United States Patent [19]

Calhoun

[11] **3,882,935**

[45] **May 13, 1975**

[54] **SUBSURFACE SAFETY VALVE WITH AUXILIARY CONTROL FLUID PASSAGE OPENABLE IN RESPONSE TO AN INCREASE IN CONTROL FLUID PRESSURE**

[75] Inventor: **Michael B. Calhoun,** Carrollton, Tex.

[73] Assignee: **Otis Engineering Corporation,** Dallas, Tex.

[22] Filed: **Dec. 26, 1973**

[21] Appl. No.: **427,795**

[52] **U.S. Cl.** ..... **166/224 A;** 251/58

[51] **Int. Cl.** **E21b 43/12**

[58] **Field of Search** ..... 166/224 A, 224, 226, 72; 251/58, 62

[56] **References Cited**

UNITED STATES PATENTS

3,696,868	10/1972	Taylor, Jr.	166/224 A
3,749,119	7/1973	Taush et al.	166/224 A
3,786,865	1/1974	Tausch et al.	166/224 A
3,786,866	1/1974	Tausch et al.	166/224 A
3,799,258	3/1974	Tausch	166/224 A

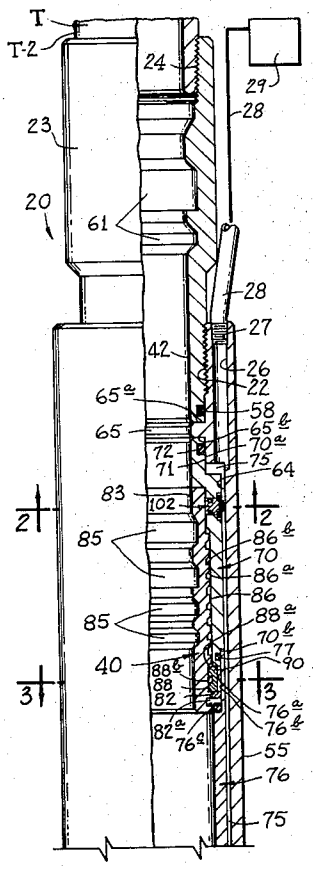
Primary Examiner—James A. Leppink

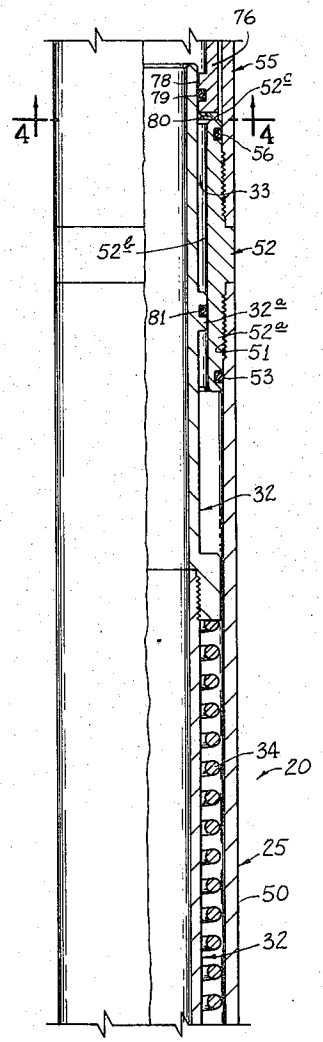
Attorney, Agent, or Firm—Albert W. Carroll

[57] **ABSTRACT**

A valve for installation in a flow conductor for controlling flow of fluids through the conductor, which may be controlled from a remote point and which may act automatically as a safety valve, including means for positively propping the valve in an open position or in a position intermediate open and closed positions for taking the valve out of operation permanently or for flowing the well without affecting operation of the valve, and further including means for locating and operating a supplemental flow control valve at such point in the flow conductor. Also includes means normally closing a lateral control fluid passage in the housing of the valve which is openable by increased control fluid pressure for thereafter conducting control fluid to and controlling a supplemental flow control which may be disposed through the valve.

15 Claims, 19 Drawing Figures





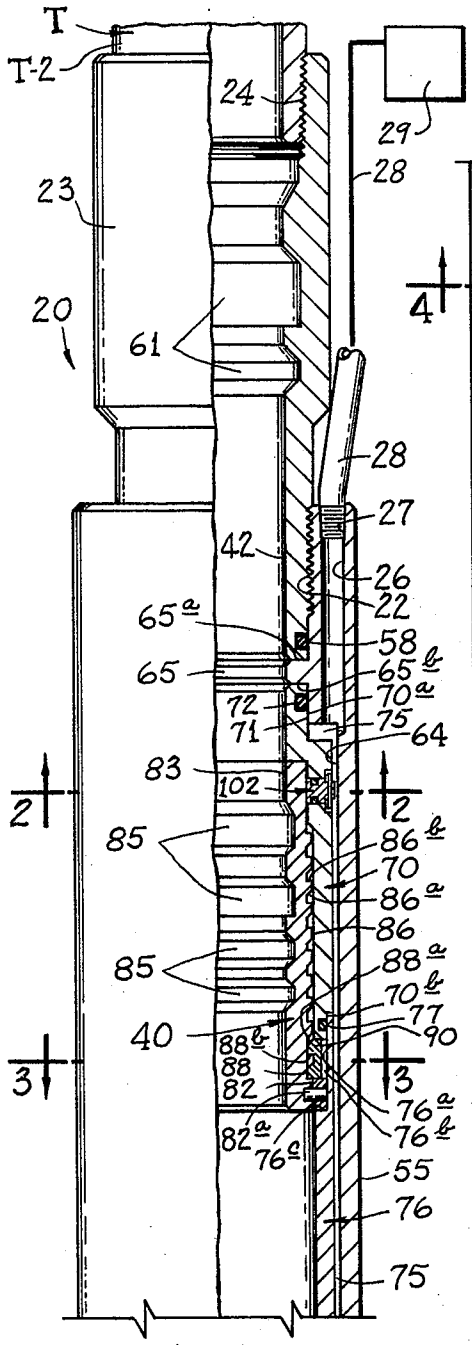


FIG. 1-A

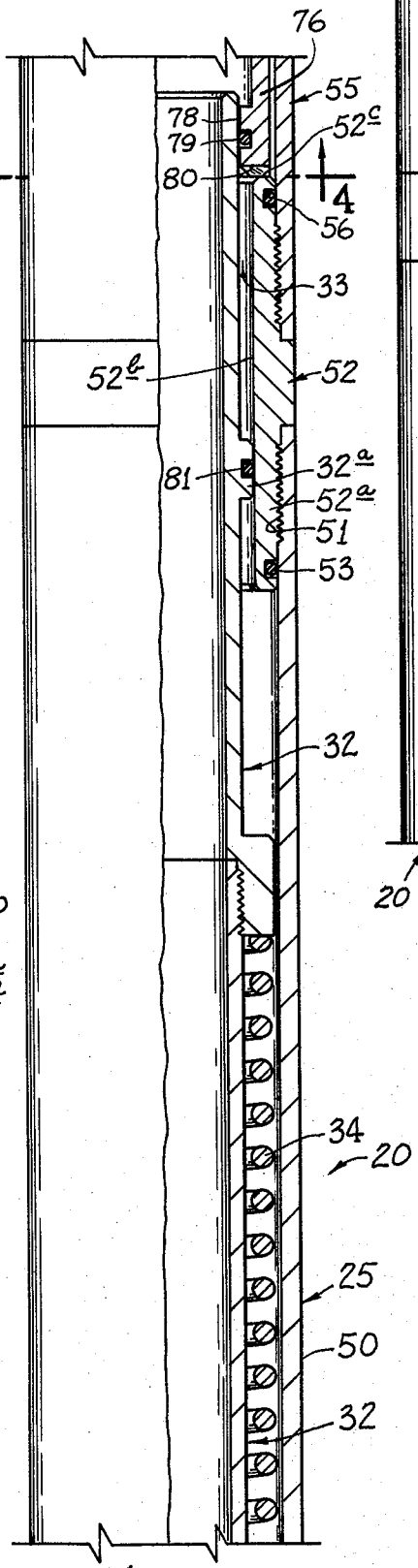


FIG. 1-B

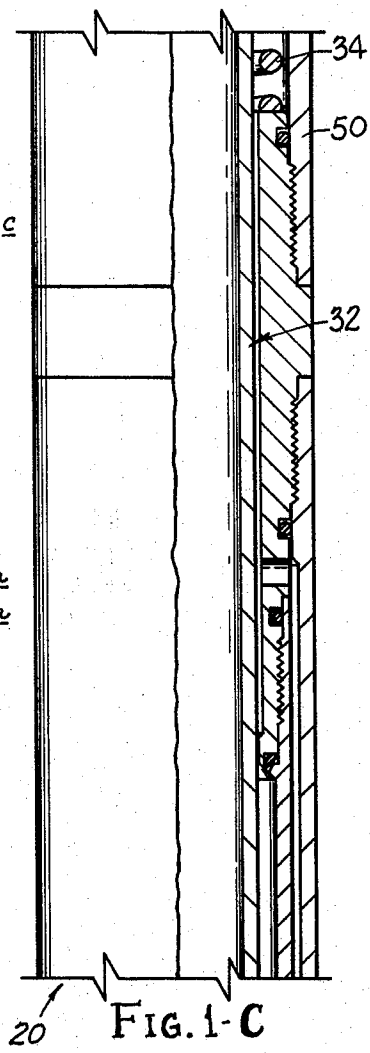


FIG. 1-C

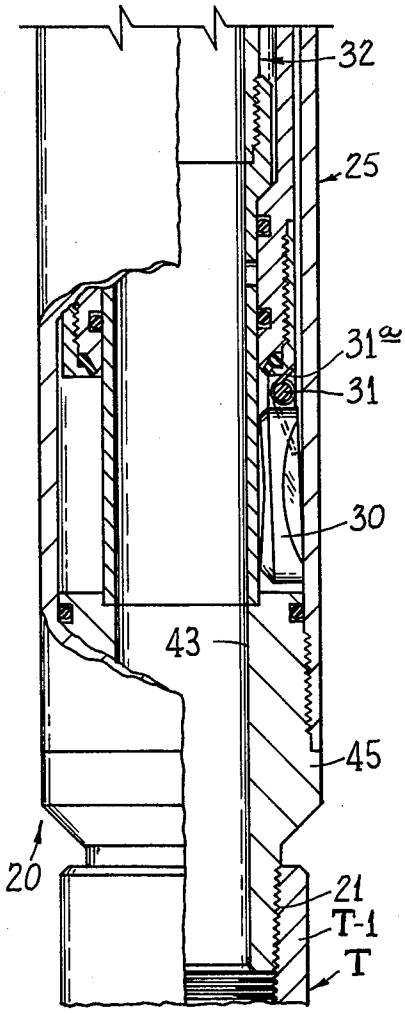


FIG. 1-D

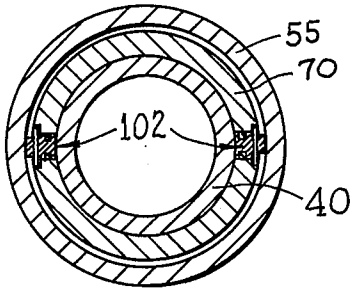


FIG. 2

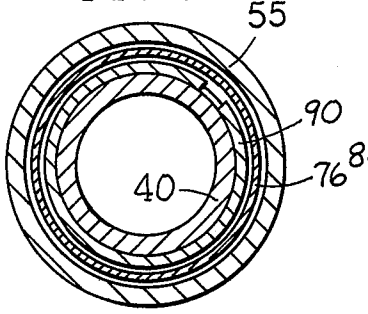


FIG. 3

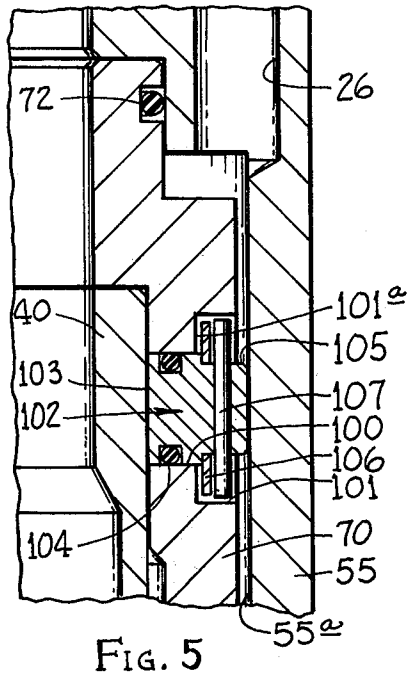


FIG. 5

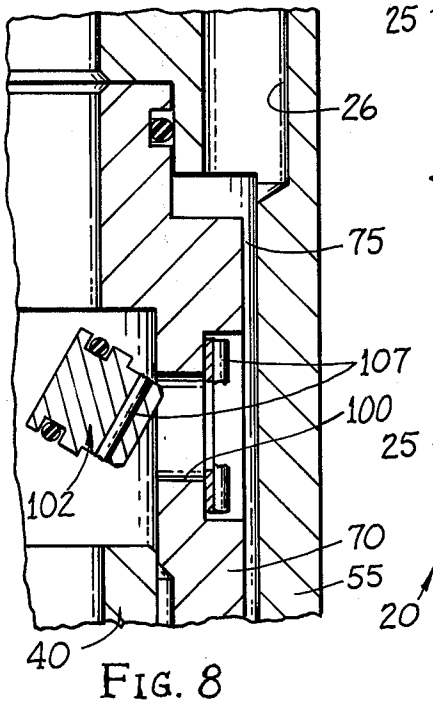


FIG. 8

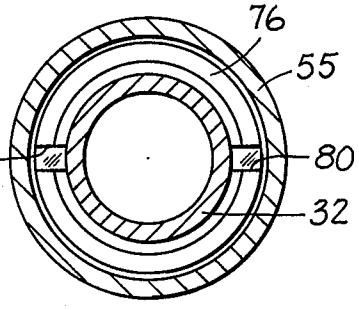


FIG. 4

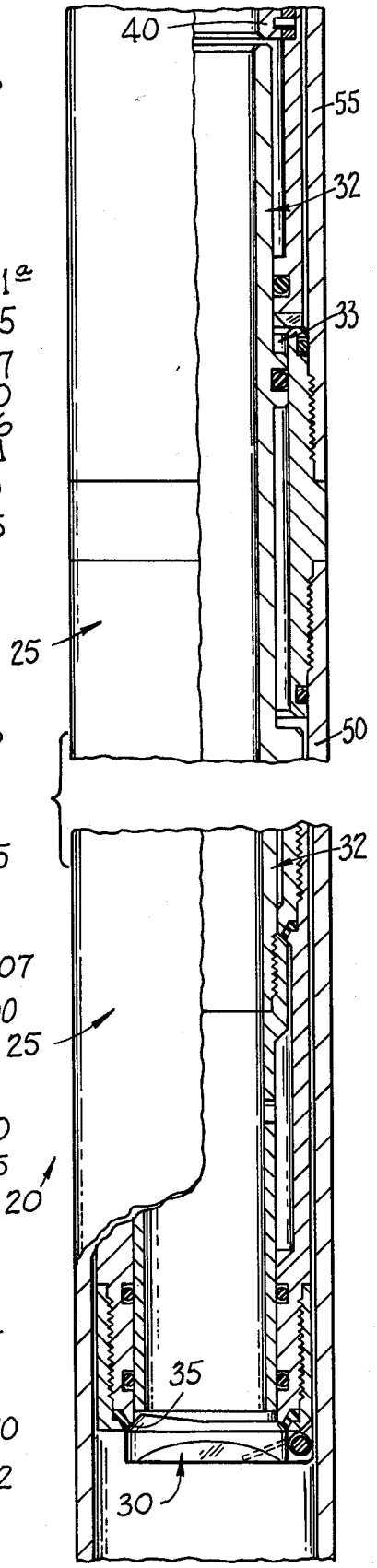


FIG. 6

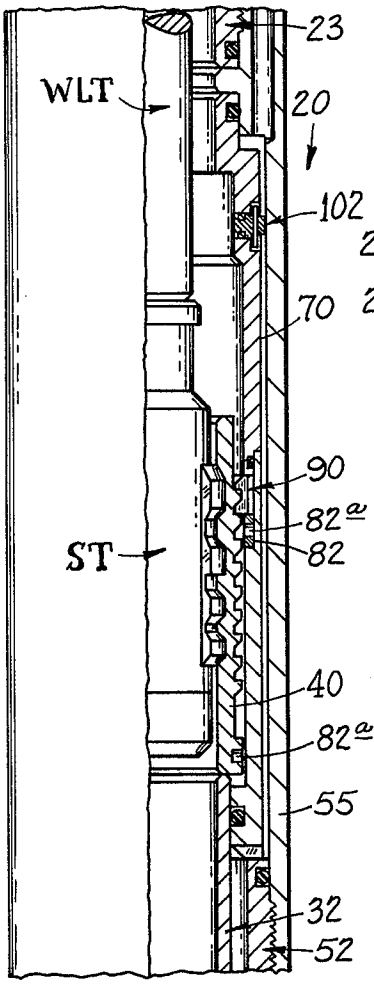


FIG. 7

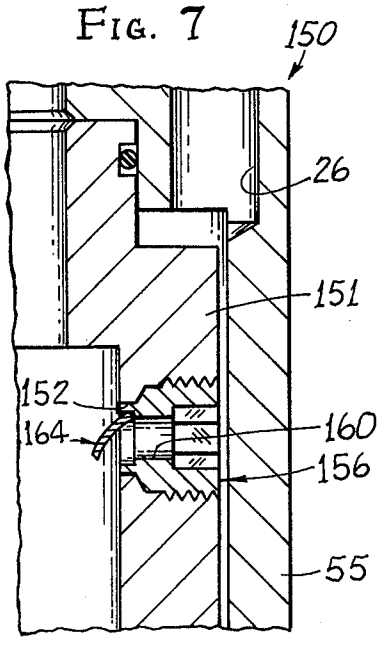


FIG. 11

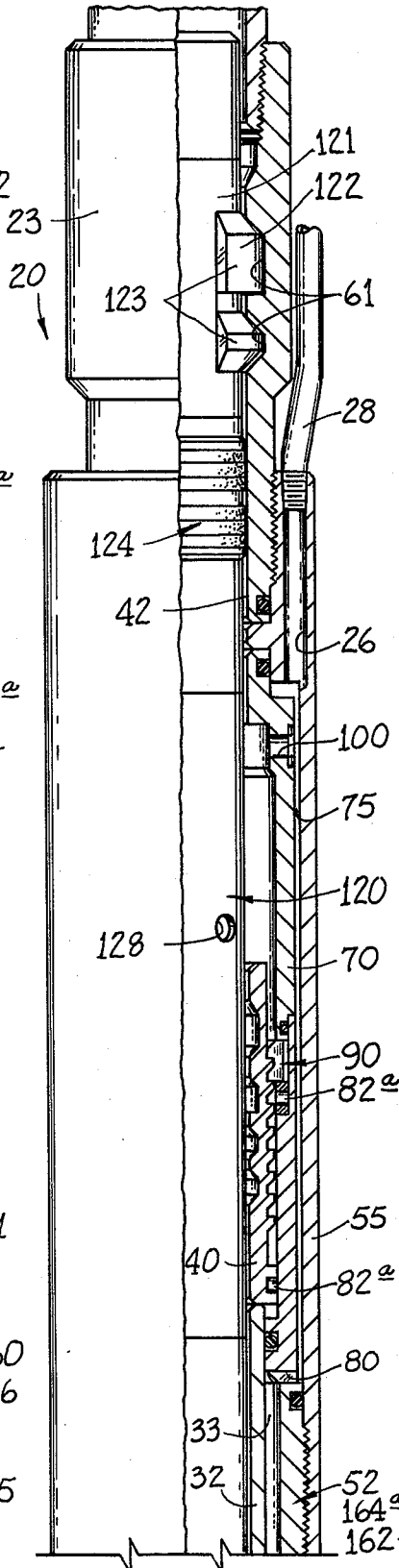


FIG. 9-A

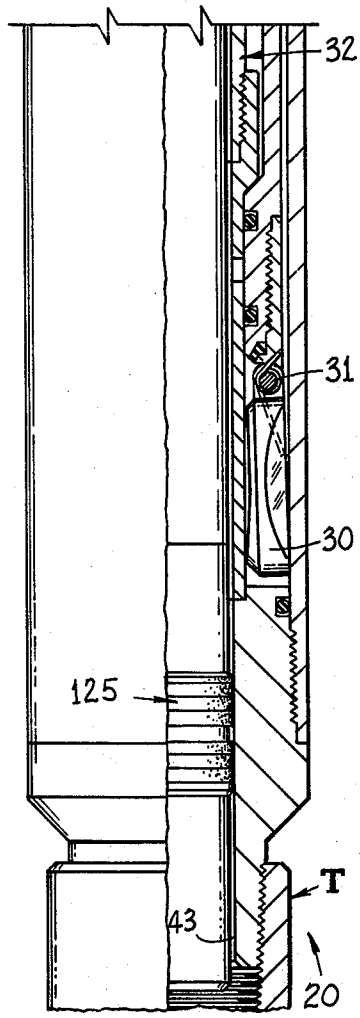
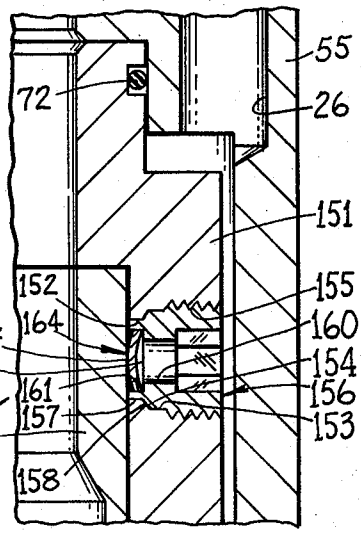


FIG. 9-B

FIG. 10



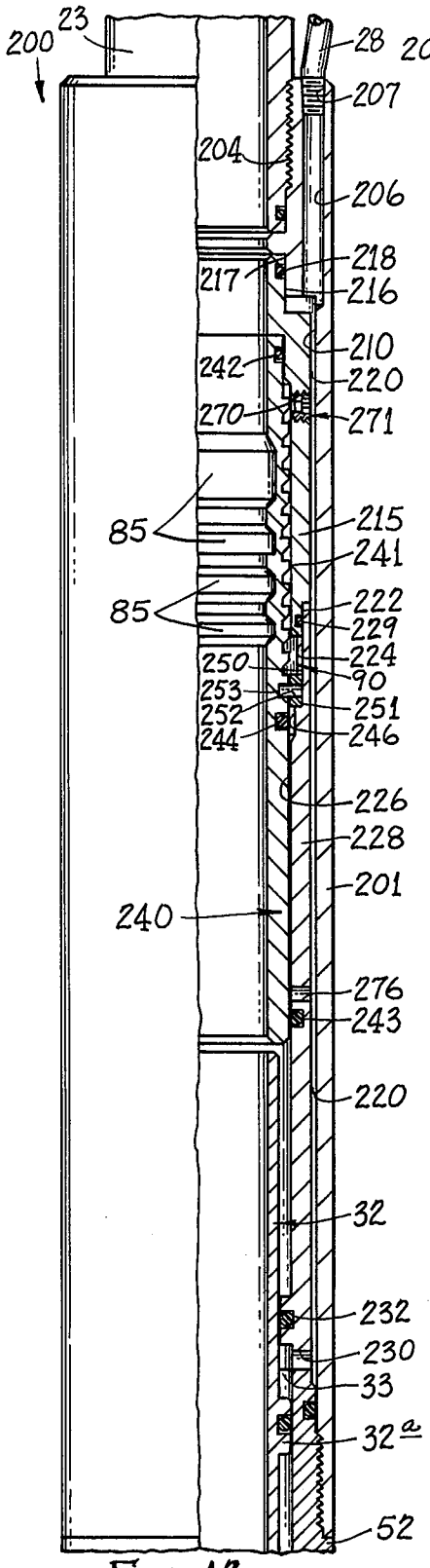


FIG. 12

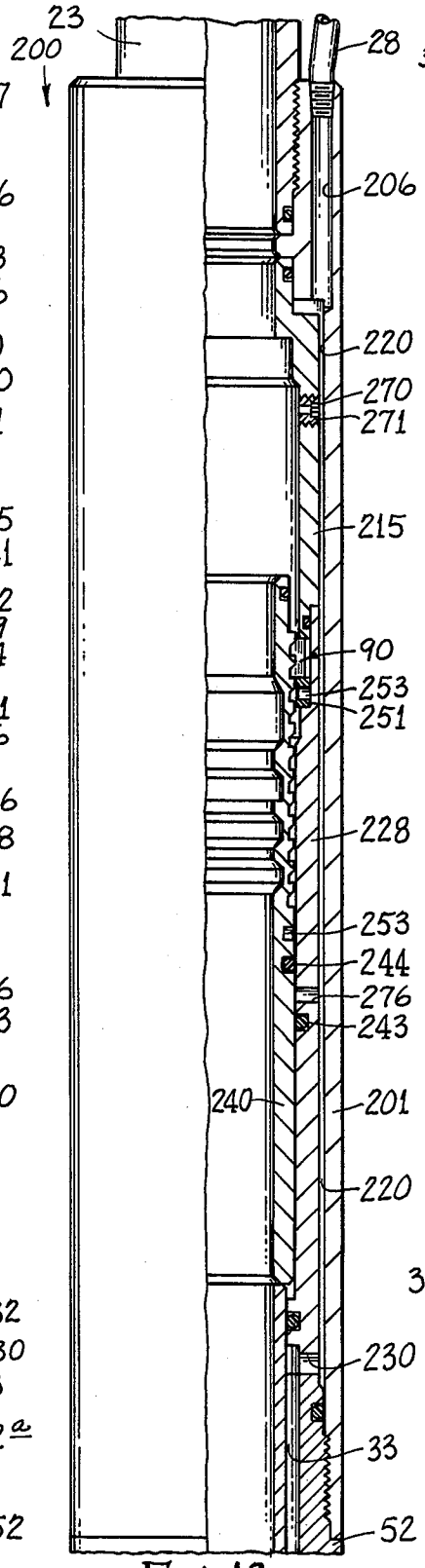


FIG. 13

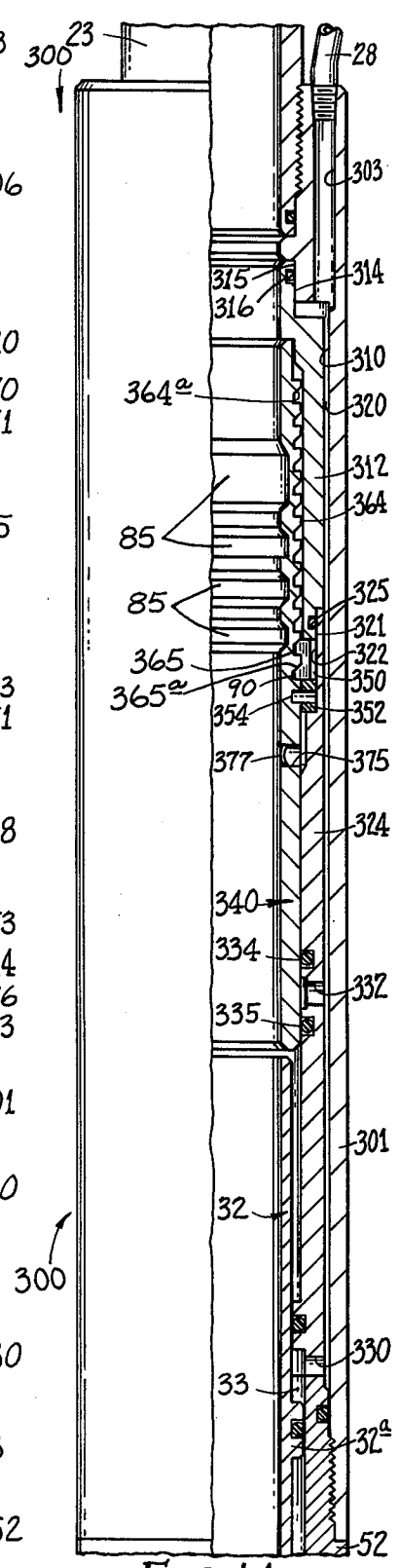


FIG. 14

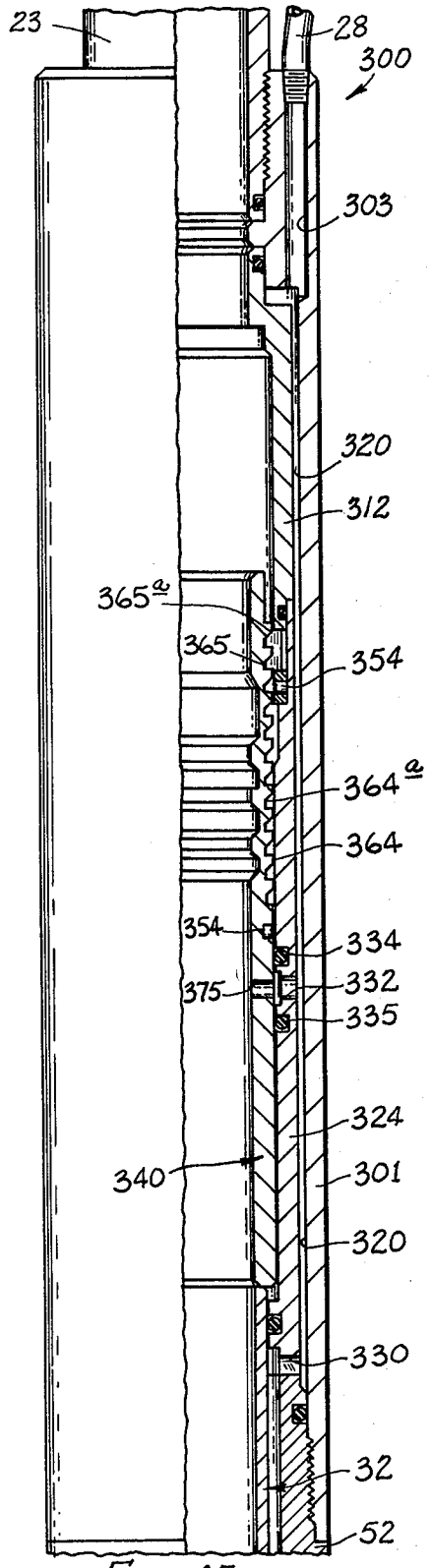

23
28
300
303
320
312
365a
365
354
364a
364
354
334
375
332
335
324
340
301
320
330
32
52

FIG. 15

SUBSURFACE SAFETY VALVE WITH AUXILIARY CONTROL FLUID PASSAGE OPENABLE IN RESPONSE TO AN INCREASE IN CONTROL FLUID PRESSURE

This invention relates to well flow control valves and more particularly to subsurface automatic safety devices for controlling the flow of fluids through flow conductors in wells and which may be responsive to the flowing well fluids for operation or may be surface controlled.

The invention illustrated and described hereinbelow is an improvement over the well control valves illustrated and described in U.S. Pat. No. 3,696,868 issued to Donald F. Taylor, Jr. on Oct. 10, 1972. It is also an improvement over the subsurface safety shut-off valve apparatus illustrated and described in U.S. Pat. No. 2,998,077 issued to Julian D. Keithahn on Aug. 29, 1961.

It is one object of this invention to provide a subsurface safety valve having means for holding the valve in open position or in a position intermediate open and closed positions.

It is a particular object of this invention to provide a well flow control valve including means for installing a supplementary valve therein after the original valve has first been locked in an inoperative position.

Another object of this invention is to provide in a valve of the character just described means for operating the valve by control fluid pressure conducted thereto from the surface.

A further object of this invention is to provide a valve of the character just described having lateral control fluid passage means leading into the interior of the valve so that a supplemental valve disposed in the first valve may be controlled also by the same control fluid pressure.

Another object of this invention is to provide means in said control fluid passage normally blocking admission of control fluid into the interior of the valve but which is openable after the original valve has been locked in an open or in an intermediate position.

Other objects and advantages will become apparent from reading the description which follows and from studying the accompanying drawing wherein:

FIGS. 1-A, 1-B, 1-C, and 1-D together form a longitudinal view, partly in section and partly in elevation with some parts broken away, showing a flow control valve embodying this invention in open position;

FIG. 2 is a cross-sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 1;

FIG. 4 is a cross-sectional view taken along line 4—4 of FIG. 1;

FIG. 5 is an enlarged fragmentary view showing means for releasably plugging the lateral control fluid flow passage in the device of FIG. 1;

FIG. 6 is a fragmentary longitudinal view, partly in section and partly in elevation with some parts broken away, showing the device of FIG. 1 with the valve mechanism in closed position;

FIG. 7 is a fragmentary view similar to FIG. 6 showing the lock sleeve shifted to position holding the valve open;

FIG. 8 is an enlarged fragmentary view similar to FIG. 5 showing the plug means of the device of FIG. 1 being expended to open the lateral control fluid passage;

FIGS. 9-A and 9-B together form a view similar to FIG. 6 showing the latch sleeve in position holding the valve open, showing the lateral control fluid passage open, and a supplementary flow control valve disposed in the original device of FIG. 1 for controlling well flow therethrough;

FIG. 10 is an enlarged fragmentary view similar to FIG. 5 but showing disk means for closing the lateral control fluid passage;

FIG. 11 is an enlarged view similar to FIG. 10 but showing the disk means in ruptured condition opening the control fluid passage;

FIG. 12 is a longitudinal view, partly in section and partly in elevation with some parts broken away, showing the upper portion only of a modified form of device having a rupture disk closing the lateral control fluid passage therein, control fluid pressure normally existing on both sides of the disk;

FIG. 13 is a fragmentary view similar to FIG. 12 showing the device of FIG. 12 with the lock sleeve in position holding the valve open and the lateral control fluid passage open, the disk therein having been ruptured;

FIG. 14 is a view similar to FIG. 12 but showing a further modified form of the invention having rupturable disk means closing the lateral control fluid passage therein, the disk being carried in the shiftable latch sleeve, well pressure normally existing on both sides of the disk; and

FIG. 15 is a view similar to FIG. 13 showing the device of FIG. 14 with the lock sleeve in position holding the valve open and the lateral control fluid passage open, the rupture disk therein having been ruptured.

Referring now to FIGS. 1 through 8 of the drawing, it will be seen that the device of this invention is indicated generally by the numeral **20.** It includes a housing **25** which is externally threaded at its lower end at **21** for attachment to the lower portion T-1 of a string of tubing T and internally threaded at its upper end as at **22** for attachment to the lower threaded end of a landing nipple **23** which is internally threaded as at **24** for attachment to the upper portion T-2 of the string of tubing T. Thus, the device **20** is connectable in a well flow conductor to become a part thereof.

Near its upper end, the housing **25** is provided with a longitudinal eccentric flow passage **26** which is threaded at its upper end as at **27** for attachment of the lower end of a control fluid conductor **28** extending downwardly from the surface control unit **29** which is located on the surface and furnishes pressurized control fluid for transmission through the control fluid conductor to the valve **20** to hold the same open to permit well products to flow upwardly therethrough from the producing formation (not shown) to the surface where such products are gathered and stored or disposed of all in the usual manner.

The surface control unit **29** includes pilot means (not shown) which will automatically relieve pressure from the control fluid conduit **28** in response to high or low pressure conditions at the wellhead or in the flow line, or in response to abnormal conditions relating to fire, storm, high fluid levels in storage vessels, or the like, depending on the pilots used and how they are installed, and will permit the valve **20** to close to block flow therethrough.

The device **20** comprises a flap valve member **30** which is swingable about pin **31** between an open position shown in FIG. **1-D** and a normally closed position shown in FIG. **6.** The flap valve member **30** is held open by tubular operator member **32** mounted in the housing for longitudinal movement therein between a valve open position, shown in FIGS. **1-A, 1-B, 1-C** and **1-D,** and a valve closed position, shown in FIG. **6.** The reciprocable operator member is provided with an external annular piston **32***a* which is acted upon from above by the pressure of the control fluid in the annular piston chamber **33** to hold the operator member down against the upward bias spring **34** and thus hold the flap valve member in its open position against the bias of spring **31***a*.

When control fluid pressure is, for any reason, relieved from the control fluid conductor **28** and, therefore, chamber **33,** the spring **34** moves the operator member upwardly to its upper position and out of the way of the flap valve member, whereupon spring **31***a* will swing it to its closed position, shown in FIG. **6,** wherein it engages the seat surface **35** and stops all flow through the valve.

It is well known that operator means such as the reciprocable tubular operator member **32** is also well suited for operating valves other than the flap type valve illustrated. For instance, such longitudinally slidably operator means have been used to operate ball-type valve closures as is illustrated and described in aforementioned U.S. Pat. No. 3,696,868. They have also been used to operate poppet-type valve closures as is illustrated and described in U.S. Pat. No. 3,273,588 issued Sept. 20, 1966, to W. W. Dollison. In fact Dollison uses his reciprocable operator means to operate all three such types of valves. It will be noted that each of the three types of valves is open when the operator member is down and closed when the operator is up. Therefore, either type of valve would be usable in the present invention, the flap type valve being illustrated and described herein by way of explanation only.

It may be desirable under some conditions to positively hold the valve **30** of the device **20** open to permit tools or devices to be lowered therethrough or to render the valve inoperative while permitting continued production from the well. In such case, a shifting tool, such as the shifting tool illustrated and described in U.S. Pat. No. 3,051,243, issued Aug. 28, 1962, to George G. Grimmer, is utilized to engage and shift the slidable lock sleeve **40** to its lower position and lock it there to hold the operator member down and thereby hold the valve open.

If the device **20** has malfunctioned, it may be desirable to install a packoff through it, after the sleeve **40** has first been shifted to its lower position, to hold the valve inoperative and permit continued production of the well. Such a packoff is installed in the manner taught by Taylor in his U.S. Pat. No. 3,696,868 mentioned above. This packoff tool is supported on a suitable locking mechanism disposed in the landing nipple **23** forming an upper portion of the device **20** and seals carried by the packoff seal between the packoff and the device **20** in the prepared bores **42** and **43** provided in the device near its upper and lower ends, respectively, as shown in FIGS. **9-A** and **9-B.**

A supplementary or auxiliary flow control valve can be provided in the packoff and its actuation can be controlled from the surface by control fluid conducted thereto from the surface controller **29** through the control fluid conductor **28** in the same manner that actuation of valve **20** is controlled. If such valve is to be installed, then the sleeve **40** must be first shifted to its lower, valve open, position, and the pressure output of the surface controller **29** must be increased until the lateral control fluid passage in the wall of the valve **20** is opened by the failure of rupturable or shearable plug means which has to this time kept such passage closed. In this manner, production of the well may be continued in the usual manner and the supplementary will close any time an undesired condition develops which will cause the surface controller **29** to respond by relieving the pressure from the control fluid conductor **28.**

The housing **25** of the device **20** includes a tubular spring housing **50** which is internally threaded at its upper end as at **51** to receive the lower threaded end **52***a* of the connector **52.** An o-ring **53** disposed in a suitable external annular recess near the lower end of the connector **52** seals between the connector and the sleeve **50.** The upper end of the connector is externally threaded as at **54** for attachment to the lower internally threaded end of the upper housing **55** and this connection is sealed by an o-ring **56** disposed in a suitable external annular recess formed near the upper end of the connector. The upper end of the upper housing **55** is internally threaded as at **22** for attachment to the lower threaded end of the landing nipple **23** and this connection is sealed by an o-ring **58** disposed in a suitable external annular recess formed on the extreme lower end of the landing nipple. The upper end of the landing nipple is internally threaded as at **24** for attachment to the lower threaded end of the tubing section T-2 of the tubing string T.

The landing nipple **23** is provided with landing recesses **61** formed in the internal wall thereof to provide means for locating and locking a suitable locking device which may be used to support a supplementary valve, or the like, in the device **20,** should the device **20** become inoperative. One suitable locking device is that illustrated and described in U.S. Pat. No. 3,208,531, issued Sept. 28, 1965, to Jack W. Tamplen. Below the recesses **61,** the bore **42** of the landing nipple is provided with a smooth finish adapted to receive seal means carried by the locking device or by the supplementary valve, or the like, mentioned above.

The upper housing **55** is provided with a small diameter longitudinal offset or eccentric passage **26** formed near its outer edge and the upper end of this passage is internally threaded as at **27** to receive the lower threaded end of the control fluid conduit **28.** The lower end of the passage **26** opens into and communicates with the enlarged bore **64** of the upper housing **55.** The passage **26,** therefore, communicates the interior of the upper housing **55** with the surface controller **29** through the control fluid conduit **28** for a purpose to be described.

An internal flange **65** is provided in the upper housing **55** and its upper surface **65a** provides a stop shoulder which is engaged by the lower end of the landing nipple **23.** The lower surface **65b** of the flange **65** provides a stop shoulder which is engaged by the upper end of a tubular sleeve housing **70** disposed inside the upper housing and whose reduced upper end portion **70***a* is telescoped into the intermediate bore **71** of the upper housing. An o-ring **72** is disposed in a suitable ex-

ternal annular recess near the upper end of the sleeve housing **70** and seals between the sleeve housing and the upper housing **55** as shown in FIG. **1-A**. The seal **72**, therefore, seals the upper end of the annular passage or annular chamber **75** formed between the sleeve housing and the upper housing. The lower end of the annular passage **75** is sealed by the o-ring **56** previously mentioned. The lower end of the sleeve housing is reduced in external diameter as at **70***b* and is telescoped into the enlarged bore **76***a* in the upper end of the spacer sleeve **76** and a seal ring **77** disposed in a suitable external annular recess on the lower end of the sleeve housing seals between the sleeve housing and the spacer sleeve.

The lower end of the spacer sleeve **76** is supported on the supper end **52***c* of the connector **52** and its lower reduced bore **78** is telescoped over the upper end of the valve operator **32** while an o-ring **79** disposed in a suitable internal annular recess in the wall of the reduced bore **78** of the spacer sleeve seals between the spacer sleeve and the exterior of the operator **32.** The lower end of the spacer sleeve **76** is grooved or slotted across its lower end as at **80** to provide a pair of radially disposed passages which conduct control fluid from the annular space **75** exterior of the spacer sleeve into the annular piston chamber **33** formed between the connector and the operator **32.** In this manner, control fluid is conducted from the surface controller **29** through the control fluid conduit **28** and through the eccentric passage **26** of the housing into the annular space **75** between the upper housing **55** and the sleeve housing **70** and from thence through the cross slot **80** at the lower end of the spacer sleeve into the upper end of the piston chamber **33** where it acts downwardly on the piston **32***a*. The piston **32**a carries an o-ring **81** disposed in a suitable external annular recess formed in the piston, as shown, and seals between the piston and the inner wall **52**b of the connector.

When the controller supplies control fluid at normal pressure to the upper side of the piston, the force created against the piston will overcome the upward bias of the spring **34** and will move the operator **32** downwardly to the position shown in FIGS. **1-A**, **1-B**, **1-C**, and **1-D**, in which position the valve **30** will be held open to permit fluid flow to take place through the device **20.**

The lower reduced end portion **70**b of the sleeve housing **70** which is telescoped into the upper end of the spacer sleeve **76** is very short and the enlarged bore **76***a* in which it is disposed is sufficiently long to provide a recess **76***b* between the lower end of the sleeve housing **70** and the upwardly facing shoulder **76***c* of the spacer sleeve. This recess **76***b* has disposed therein a retainer ring **82** supported on the shoulder **76***c* and a snap ring **88** supported on the retainer ring. The retainer ring **82** is provided with one or more suitable apertures through the wall thereof for receiving one or more suitable shear pins, such as the shear pin **82***a*, whose inner ends are disposed in a suitable external annular recess formed in the lower end of a shiftable lock sleeve **40** disposed within the sleeve housing **70.** The lock sleeve **40** has an internal bore **83** which is approximately the same size as the bores through the landing nipple and the operator assembly and, in the wall of the bore **83,** a plurality of recesses **85** are formed which are engageable by a suitable shifting device such as the shifting tool ST by which the sleeve is shifted downwardly to its lower position wherein it will hold the operator assembly down and, therefore, hold the valve open.

The shear pins **82***a* releasably retain the slidable lock sleeve **40** in its upper inoperative position where it clears the upper end of the valve operator **32** when it is in its upper position and, therefore, will not interfere with its operation until such time that the shiftable sleeve is moved downwardly by the shifting tool ST to lock the valve open. At this time a downward force applied to the sleeve through the shifting tool ST and suitable wireline tools WLT, or the like, causes the pin or pins **82***a* to shear and forces the shiftable lock sleeve to be moved downwardly relative to the sleeve housing **70.**

A buttress-like thread or longitudinally spaced circumferential buttress-like flanges **86** are formed on the exterior of the slidable lock sleeve **40** and extend from just above the shear pins **82***a* to a point near the upper end of the sleeve and these buttress-like flanges are engageable by complementary buttress-like flanges **88** formed in the interior of the ratchet pawl or snap ring **90** disposed in the recess **76***b* between the retainer ring **82** and the lower end of the sleeve housing **70.**

The buttress-like exterior flanges **86** on the sleeve **40** are each formed with a downwardly facing cam shoulder **86***a* and an upwardly facing abrupt stop shoulder **86***b*. Similarly, the complementary interior buttress-like flanges **88** in the snap ring are each formed with an upwardly facing cam shoulder **88***a* and a downwardly facing abrupt stop shoulder **88***b*. The snap ring is inherently sprung inwardly to the contracted position shown in FIG. **1-A** and when the lock sleeve **40** is moved downwardly therethrough the cam surfaces **86**a on the lower side of the buttress-like flanges on the sleeve coact with the complementary cam surfaces **88***a* formed on the upper side of the buttress-like flanges in the snap ring **90** so that the downward movement of the lock sleeve **40** will cam or expand the ring open so that the sleeve can move downwardly through the snap ring.

When the lock sleeve **40** is for any reason thereafter biased upwardly, the snap ring or annular pawl **90** will contract so that the downwardly facing stop shoulders **88***b* of its inner buttress-like flanges **88** will engage the complementary upwardly facing abrupt stop shoulders **86***b* of the buttress-like flanges on the lock sleeve **40** to prevent further upward movement of the sleeve relative to the snap ring and sleeve housing. The snap ring, therefore, acts as a ratchet pawl, permitting the sleeve to be moved downwardly relative thereto, and preventing upward movement thereof.

When the lock sleeve **40** is moved downwardly, it is preferably moved to its lowermost position so that the valve **30** will be held fully open. If, however, debris or the like should interfere with the mechanism so that the valve cannot be moved to its fully open position, or the operator assembly **32** or the lock sleeve cannot be moved to their lowermost positions, the lock sleeve **40** will be prevented from moving upwardly so that the operator **32** will be locked in the lowest position reached and the valve will be held open as wide as possible in such case.

At least one lateral passage or aperture **100** and preferably two are provided in the wall of the sleeve housing **70** opposite the upper end portion of the lock sleeve **40** when the lock sleeve is in its upper position as is shown in FIG. **1-A**. Each aperture **100** communicates

the interior of the sleeve housing with the exterior thereof so that control fluid from the annular passage **75** will be conducted through the lateral passage or aperture **100** into the interior of the lock sleeve for operation of a supplementary safety valve subsequently placed in the device **20.**

The lateral aperture **100** is provided with a large counterbore **101** providing a shoulder **101***a*, as is shown in FIG. **5,** and a plug **102** is disposed in the sperture **100** with its inner end surface **103** in close proximity to the exterior surface of the lock sleeve **40** and may even engage the same. The plug **102** is provided with a suitable external annular recess in which is disposed an o-ring **104** which seals between the plug **102** and the inner wall of the aperture **100.** The outer end of the plug is reduced in diameter as at **105** and a flat washer **106** is disposed thereabout while a shear pin **107** is disposed through a suitable aperture near the outer end of the plug with its outer ends extending outwardly from the plug and being engageable with the washer **106** to retain the plug in place against inward displacement as shown. The washer **106** and the shear pin **107** are disposed within the counterbore **101** of the aperture **100.** The plug is sufficiently long so that its outer end is very close to the inner wall **55**a of the upper housing **55** to prevent its outward displacement. Therefore, the plug is rather closely confined between the inner wall of the upper housing **55** and the exterior of the upper end portion of the shiftable lock sleeve **40** and cannot move longitudinally out of its sealing position in the aperture **100.** The plug will thus prevent the flow of fluids from the annular passage **75** into the interior of the sleeve housing **70** until it is displaced from such sealing position as will be explained later.

When it is desired to lock the valve **30** open and render the device **20** inoperative, a suitable shifting tool such as that illustrated and described in the aforementioned U.S. Pat. No. 3,051,243 to Grimmer is utilized to engage the recesses **85** in the shiftable lock sleeve **40** and to move it downwardly, moving the valve operator **32** downwardly therewith in order to swing the valve **30** to its open position, shown in FIGS. **1-A, 1-B, 1-C** and **1-D.** With the shiftable lock sleeve moved to its lower position and locked in such position by the engagement of its exterior buttress-like flanges with the buttress-like flanges in the snap ring, the valve cannot move from its open position toward its closed position. Accordingly, production of the well can be continued as desired.

When the lock sleeve **40** is moved downwardly from its upper position shown in FIG. **1-A** and the upper end thereof clears the plug **102** which is disposed in the aperture **100,** the control fluid pressure, conducted to the valve **20** from the surface controller **29** through the control fluid conduit **28** and through the longitudinal eccentric passage **26** in the upper housing to the annular chamber **75,** will act on the plug **102** and tend to move it inwardly to displace it from its sealing position in the aperture **100.** This displacement cannot at this time take place because the washer **106** will then engage the bottom **101**a of the counterbore **100** and the outer ends of the shear pin **107** will engage the washer **106** to prevent further inward movement of the plug **102.** Thus, it may be readily seen that the plug will remain intact since the shear value of the shear pin exceeds the forces developed by normal control fluid pressure acting across the plug. If, however, it is desired to install a supplementary safety valve within the valve device **20** and to control such supplementary valve by control fluid pressure conducted thereto from the surface controller **29,** it is only necessary to increase the control fluid pressure to a value substantially above normal until such increased pressure is sufficient to shear the shear pin **107** and permit the plug **102** to move inwardly out of aperture **100** as shown in FIG. **8,** and into the central bore of the device **20** where it will fall harmlessly to the bottom of the wall.

In the absence of the plug **102,** the aperture **100** will be open and control fluid pressure can pass freely from the chamber **75** into the interior of the sleeve housing **70.**

A supplementary safety valve such as the valve **120** is then attached to the lower end of a suitable locking device such as the locking device **121** and lowered into the wall on a suitable running tool and string of wireline tools (not shown) and installed as shown in FIGS. **9-A** and **9-B.** The locking device **121** has keys **122** having bosses **123** which engage in the lock recesses **61** of the landing nipple **23** and support the valve **120** therein in the proper position. Suitable seal rings **124** carried by the locking device **121** seal between the device and the inner wall **42** of the landing nipple while suitable seals **125** carried on the valve **120** near the lower end thereof engage the inner wall **43** of the lower sub **45** at the lower end of the safety valve device **20** to seal between the lower end of the supplementary safety valve **120** and the lower portion of the safety valve device **20.** Thus, control fluid passing through the open aperture **100** in the sleeve housing **70** is confined to the region between the supplementary valve **120** and the inner wall of the device **20** between the upper and lower seal assemblies **124** and **125.** This control fluid is then conducted through the inlet port **128** into the mechanism of the supplementary valve for actuation of the same. Thus, the flow of well fluids through the well tubing T is controlled by controlling the supplementary valve from the surface in exactly the same manner as was the valve device **20.**

When suitable pilot means (not shown) in the surface controller **29** responds to a particular condition and acts to bleed or relieve the control pressure from the control fluid conduit **28,** the supplementary valve **120** will close to stop flow through the valve. When such particular condition has been cleared up and the surface controller **29** used to reinstate control pressure to the system, the valve **120** will open so that production from the well may be continued in the usual manner.

Thus, it has been shown that a subsurface safety valve has been provided which is controllable from the surface and which can be locked in open position by sliding a shiftable lock sleeve downwardly which will force the operator downwardly and, therefore, force the valve closure member to its open position; that the lock sleeve can be locked in its lowermost or any intermediate position so that upward movement of the lock sleeve from such position is not possible; that such valve can be locked in open position and production continued from the well if desired; that a supplementary valve can be installed in the safety valve device and supported from a suitable lock mandrel and that such supplementary safety valve can be controlled from the surface in the same manner as was the original safety valve but before such supplementary valve is installed; that prior to installation of such supplementary valve, the control pressure is temporarily raised to a much

higher than normal level to open up a passage or port means in the valve mechanism and establish means for admitting control fluid into the inner bore of the device where the supplementary safety valve is disposed. Of course, it si understood that a packoff mechanism or other tool can be installed in place of the supplementary safety valve to packoff a faulty valve such as the safety valve device **20**, in which case the locking mandrel **121** would carry an open bore valveless tubular body between the upper and lower seal assemblies **124** and **125** to that production fluids would be conducted therethrough past the faulty valve. If such packoff tool is used, it is not necessary to conduct control fluid thereto; so the plug **102** is left intact in its place closing the lateral aperture **100**. A packoff tool is usable, for instance, in cases where the control fluid conduit **28** breaks, and also at the same time, a failure occurs in the plug **102** or in the seals **124** or **125** of the safety valve such that well fluids otherwise escape from the well tubing through the faulty safety valve and through the broken control fluid conduit **28** into the surrounding casing which may not be able to withstand high well pressures. A packoff tool thus prevents such leakage and permits continued production from the well but without protection previously afforded by the surface controlled downhole safety valve **20**.

A modified form of the invention is illustrated in FIGS. **10** and **11** where it is indicated generally by the numeral **150**.

In this form of the invention, the upper housing section **55**, having the offset or eccentric control fluid passage **26**, has mounted therein a modified sleeve housing **151**. This sleeve housing has at least one lateral aperture or control fluid passage **152** formed in its wall and this aperture is enlarged as at **153** providing a seating surface **154** and is internally threaded as at **155** to receive a plug **156** having its inner end portion **157** reduced in diameter to fit within the aperture **152** and to provide a seal surface **158** which engages the seating surface **154** of the aperture to prevent leakage of control fluid around the plug.

The plug **156** is provided with a bore **160** therethrough and this bore is enlarged as at **161** to provide a stop shoulder **162**. A sealing or rupture disk **164** is disposed in the enlarged bore **161** of the plug and engaged against the stop shoulder **162** where it is sealingly secured in place by silver solder, epoxy cement, or the like, to seal the plug bore **160** against leakage of control fluid therethrough. If desired, the disk may be dished or cupped and its convex surface faced inwardly as is clearly shown in FIG. **10**.

It will be noted that the inner side **164***a* of the sealing or rupture disk is substantially in engagement with the exterior wall surface of the shiftable sleeve **40** which helps to support the disk against premature rupture or displacement from its sealing position, although the disk is preferably sufficiently strong to make such support normally unnecessary.

If, after the shiftable lock sleeve **40** has been shifted to its lower position to force the valve **30** open and to hold it in this open position, it is desired to install a supplementary device, such as the supplementary safety valve **120**, in the device **150**, the control fluid pressure is increased until the disk **164** is displace or ruptured to open the bore **160** through the plug **156** as shown in FIG. **11**, thus providing a lateral control fluid passage through the wall of the sleeve housing **151**. Subsequently, the supplementary safety valve is installed and actuated from the surface as before explained.

Thus, it will be seen that the plug **156** of the device **150** serves exactly the same function as does the plug **102** of the device **20** previously described and that the lateral aperture **100** of the device **20** and the aperture **152** of the device **150** each are opened in exactly the same manner, that is, by increasing the control fluid pressure until the plug fails, opening the lateral control fluid passage.

Another modified form of the invention is illustrated in FIGS. **12** and **13** where it is indicated generally by the numeral **200**. The device **200** may be exactly like the devices previously described below its connector **52** in whose bore the piston **32a** is slidable. Above the connectors **52** there are substantial differences in structure. For this reason, only the upper portion of the device **200** is shown.

The upper housing **201** is substantially the same as the upper housing **55** of the device **20** first described but is considerably longer. The upper housing **201** is threadedly attached at its lower end to the upper threaded end of the connector **52** and its upper end is internally threaded as at **204** for attachment to the landing nipple **23**. An eccentric of offset longitudinal control passage **206** is provided in the upper portion of the upper housing **201** and is threaded as at **207** at its upper end for attachment of the control fluid conduit **28**. The passage **206** has its lower end opening into the enlarged bore **210** of the upper housing. Thus, control fluid is conducted from a surface controller such as the surface controller **29** on the surface through the control fluid conduit **28** to the device **200** where it enters through the passage **206** and from there is conducted to the valve mechanism as will be described.

A sleeve housing **215** is disposed within the upper housing **201** and its reduced upper end portion **216** is telescoped into the intermediate bore **217** in the upper portion of the upper housing **201** as shown. A seal ring such as the o-ring **218** is disposed in a suitable external annular recess near the upper end of the sleeve housing **215** and seals between the upper end of the sleeve housing and the upper housing. The outside diameter of the sleeve housing **215** is somewhat less than the inside diameter of the upper housing so that an annular space or passage **220** is provided between the sleeve housing and the upper housing. It is readily seen that the o-ring **218** seals the upper end of this annular passage **220**. The lower end portion **222** of the sleeve housing is reduced in diameter and is telescoped into the enlarged portion **224** of the bore **226** of the spacer sleeve **228** while a seal ring such as the o-ring **229** seals between the sleeve housing and the spacer sleeve as shown. The lower end of the spacer sleeve **228** is supported upon the upper end of the connector **52** and is provided with a groove or slot **230** across its lower end to provide a radial passage through which control fluid may be conducted from the annular passage **220** into the piston chamber **2** where it acts downwardly upon the piston **32a** to move the valve operator **32** down for opening the valve.

As in the preceeding embodiment, the spacer sleeve is telescoped over the upper end of the valve operator **32** and a seal ring such as the o-ring **232** disposed in a suitable internal annular recess formed in the spacer sleeve seals between the spacer sleeve and the exterior

of the valve operator to close the upper end of the piston chamber **33.**

Thus, control fluid is conducted from the offset or eccentric passage **206** into the upper end of the annular passage **220** and from the annular passage **220** through the cross slot or groove **230** of the spacer sleeve into the chamber **33** to operate the piston.

An elongate slidable lock sleeve **240** has its upper portion disposed in the sleeve housing **215** and its lower portion extending down into the spacer sleeve **228** as shown. The upper portion of the lock sleeve is provided with external buttress-like flanges or threads **241** which may be exactly like the external flanges **86** on the lock sleeve **40** of the device **20.** The lock sleeve **240** is also provided with a plurality of suitable internal annular recesses **85** which are engageable by a suitable shifting tool such as the shifting tool ST previously mentioned for shifting the sleeve to a lower position for holding the valve open or in an inoperative position as was before explained.

A seal ring such as the o-ring **242** is disposed in a suitable external annular recess near the upper end of the shiftable lock sleeve to seal between the lock sleeve and the sleeve housing. A seal ring such as the o-ring **243** is disposed in a suitable internal annular recess formed in the mid portion of the spacer sleeve **228** to seal between the spacer sleeve and the lower end of the slidable lock sleeve **240.** A seal ring such as the o-ring **244** is disposed in a suitable external annular recess formed in the mid portion of the lock sleeve. When the sleeve is in its upper position as shown in FIG. **12,** the seal ring **244** does not seal between the slidable lock sleeve and the spacer sleeve because the seal ring **244** is disposed in a slightly enlarged intermediate bore **246** in the spacer sleeve between the main bore **226** and the enlarged bore **244** where it is ineffective to provide a seal.

The enlarged bore **224** at the upper end of the spacer sleeve is considerably longer than the length of the reduced portion **222** of the sleeve housing, telescoped thereinto thus providing a wide internal annular recess **250** between the lower end of the enlarged bore **224** and the lower end of the sleeve housing **215.**

A retainer ring **251** having one or more apertures **252** through the wall thereof is disposed in the lower part of the recess **250** and carries one or more shear pins **253** disposed in such apertures, each shear pin having its inner end disposed in a suitable external annular groove formed in the mid portion of the shiftable lock sleeve **240** to retain the shiftable sleeve in its upper inoperative position shown in FIG. **12.** Between the retainer ring **251** and the lower end of the sleeve housing **251,** a snap ring or annular pawl **90** is disposed in the internal annular recess **250** and this snap ring may be exactly the same as the snap ring **90** in the device **20** previously described and which is shown in FIG. **1-A.** The snap ring is provided as before explained with internal buttress-like projections and the exterior of the upper portion of the shiftable lock sleeve **240** is formed with complementary exterior buttress-like projections which may be exactly like those on the sleeve **40** in the device **20** previously described.

The shiftable sleeve **240** is shifted to its lower position through use of a suitable shifting tool such as the shifting tool ST which engages the internal recesses **85** in the shiftable sleeve and when a downward force of sufficient magnitude is applied to the sleeve, the pins **253** are sheared and the sleeve moved downwardly, the lower end of the sleeve contacting the upper end of the operator **32,** if the operator is in an upper position, and forcing the operator **32** downwardly to a lower position wherein it holds the valve (not shown) open. During downward movement of the lock sleeve **240,** the external buttress-like flanges thereon cam their way through the snap ring **90** which is inherently sprung inwardly and when the sleeve reaches a lower position any tendency for it to move upwardly thereafter will result in engagement of the abrupt surfaces on the complementary buttress-like flanges of the sleeve and snap ring, thus preventing further upward relative movement of the sleeve. Thus, the shiftable sleeve is locked in a lower position holding the valve open.

It will be noted that the sleeve housing **215** is provided with a lateral port or passage **270** near its upper end and that this port is closed with a plug **271** which may be exactly like the plug **102** in the device **20,** or like the plug **156** in the device **150** as shown. The plug **271** prevents the passage of control fluid from the annular passage **220** exterior of the sleeve housing to the interior thereof.

It will further be noticed that the spacer sleeve **228** is provided with a lateral aperture **276** located immediatelyabove the seal ring **243** in the mid portion of this spacer sleeve. When the shiftable lock sleeve **240** is immediately above its upper inoperative position, as is shown in FIG. **12,** control fluid conducted to the device **200** through the control fluid conduit **28** passes through the eccentric or offset passage **206** into the annular passage **220** between the upper housing **201** and the sleeve housing **215** and from the annular passage through the cross slots **230** at the lower end of the spacer sleeve into the piston chamber **33** for operation of the piston and actuation of the valve.

Control pressure can also pass from the annular passage **220** through the lateral aperture **276** in the spacer sleeve but cannot move downwardly past the seal ring **243.** It can, however, move upwardly between the exterior of the lock sleeve **240** and interior of the spacer sleeve **228** and past the seal ring **244** which is spaced from the inner wall of the immediate bore **246** and can pass beyond the retaining ring **251** and the snap ring **90** and upwardly between the shiftable lock sleeve **240** and the interior of the sleeve housing **215** as far as the seal ring **242.** The control pressure thus acts on the inward side of the plug **271** and at the same time acts on the outward side of the plug since the outward side is clearly exposed to fluid in the annular passage **220.** It will thus be seen that when the lock sleeve **240** is in its upper position, as shown in FIG. **12,** the plug is isolated from well fluids and no differential pressure can act on it to shear or displace the same since its ends are exposed to a common pressure, namely, control fluid pressure.

When the shiftable sleeve **240** is moved to its lowermost position as is shown in FIG. **13,** the seal ring **244** carried by the lock sleeve comes to rest in sealing position above the lateral aperture **276** in the spacer sleeve, thus preventing control fluid pressure from moving upwardly therepast. At the same time, when the sleeve has been moved downwardly, the seal ring **242** carried near the upper end of the sleeve moves out of its sealing position above the lateral apertue **270** in the wall of the sleeve housing and clears the plug **271,** thus allowing well pressure to come to bear against the inner side of

the plug **271**. The plug now has its inner end exposed to well pressure while its outer end is still exposed to control fluid pressure.

When the shiftable sleeve **240** is in its lower position as shown in FIG. **13**, the device **200** is understandably held inoperative, the shiftable sleeve being locked by the snap ring in its lower position holding the valve operator **32** down and thus holding the valve open.

If it is desired to install a supplementary safety valve, such as the supplementary safety valve **120** in the device **200** and to control it from the surface, it will be necessary to raise the control fluid pressure to a level which will cause the plug **271** to fail, thus opening the lateral passage **270** through the wall of the sleeve housing and admit cntrol fluid pressure into the interior of the device **200** in the manner already described.

The advantages of the structure just described and which is shown in the FIGS. **12** and **13** are that, under normal conditions when the shiftable sleeve **240** in its upper position and the plug **271** is intact, the plug has clean noncorrosive control fluid on both of its sides and is isolated from well fluids which may be corrosive and ladened with abrasive particles, etc., and the plug will not be subjected to pressure differentials.

A further modified form of the invention is illustrated in FIGS. **14** and **15** and is there indicated by the number **300**. This form of the invention is very similar to the form last described and its lower portion from the connector **52** of the housing downwardly is exactly the same as the embodiments previously described. Attached to the upper end of the connector **52** is an upper housing **301** which may be exactly like the upper housing **201** of the previous embodiment and this upper housing **301** is threadedly attached to the lower end of the landing nipple **23** thereabove and has an offset or eccentric longitudinally disposed control fluid passage **303** connected at its upper end to the control fluid line **28** and its lower end opening into the enlarged bore **310** of the upper housing as in the previous embodiments. Disposed within the upper housing is a sleeve housing **312** which is similar to the sleeve housing **215** in the embodiment previously deacribed but is not provided with an aperture in the wall thereof. The upper reduced portion **314** of the sleeve housing is telescoped into the intermediate bore **315** of the upper housing and a seal ring such as the o-ring **316** seals between the upper end of the sleeve housing and the upper housing. The outside diameter of the sleeve housing **312** is somewhat less than the inside diameter of the upper housing, thus providing an annular passage **320** therebetween. The lower reduced diameter position **321** of the sleeve housing is telescoped into the enlarged bore **322** at the upper end of the spacer sleeve **324** and a seal ring such as the o-ring **325** seals between the sleeve housing and the spacer sleeve.

The length of the reduced diameter portion **321** on the lower end of the sleeve housing **312** is somewhat shorter than the length of the enlarged bore **322** in which it is received, thus providing a wide internal annular recess **350**.

A retainer ring **352** having one or more radial apertures in its wall is disposed in the annular recess **350** and one or more shear pins **354** have their outer ends disposed in the one or more apertures in the retainer ring **352** while their inner ends are engaged in a suitable external annular recess formed in an elongate shiftable lock sleeve **340** having its upper portion disposed in the sleeve housing **312** and its lower portion extending down into the spacer sleeve **324** as shown in FIGS. **14** and **15**. The pins **354** obviously retain the lock sleeve in its upper inoperative position shown in FIG. **14**.

An elongate shiftable or slidable lock sleeve **340** is provided with a plurality of internal recesses **85** which are engageable by a suitable shifting tool such as the shifting tool ST previously mentioned for shifting the sleeve from the upper portion shown in FIG. **14** to its lower position shown in FIG. **15**. The slidable lock sleeve **340**, like the lock sleeves **40** and **240** of the devices **20** and **200**, previously described, has external buttress-like flanges or threads **364** formed about its upper portion, each such flange or thread having a lower side which slopes downwardly and inwardly to provide a cam surface indicated by the numeral **364***a*.

A ratchet pawl in the form of a snap ring **90**, which may be identical with the snap rings **90** previously described is disposed in the recess **350** above the retainer ring and has ratchet teeth of flanges **365** formed therein, each such flange having its upper side sloping downwardly and inwardly to provide a cam surface indicated by the numeral **365***a* which cooperates with the cam surfaces **364***a* on the flanges of the lock sleeve **340** as will be explained.

The lock sleeve **340** is shifted to a lower position to hold the valve open by lowering a suitable shifting tool into the well flow conductor, engaging it in the recesses **85** in the lock sleeve **340** and applying a downward force thereto. This downward force shears the pins **354** in the retainer ring **352** and moves the lock sleeve downwardly through the snap ring **90**. During downward movement of the lock sleeve, the cam surfaces **364***a* on the lower sides of its external buttress-like flanges coact with similar cam surfaces **365***a* on the upper sides of complementary flanges in the snap ring to force open the snap ring and permit the lock sleeve to move downwardly therethrough. When the slidable lock sleeve **340** reaches its lower position as is shown in FIG. **15**, or an intermediate position, it is locked in such position by the pawl snap ring **90** and holds the valve operator member **32** in such lower position and thus holds the valve (not shown) in open position as was previously described.

Control fluid is conducted to the device **300** for holding the valve therein open, such control fluid passing through the control fluid conduit **28** connected to the upper housing and through the eccentric passage **303** into the enlarged bore **310** of the upper housing section and being conducted through the annular passage **320** between the upper housing **301** and the sleeve housing **312** and spacer sleeve **324** until it passes through the cross slot **330** formed in the lower end of the spacer sleeve and into the piston chamber **33** where it acts downwardly on the piston **32***a* for actuating the valve (not shown) therebelow.

The spacer sleeve **324** is provided with a lateral passage or aperture **332** formed in the wall thereof and a pair of seal rings such as the seal rings **334** and **335** disposed in suitable internal annular recesses formed in the inner wall of the spacer sleeve **324** seal between the spacer sleeve **324** and the exterior of the lower portion of the shiftable sleeve **340** above and below the lateral aperture **332**, respectively, so that control fluid passing from the annular passage **320** through the lateral aperture **332** is confined between the two seal rings **334** and cannot move therepast.

The lock sleeve **340** is provided with a lateral aperture **375** through its wall located just below the shear pin groove formed in the exterior thereof and this aperture may be closed by any suitable means such as one of the plugs previously described or may be sealed by a suitable disk such as the disk **377** secured therein much like the disk **164** is secured in place in plug **156** of the device of FIGS. **10** and **11**. It will be noted that the disk **377**, when the shiftable sleeve **340** is in its upper position shown in FIG. **14**, is in a well fluid environment since the inner side of the disk is exposed to well fluids existing in the bore of the lock sleeve **340** and its outward face is exposed to well fluids conducted thereto from the bore of the shiftable sleeve **340** since such well fluids can pass around the upper end of the lock sleeve and downwardly between it and the sleeve housing, past the snap ring and the retainer ring, and between the shiftable sleeve **340** and the spacer sleeve **324** as far as the upper seal ring **334** located just above the lateral port **332** in the spacer sleeve. Thus, during normal operation of the well, the disk **377** or other suitable plug which may be used in place thereof is not subjected to differential pressures and therefore there is no tendency for the same to be displaced or ruptured prematurely. The plug or disk is obviously isolated from control fluid pressure.

When the shiftable sleeve **340** is moved to its lower position wherein it is locked in such position by the snap ring **90** and wherein it holds the valve operator **32** in its lower position to lock the valve therebelow open, the aperture **375** in the wall of the lock sleeve will then be located between the two o-rings **334** and **335** in the wall of the spacer sleeve and, therefore, will be in direct communication with the aperture **332** in the wall of the spacer sleeve. Control fluid pressure may then be conducted through the aperture **332** in the spacer sleeve into the sleeve between the spacer sleeve and the exterior of the lock sleeve and into the aperture **375** where it will act against the outer face of the disk **377** or against the outer end of such other suitable plug as may be used in lieu of the disk **377**. The disk or plug, whichever is used, should preferably be sufficiently strong to withstand normal control fluid pressures. If, however, a supplementary subsurface safety valve such as the supplementary safety valve **120** is to be installed in the device **300** and is to be controlled from the surface, then prior to the installation of such supplementary safety valve the control pressure must be increased until such control pressure acting on the disk **377** will cause the disk to be ruptured or be displaced from its place in the aperture **375** of the shiftable sleeve **340**, thus opening the aperture or lateral passage **375** so that control fluid pressure will be conducted to the interior of the lock sleeve **340** where it can act on the supplementary safety valve **120** to actuate the same.

From the foregoing it will be seen that a subsurface safety valve for well flow conductors has been provided which is operated by control fluid pressure conducted thereto from a surface controller located on the surface of the earth; that the safety valve has means therein for locking the valve mechanism in an open or inoperative position or in an intermediate position between closed and open positions; that the safety valve also has means therein responsive to control fluid pressure for opening a fluid passage into the interior of the safety valve by increasing the control pressure substantially above normal after the locking means has first been moved to position locking the valve mechanism in an open or partly open position; and that a supplementary safety valve may then be installed in the original valve and actuated by control fluid pressure from the surface conducted thereto through the newly opened passage. Further, it has been shown that such pressure responsive means for opening the control fluid passage into the interior of the safety valve may be a plug, a disk, or a disk in a plug, or the like; that the plug or disk can be carried in the housing or in a slidable sleeve; that such plug or disk may normally be disposed in an environment of well fluids, or of control fluid, or disposed so that one of its ends is exposed to well fluids and the other of its ends is exposed to control fluid; and that, in either case, the plug or disk can be displaced or opened only after the slidable sleeve has been moved or shifted from its inoperative position to a position engaging the valve mechanism to hold the valve open or partly open.

Thus, the subsurface safety valve of this invention fulfills all of the objects set forth in the beginning.

The foregoing description of the invention is explanatory only, and changes in the details of construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the true spirit of the invention.

What is claimed and desired to be secured by letters patent is:

1. A well flow conductor valve including: a housing having means for connecting it in flow communication with a well flow conductor; valve means disposed in the housing and movable therein between open and closed positions for controlling flow through the housing; operating means in said housing movable longitudinally thereof for actuating said valve to move the same between the open and closed positions; locking means in the housing initially in an inoperative position spaced from said operating means and movable to a position engaging said valve operating means to positively lock said valve operating means in position holding said valve in open position; fluid pressure responsive means on said operating means; means for conducting control fluid pressure to said valve housing for acting on said fluid pressure responsive means to control movement of said operating means in response to such control fluid pressure; means at the surface for controlling fluid pressure conducted through said control fluid conductor means to the valve in response to predetermined conditions; and means providing a control fluid passage into the interior of the valve housing responsive to an increased control fluid pressure after said locking means has been moved to position locking said valve means in open position, said increased control fluid pressure being substantially higher than the control fluid pressure required to operate said operating means.

2. The device of claim **1** in combination with a supplementary safety valve disposed therein and actuated by control fluid pressure conducted to the same through said control fluid passage.

3. The device of claim **1** wherein said means for providing said control fluid passage into the interior of said valve includes: a port in the wall of said housing; plug means plugging said port; and means releasably retaining said plug means against displacement from said port means and releasable in response to said increased control fluid pressure.

4. The device of claim 5 wherein said plug in said port has its inner and outer sides subjected to control fluid pressure when said sleeve is in said inoperative position.

5. The device of claim 3 wherein said plug in said port has its inner and outer ends subjected to well fluid pressure when said sleeve is in said inoperative position.

6. The device of claim 3 wherein said plug means includes a plug disposed in said port and seal means engaged between said plug and the wall of said port for preventing flow of control fluid through said port when said plug is disposed therein, and said releasable means is a shear pin disposed in an aperture in said plug and having at least one of its ends engaged with said housing, said shear pin being shearable responsive to said increased control fluid pressure to displace said plug from said port, whereby said control fluid passage into the interior of said valve housing is opened upon a substantial increase in control fluid pressure.

7. The device of claim 3 wherein said plug means is a disk sealingly disposed in said port and being displaceable from such sealing position by said increased control fluid pressure.

8. A well flow conductor valve comprising: a housing having means connecting it in flow communication with a well flow conductor; valve means disposed in the housing and movable therein between open and closed positions for controlling flow through the housing; operating means in said housing movable longitudinally thereof for actuating said valve to move the same between open and closed positions; fluid pressure responsive means on said operating means; means for conducting control fluid pressure to said valve housing for acting on said fluid pressure responsive means to control movement of said operating means in response to such control fluid pressure; means at the surface for controlling fluid pressure conducted through said control fluid conductor means to the valve in response to predetermined conditions; and means providing a control fluid passage into the interior of the valve housing responsive to an increased control fluid pressure substantially higher than the control fluid pressure required to operate said operating means.

9. The device of claim 8 wherein said means for providing said control fluid passage into the interior of said valve is a port in the wall of said housing and includes plug means plugging said port and means releasably retaining said plug means against displacement from said port means and releasable in response to said increased control fluid pressure.

10. The device of claim 9 wherein said plug is a disk sealingly disposed in said port and being displaceable from such sealing position by said increased control fluid pressure.

11. The device of claim 9 in combination with a supplementary safety valve disposed therein and actuated by control fluid pressure conducted to the same through said control fluid passage.

12. The device of claim 9 wherein said plug in said port has its inner and outer sides subjected to control fluid pressure when said sleeve is in said inoperative position.

13. The device of claim 12 in combination with a supplementary safety valve disposed therein and actuated by control fluid pressure conducted to the same through said control fluid passage.

14. The device of claim 9 wherein said plug in said port has its inner and outer ends subjected to well fluid pressure when said sleeve is in said inoperative position.

15. The device of claim 14 in combination with a supplementary safety valve disposed therein and actuated by control fluid pressure conducted to the same through said control fluid passage.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,882,935 Dated May 13, 1975

Inventor(s) Michael B. Calhoun

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 13: After "bias" insert --of--.

Column 4, line 11: After "supplementary" insert --valve--.

Column 7, lines 8 and 9: for "sperture" read --aperture--.

Column 8, line 9: for "wall" read --well--.

Same column, line 17: for "wall" read --well--.

Column 9, line 5: for "si" read --is--.

Column 10, line 26: for "of" read --or--.

Column 12, lines 25 and 26: for "immediatelyabove" read --immediately above--.

Column 13, line 15: for "cntrol" read --control--.

Same column, line 51: for "position" read --portion--.

Column 17, line 1: for "The device of claim 5" read --The device of claim 3--.

Signed and Sealed this

seventh Day of October 1975

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks