radially movable through the windows of the cylinder wall in response to axial movement of the piston, a packer connected to the lower end of the chamber and provided with an axial passage communicating between...
the mandrel and the well, and means for directing balanced hydrostatic pressure from the mandrel into the chamber and into the well below the packer.

5. A hold-down for well apparatus arranged to be lowered into a well by a string of operating pipe comprising a tubular mandrel attachable to the string of pipe, a cylinder mounted over the mandrel for limited axial movement relative thereto and having a windowed wall portion spaced from the mandrel and forming a chamber around the mandrel, a pressure-sealed piston within the chamber slidably movable relative to the mandrel and forming a movable wall of the chamber, slips slidably mounted on the piston and radially movable through the windows of the cylinder wall in response to axial movement of the piston, a packer connected to the lower end of the chamber and provided with an axial passage communicating between the mandrel and the well, means for directing balanced hydrostatic pressure from the mandrel into the chamber above the piston and into the well below the packer, and a shoulder upon the mandrel movable axially into displacing engagement with the piston.

6. A hold-down for well apparatus arranged to be lowered into a well by a string of operating pipe comprising a tubular mandrel attachable to the string of pipe, a sleeve threaded onto the lower end of the mandrel and provided with splines and a downwardly disposed reduced extension, a windowed cylinder mounted over the mandrel and provided with an upper cylinder head slidably engaging the mandrel and a lower cylinder head slidably engaging the reduced extension, splines upon the lower cylinder head adapted to slidably engage the splines of the sleeve, the splines on said lower cylinder head being smaller circumferentially than the splines on said sleeve to permit limited rotational movement between said sleeve and said lower cylinder head, a piston slidably mounted upon the mandrel within the cylinder, slips movable radially through the windows of the cylinder in response to axial movement of the piston, a packer connected to the lower cylinder head, and passages opening outwardly from the mandrel for directing fluid pressure from the mandrel into the cylinder above the piston and into the well below the packer.

7. A hold-down for well apparatus arranged to be lowered into a well by a string of operating pipe comprising a tubular mandrel attachable to the string of pipe, a sleeve threaded onto the lower end of the mandrel and provided with splines and a downwardly disposed reduced extension, a windowed cylinder mounted over the mandrel and provided with an upper cylinder head slidably engaging the mandrel and a lower cylinder head slidably engaging the reduced extension, splines upon the lower cylinder head adapted to slidably engage the splines of the sleeve, the splines on said lower cylinder head being smaller circumferentially than the splines on said sleeve to permit limited rotational movement between said sleeve and said lower cylinder head, a piston slidably mounted upon the mandrel within the cylinder, slips movable radially through the windows of the cylinder in response to axial movement of the piston, a packer connected to the lower cylinder head, and passages opening outwardly from the mandrel for directing fluid pressure from the mandrel into the cylinder above the piston and into the well below the packer.

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