ABSTRACT

In a well safety valve for controlling the fluid flow through a well tubing in which the valve closure means is controlled by a longitudinal movable tubular member, the improvement of a lockout means for locking the valve closure member in the open position by providing a second tubular member telescoping with the first tubular member and initially secured thereto. Means for preventing inadvertently locking out the valve while the valve is in the open position. Tool engaging means on the second telescoping section for moving the second section downwardly for opening the valve closure member, and holding means for engaging the second section downwardly for locking the valve open. The holding means may include coacting ratchet teeth between the first and second tubular sections and may be releasable if desired. Or the holding means may include coacting ratchet means between the second section and the valve housing. Tool engaging means may be provided on both the first and second sections for moving the second section downwardly by engaging only the tool engaging means on the second section. Or the second section may be moved downwardly by a tool engaging both the first and second sections and moving the first and second sections apart.

14 Claims, 15 Drawing Figures
LOCKOUT FOR WELL SAFETY VALVE

BACKGROUND OF THE INVENTION

Various safety valves have been used in the past in a well tubing to shut off the production of well fluids from oil or gas wells such as shown in U.S. Pat. Nos. 3,078,923 and 3,627,042 in which the opening and closing of the valve is controlled by a longitudinal movable tubular member. Generally, the tubular member is pressure actuated and requires close tolerances which are subject to binding by deposits such as sand. One cause of safety valve problems is the inability to operate the safety valve due to the binding of the tubular member as a result of the well deposits including accumulated sand that is often found in produced well fluids. Of course, if the movable tubular member becomes stuck, the valve cannot be actuated. If the safety valve is retrievable, it can be removed and repaired, or if it forms a portion of the well tubing, the tubing string must be pulled to perform any safety valve repairs.

Such operations are costly and time consuming. It is sometimes desirable to delay the repair of the safety valve until a more convenient time. In this event, the safety valve is locked out which means it is moved to a fully opened position, such as for the purpose of producing from the well or performing other work in the tubing below the safety valve. While a lockout of the safety valve will not eliminate the need for pulling the safety valve or tubing for safety repairs, the lockout will allow the well to stay on production or perform other well functions in the tubing until the safety valve work can be conveniently scheduled. One type of safety valve lockout is shown in U.S. Pat. No. 3,696,850 in which a lockout sleeve is moved downward against the top of the longitudinal tubular member for moving the tubular member in a direction to open the valve and lock the valve open. However, if the cause of the failure is due to the sticking or binding of the tubular member, it may be difficult to obtain a sufficient movement of the tubular member to provide the desired lockout. That is, the operating tubular member is generally moved in at least one direction by fluid pressure which requires that the tubular member have seals or sealing surfaces and close clearance areas that are conducive to binding in the presence of well deposits.

The present invention is directed to a lockout for a safety valve which cannot inadvertently be locked out while the valve is in the open position, and a lockout member which does not coact with any sealing surfaces so that the clearance between it and other members can be made sufficiently great to prevent binding from well deposits.

SUMMARY

The present invention is generally directed to providing a lockout for a well safety valve that may be actuated even in the event that the longitudinal movable operating member of the safety valve is stuck and immovable.

The present invention is further directed to the improvement in a well safety valve which controls the fluid flow through a well tubing and includes a longitudinal movable tubular member controlling the movement of the valve closure member of a lockout means for locking the valve closure member in the open position by providing a telescoping section on the tubular member with means for initially securing the telescoping section to the tubular member. Tool engaging means are provided on the telescoping section for moving the telescoping section downwardly for opening the valve closure member. Holding means are provided for engaging the section for holding it in the downward position for locking the valve open.

A further object is the provision of a lockout which cannot inadvertently lock out the valve while the valve is in the open position and prevent normal operation of the safety valve.

Yet a further object of the present invention is a provision of holding means on the telescoping section which is releasable for resetting the lockout member and closing the valve.

Still a further object of the invention is the provision of a lockout means in which the lockout member is positioned out of engagement with any fluid seals so that it may be easily moved in the valve in spite of well deposits.

Still a further object of the present invention is the provision of tool engaging means on both the tubular actuating member and the lockout member for utilizing a tool which moves the lockout member relative to the tubular operating member.

Other and further objects, features and advantages will be apparent from the following description of presently preferred embodiments of the invention, given for the purpose of disclosure and taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is an elevational view, partly in cross section, of the top portion of a tubing retrievable safety valve, FIG. 1B is a continuation of FIG. 1A,
FIG. 1C is a continuation of FIG. 1B showing one form of the lockout means of the present invention in its inoperative position but with the safety valve in the open position,
FIG. 2 is a fragmentary elevational view, partly in cross section, of the lower portion of the safety valve of FIGS. 1A, 1B and 1C, shown in the closed position,
FIG. 3 is a fragmentary elevational view, partly in cross section of the lower portion of the safety valve showing the actuation of the lockout section for holding the valve in the open position,
FIG. 4 is an enlarged fragmentary view showing one form of the holding means for holding the lockout section in a lockout position,
FIG. 5 is an enlarged fragmentary view of a modified type of holding means for holding the lockout section in a lockout position,
FIG. 6A is an elevational view, partly in cross section of the top portion of a safety valve with another embodiment of the present invention,
FIG. 6B is a continuation of FIG. 6A showing the intermediate portion of the safety valve,
FIG. 6C is a continuation of the FIG. 6B showing the lower portion of the safety valve with the lockout member inoperative and the valve in the open position,
FIG. 7 is an elevational view, in cross section, of the top portion of the safety valve of FIGS. 6A, 6B and 6C with a tool for actuating a fluid control,
FIG. 8A is an elevational view, partly in cross section, of the top portion of the safety valve of FIGS. 6A, 6B and 6C and including the top portion of a lockout setting tool,
FIG. 8B is a continuation of FIG. 8A showing the intermediate portion of the safety valve and lockout setting tool.

FIG. 8C is a continuation of FIG. 8B showing the lower portion of the setting tool and safety valve, and FIG. 9 is a fragmentary elevational view, partly in cross section, of the lower portion of the valve of FIGS. 6A, 6B and 6C with the lockout tool shown in position for moving the lockout member to the lockout position.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

For the purpose of illustration only, the present invention will be described in connection with a tubing retrievable flapper type safety valve. However, it is to be recognized that the present lockout mechanism may be used with other types of safety valves including those having different valve closure means.

Referring now to the drawings, and particularly to FIGS. 1A, 1B and 1C, the reference numeral 10 generally indicates a well safety valve of the tubing retrievable type adapted to form a portion of a well tubing 12 by being connected therein by suitable threaded connections 14 (FIG. 1A) at the top and a suitable threaded connection at the bottom (not shown). The safety valve 10 is provided to control the fluid flow through the bore 30 of the well tubing 12 and the safety valve 10. Under normal flow conditions, the safety valve 10 is in the open position. The valve 10 is closed in the event of equipment failure or other undesirable conditions to shut off well production through the bore 30.

The safety valve 10 generally includes a valve body 18, a valve closure member such as a flapper valve 20 (FIG. 1C), a longitudinal movable tubular operating member generally indicated by the reference numeral 22 for controlling the movement of the flapper valve 20. The flapper valve 20 is carried about a pivot 24 and may include a spring 26 for yieldingly urging the flapper valve 20 about the pivot 24 and into an annular well seat 28 for closing the valve 10 and blocking upward flow of fluid through the bore 30 of the valve 10 and tubing 12.

The tubular member 22 is longitudinally movable in the valve body 18. When the lower end 32 contacts the flapper 20, the flapper 20 is moved off of the valve seat 28 and into a downward and open position, as best seen in FIG. 1C, thereby permitting fluid flow through the bore 30. However, when the tubular member 22 is moved upwardly and its lower end 32 is moved above the valve seat 28, the spring 26 and/or fluid flow upwardly through the valve 10 closes the flapper 20.

Any suitable control means for controlling the movement of the tubular member 22 may be used. For example, a biasing spring 34 (FIG. 1B) may be provided positioned between a shoulder 36 on the valve body 18 and a shoulder 38 on the tubular member 22 for biasing the tubular member 22 upwardly and in a direction allowing the flapper 20 to close. In order to provide means for moving the tubular member 22 in a downward direction, a piston 40 (FIG. 1A) may be provided on the tubular member 22 for movement in a cylinder 42 formed by seats 44 and 46. A control line 50 may be provided leading to the well surface for supplying a fluid therein which communicates with the cylinder 42 for controlling the movement of the piston 40 and thus of the tubular member 22. If fluid pressure is applied through the line 50 and into the cylinder 42, the piston 40 and the tubular member 22 is moved downwardly overcoming the spring 34 and opening the flapper 20, as best seen in FIG. 1C. The flapper 20 is closed, as best seen in FIG. 2, by reducing the fluid pressure in the control line 50 and thus in the chamber 42 allowing the spring 34 to move the tubular member 22 upwardly releasing the flapper valve 20. The above operation of the safety valve is generally conventional.

However, the safety valve 10 may fail for some reason. Of course, if it fails with the tubular member 22 held in the downwardly extended position, there is no need to use a lockout.

However, in the event the safety valve becomes inoperative when the tubular member 22 is in the upward or partially upward position, it may be desirable to lock out the safety valve until it can be conveniently retrieved. To lock out the safety valve 10 is to hold the valve closure member 20 in the fully opened position for purposes of providing well production therefrom or performing through tubing work until the safety valve 10 may be retrieved or repaired. One cause of safety valve problems is the inability to operate the safety valve 10 due to the binding or sticking of the tubing 12 relative to the seals 44 and 46, then it is difficult to utilize a lockout which requires movement of the tubular member relative to the seals 44 and 46 for opening and locking out the valve 20.

As best seen in FIG. 1C, the present invention includes a telescoping lockout section incorporated as part of the tubular member 22. Therefore, the tubular member 22 is provided with a first section 52 and a second lockout section 54 telescopically positioned relative to each other. The first section 52 is positioned relative to the body 18 and seals 44 and 46 with the necessary close tolerances required to enclose the pressure chamber 42. However, the second section 54 is not required to engage any high pressure seals and therefore the clearance between section 54 and the mating bore of the valve body and member 22 will be sufficiently great to prevent binding even in the pressure of well deposits, such as sand. The first and second tubular sections 52 and 54 are initially secured together by any suitable releasing means, such as a shear pin 56.

The inside of the second telescoping section 54 includes a suitable tool engaging means such as a recess 58 having a beveled upper edge 60 and a beveled lower edge 62 for suitable engagement by any conventional sliding sleeve actuating tool such as a Z-lock manufactured by Camco, Incorporated. The upper and lower beveled shoulders 60 and 62 eliminate any sharp corners upon which tools used in wireline or pump-in operations may become engaged and cause undesirable actuation of the locking section 54.

As best seen in FIG. 3, a suitable sleeve setting tool 66 is shown engaged in the recess 58 which may be jarred downwardly shearing the pin 56 and allowing the second locking section 54 to be moved downwardly against and opening the valve 20.

Suitable holding means are provided for engaging the second lockout section 54 and holding it in the set or downward position so that the section 54 may in turn engage and hold the valve 20 in the open position. For example, such means may include buttress threads 70, as best seen in FIGS. 3 and 4, that may allow easy
downward shifting of the lockout sections 54, but prevent the return to the upper position of the lockout section 54. The teeth 70 are formed for a sufficient length along the exterior of the member 54 to allow the telescoping section 54 to reach and bottom off against the flapper 20 should the upper section 52 be fully up at the time the lockout operation is actuated. Of course, should the section 52 be in any other position, the telescoping section 54 would still be able to bottom out against the flapper 20 and the teeth 70 will hold the section 54 relative to section 52.

Coacting with the teeth 70 for providing the desired means for holding the section 54 downwardly is a collet section 72 connected to the upper telescoping section 52. The inside tips of the collet sections 72 include coacting threads 74 to coat with the teeth 70 for completing the holding mechanism. The buttress type teeth 70 and 74 provide a permanent type lockout. That is, the lockout sleeve 52 is securely held in a downward position and is not reset upwardly to allow the valve 20 to reclose.

If desired, the holding means, such as the threads 70 and 74, could be profilled so that the lockout section 54 may be shifted downwardly to provide a lockout against the valve 20 or can be moved up to allow the valve 20 to close with the ease or difficulty of movement being controlled by the angle of the teeth. For example, as best seen in Fig. 5, in a modification, teeth 73, on the section 54, may be provided to coat with teeth 75 on the collet sections 72. The teeth 73 and 75 are generally standard threads which allow either upward or downward movement of the lockout section 54 relative to the section 52. In addition, it is to be noted that the various holding means previously described for holding the lockout section 54 in the downward position, such as the teeth 70 and 72, can, if desired, perform the function of shear pin 56 for initially securing the telescoping sections together.

Thus, the present lockout device can be utilized whether or not the hydraulic pressure in the chamber 42 is able to provide full movement of the operating tubular member 22 for opening of the valve 20. The lockout section 52 may be a permanent or a resettable lockout as desired, and since the telescoping section 54 is not subjected to high pressure seals, the clearance between it and its mating bore in the valve 10 may be made sufficient to prevent binding by well deposits; and in the absence of square shoulders on the lockout section 54, reproduces the likelihood of accidental actuation of the member 54 on being encountered by any square shoulders on normal tubing tools. Furthermore, the safety valve 10 still retains its straight through bore configuration without adding sections that may generate turbulence.

Referring now to FIG. 1C, it is to be noted that the lower end 32 of the lockout section 54 abuts a shoulder 19 of the valve body 18 when the tubular member 22 is in the fully extended downward position holding the valve 20 in the open position. Therefore, with the valve in open position, the lockout section 54 cannot be inadvertently actuated into the lockout position because of the shoulder 19.

Of course, other and further modifications of the present invention may be utilized. Referring now to FIGS. 6A, 6B and 6C, a further embodiment of the present invention is shown wherein like parts to those in FIGS. 1-4 are shown with like numbers and the addition of the suffix "a." Referring now to FIG. 6A, 6B and 6C, the valve 20a is controlled by the operating tubular member 22a consisting of upper section 52a and lower section 54a. The member 22a is biased upwardly by the spring 34a for closing the valve 20a and fluid pressure may be exerted into conduit 50a and into the chamber 42a for acting on the piston 40a for moving the tubular member 22a downwardly and opening the valve 20a. The lockout section 54a is initially secured to upper section 52a by shear pin 56a and includes a tool engaging recess 58a for moving the lockout member 54a downwardly for engaging and holding the valve 20a in the locked out position.

Suitable means for engaging and holding the second section 54a downwardly for locking out the valve 20a is provided, as best seen in FIG. 6C, by a plurality of teeth 80 on the exterior of the locking section 54a for coacting with teeth on ratchet clutch 82, which is generally urged inwardly by a quarter spring 84. As best shown in FIG. 6C, the valve 10a is in the open position in normal operation. In the event a setting tool is engaged in the recess 58a and driven downwardly shearing the pin 56a, the teeth 80 on the member 54a would engage the ratchet clutch 82 for holding locking section 54a downwardly and the valve 20a open. However, in normal operation, as best seen in FIG. 6C, in which the locking member 58a is not actuated, the locking teeth 80 do not contact the ratchet clutch 82.

While the lockout mechanism shown in FIG. 6C may be actuated by a tool as previously described with the embodiments of Figs. 1-3, it is to be noted, referring to FIG. 6B, that the upper telescoping section 52a also includes a recess 86. If instead of merely having a tool engage the recess 58a of locking member 54a and driving member 54a downwardly, a suitable tool may be provided having suitable engaging lugs, one of which engages recess 58a on section 54a, and recess 86 on section 52a in which the tool would move the sections 52a and 54a telescopically apart for setting the locking section 54a. While such a tool may be mechanically actuated, it is preferable that it be hydraulically actuated such as by the hydraulic control fluid in line 50a. Referring now to FIG. 6A, a sliding sleeve 88 is provided having an actuating notch 90 which is connected to a shear plug 92 which is normally closed, but which is sheared upon movement of the sliding sleeve 92 to open fluid communication between the bore 30 of the tool 10a and the fluid control line 50a for supplying control fluid to the interior of the valve 10a for actuating a hydraulic setting tool which will be more fully described hereinafter.

Referring now to FIGS. 6A and 7, a no-go shoulder 94 is provided above the sleeve 88 with a recess 96 therebelow which are provided for positioning a suitable shifting tool for shifting the sleeve 88. The shifting tool 100 includes an outer body 102 and an inner mandrel 104. When mandrel 104 is driven downwardly with respect to the body 102, a wedge face 106 on the mandrel 104 moves setting dogs 108, carried by body 102, outwardly into engagement with the shoulder 88 on the sleeve 88. Further downward movement of the shifting tool 100 will move the sleeve 88 and shear the plug 92. Normally, the mandrel 104 is held upwardly relative to the body 102 by a detent 110, carried by body 102, protruding into notch 112 in the mandrel 104. Downward movement of the tool 100 causes the body 102 to contact the no-go shoulder 94 in the tubing 12 shearing
a first shear pin 114 allowing the detent 110 to be moved downwardly into a slot 116 in the body 102 and further downward movement of the body 102 shears a second shear pin 118 allowing the outer body 102 to be further moved downwardly for positioning the dogs 108 opposite the notch 90. Further downward movement of the tool 100 causes the lockout section 54a to engage the ratchet clutch 82 and forcing the tubular member sections 52a and 54a apart to move the lockout section 54a downwardly into a position holding the valve 28a open until, as best seen in FIG 9, the teeth 80 on the lockout member 54a engages the ratchet clutch 82 to secure the lockout member 54a in thelocked out position.

The present invention, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned as well as others inherent therein. While presently preferred embodiments of the invention have been given for the purpose of disclosure, numerous changes in the detail of construction and arrangement of parts, may be provided, without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In a well safety valve for controlling the fluid flow through a bell tubing, the valve adapted to be positioned in the well tubing and having a valve closure member moving between open and closed positions, a longitudinally movable tubular member for controlling the movement of the valve closure member, first means for moving the tubular member in a first direction, second means for moving the tubular member in a second direction, the improvement in lockout means for locking the valve closure member in the open position comprising,
said tubular member including first and second telescoping sections, releasable means initially securing the telescoping sections together, tool engaging means on the second telescoping section for moving said second section downwardly for opening the valve closure member, and holding means for engaging the second section for holding the second section downwardly and locking said valve open.

2. The apparatus of claim 1 wherein the second section is connected to the lower part of the first section, and one of the means for moving the tubular member including a piston and cylinder assembly including coating seals, but in which the seals are positioned out of engagement with the second section whereby said second section may be easily moved downwardly without binding in seals.

3. The apparatus of claim 1 wherein the holding means includes coating ratchet teeth between the first and second sections.

4. The apparatus of claim 3 wherein the holding means is releasable.

5. The apparatus of claim 1 wherein said valve includes a shoulder positioned below the closure member and adjacent the bottom of the downward extent of travel of the tubular member whereby said second section will not be inadvertently moved to the locked out position while the valve is open.

6. The apparatus of claim 1 wherein the holding means includes coating ratchet means between the second section and the valve housing.

7. The apparatus of claim 1 including tool engaging means on the first section for moving the sections apart.

8. The apparatus of claim 7 wherein the tool engaging means on the first and second sections include a recess in each section.

9. The apparatus of claim 2 including a normally closed passageway leading from the communication with the cylinder to the interior of the valve housing,
a sliding sleeve positioned internally of the housing for opening said passageway on longitudinal movement.

10. The apparatus of claim 1 wherein the second section is positioned internally of the first section.

11. In a well safety valve for controlling the fluid flow through a well tubing, the valve adapted to be positioned in the well tubing and including a housing and a valve closure member moving between open and closed positions, a longitudinally movable tubular member for controlling the movement of the valve closure member, spring means for biasing the tubular member in a first direction for opening the valve closure member, a piston and cylinder assembly including coacting seals for receiving fluid for moving the tubular member in a direction for closing the valve closure member, the improvement in lockout means for locking the valve closure member in the open position comprising:

said tubular member including first and second telescoping sections, said second section telescoping internally of the first section and positioned out of engagement with said seals,

releasable means initially securing the telescoping sections together, a tool engaging recess positioned on the interior of the second section for moving said second section downwardly for opening the valve closure member, and holding means for engaging the second section for holding the second section in a downward position and locking said valve open.

12. The apparatus of claim 11 wherein the holding means includes coacting engaging means between the first and second sections.

13. The apparatus of claim 11 wherein the holding means includes coacting engaging means between the second section and the valve housing.

14. The apparatus of claim 11 wherein said valve includes a shoulder positioned below the closure member and the adjacent the bottom of the downward extent of travel of the tubular member whereby said second section will not be inadvertently moved to the lockout position while the valve is open.

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