United States Patent

[11] **3,530,874**

[72] Inventors **Charles Paul Lamb; William A. Dudley; J. Boyd Fox, Garland, Tex.**

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[45] Patented **Sept. 29, 1970**

[73] Assignee **Merla, Inc., Garland. Texas a corporation of California**

[54] **VALVES**
10 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** **137/155,** 103/232, 137/624.27

[51] **Int. Cl.** **F04f 1/20**
[50] **Field of Search** 137/155, 624.27; 103/232

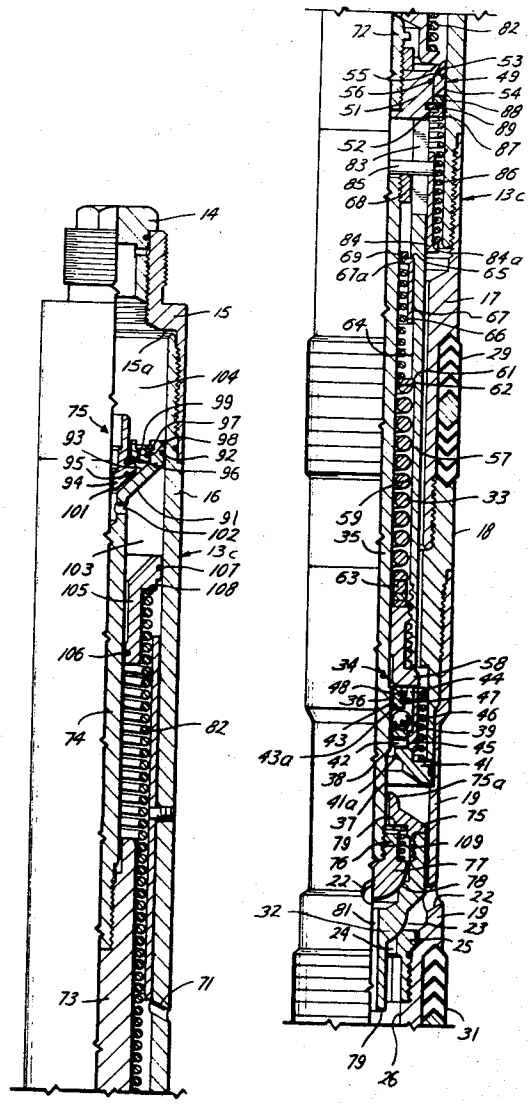
[56] **References Cited**

UNITED STATES PATENTS

3,213,806 10/1965 Walton 137/155X

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ABSTRACT: This patent discloses a gas lift valve which opens in response to tubing pressure and closes at a selected time interval thereafter.



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Fig. 2B

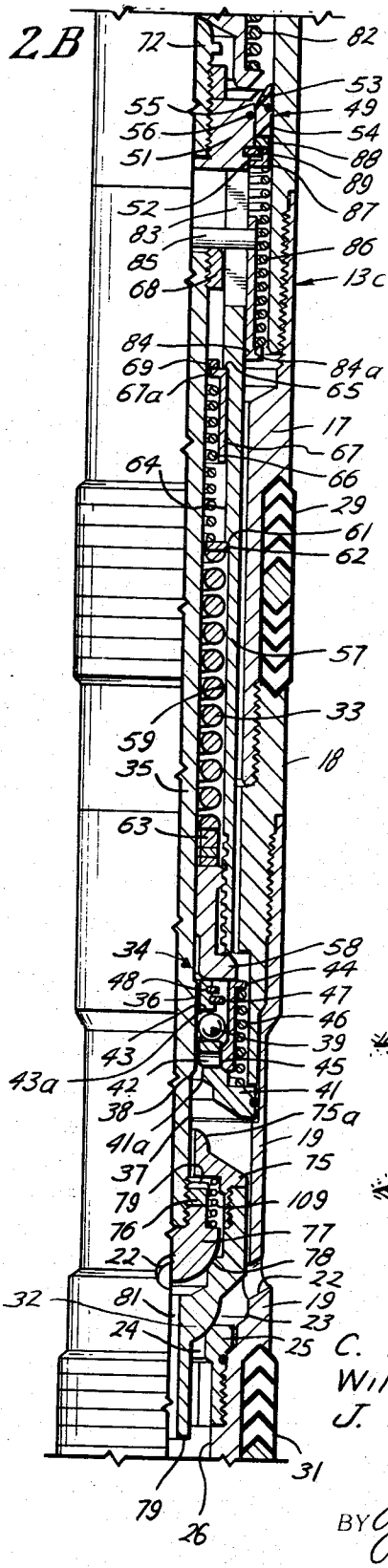


Fig. 2A

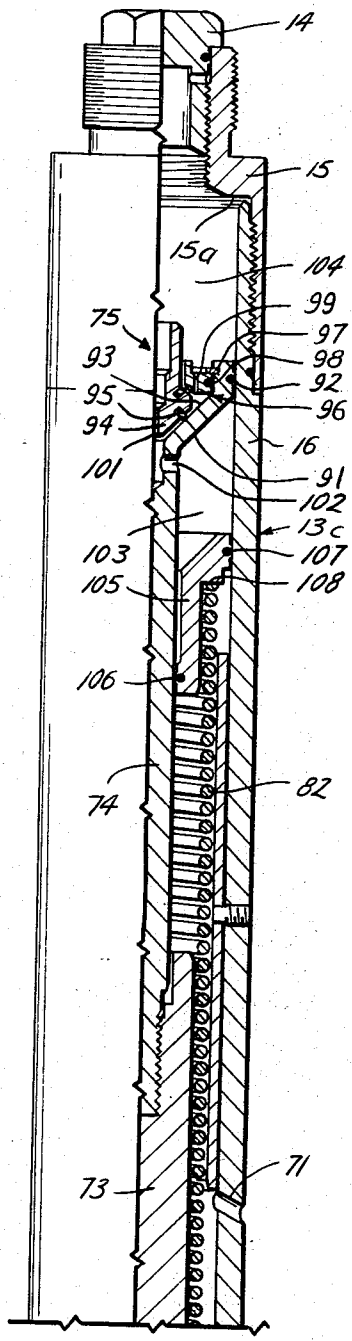
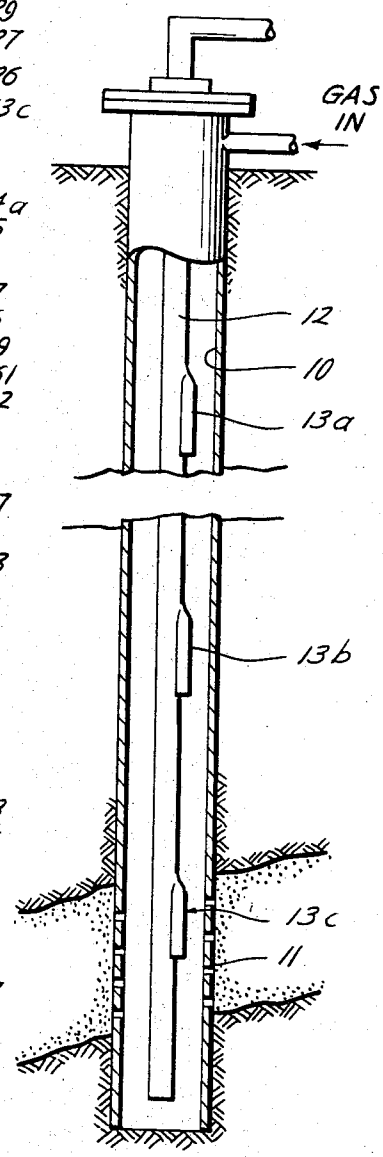


Fig. 1



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Fig. 2C

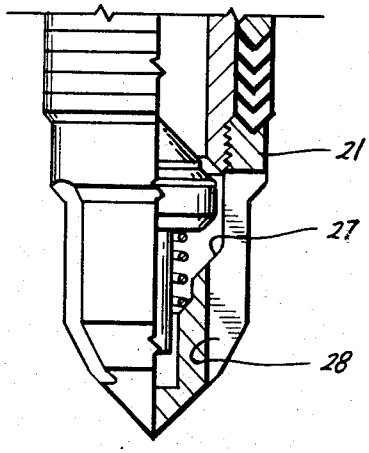


Fig. 4

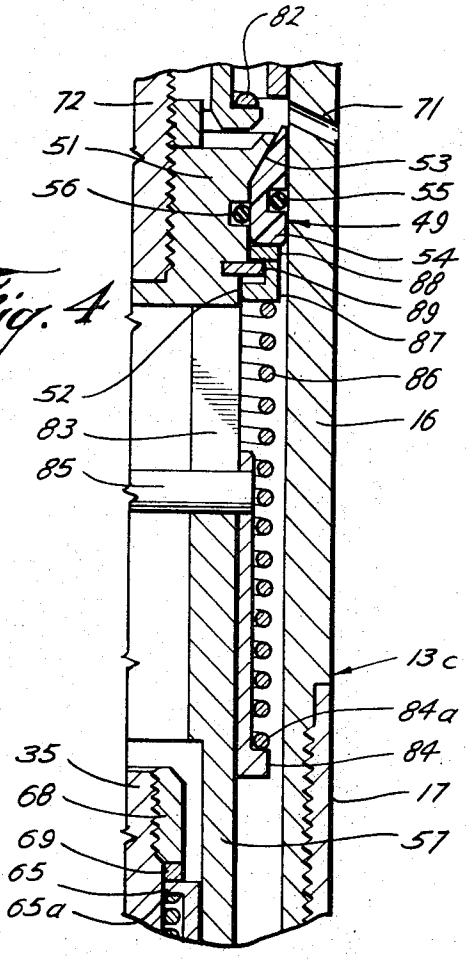
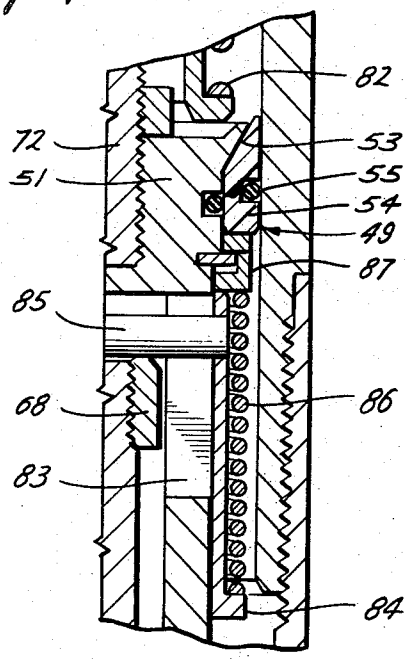


Fig. 5



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Fig. 3A

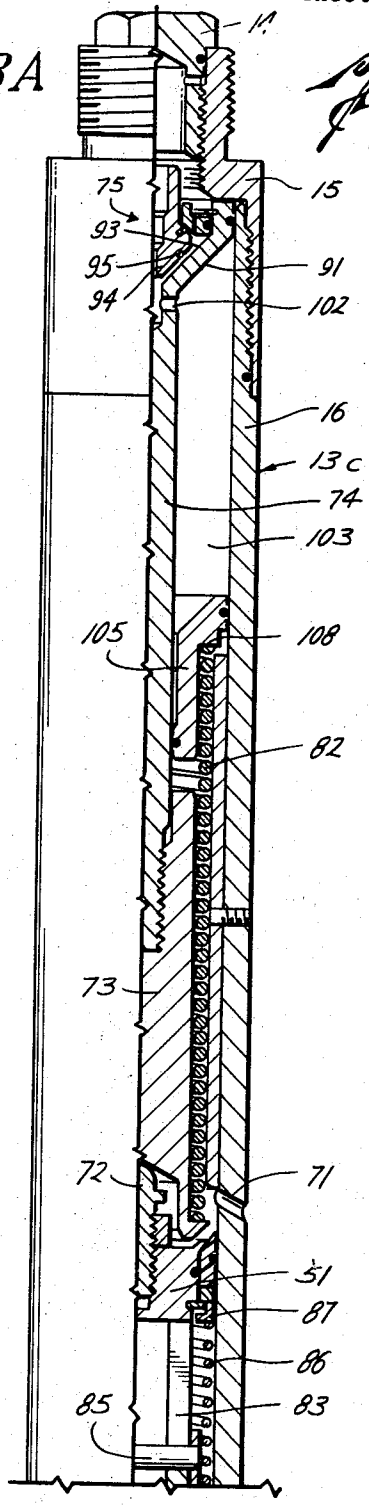
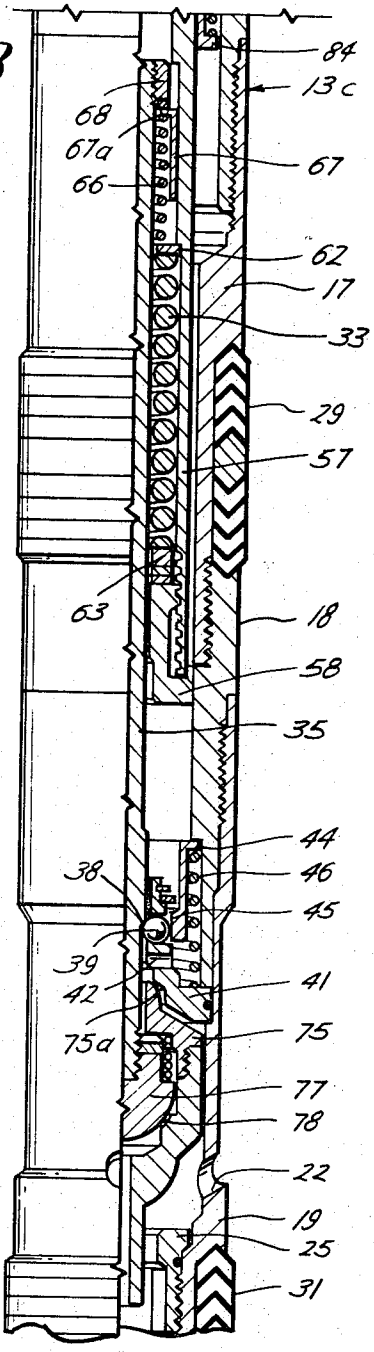


Fig. 3B



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VALVES

This invention relates to gas lift valves.

It is well recognized that it is to advantage to open a gas lift valve in response to a tubing-casing differential so that it will be certain that the proper amount of liquid to be lifted relative to the gas pressure is present. However, gas lift valves of this type usually have the disadvantage of not opening and closing rapidly, and tending to aerate the column of oil. Casing-responsive valves are readily designed which open and close rapidly, but they assume the presence of a suitable head of liquid in the tubing for lifting. If this assumption be incorrect, the efficiency of the injected gas is low. It has been proposed to solve the problems of these types of valves by using time control valves. See U.S. Pat. Nos. 3,213,806 and 3,326,229.

One area of possible trouble with these time control valves, such as the Dudley valve, is the possiblity of the timing fluid being lost or becoming contaminated with well fluids.

By this invention a new time control valve is provided which is positive in action, which snaps to open and closed position in response to tubing conditions and a selected opening time. The valve minimizes the possibility of the timing fluid becoming contaminated with well fluid, and eliminates or reduces the effect on the timing cycle of loss of some fluids from the timing chamber.

It is an object of this invention to provide a new time control valve in which the control of the lifting cycle is entirely contained within the valve assembly, and in which the possibility of contamination of the time control mechanism by well fluids is greatly reduced.

Another object is to provide a time control valve in which the lifting cycle is controlled by the timing valve assembly, and in which loss of some of the timing fluid from the assembly will not adversely affect the operation of the valve.

Another object is to provide a time control valve in which, upon opening, the valve is positively and rigidly held in full open position for a selected period of time, after which the mechanism holding the valve in open position is mechanically released to permit the valve to be closed with a snap action.

Other objects, features and advantages of the invention will be apparent from the specification, the drawings and the claims.

In the drawings, wherein like numerals indicate like parts, and wherein the preferred embodiment of this invention is shown;

FIG. **1** is a view partially in elevation and partially in vertical section through a well equipped with this invention;

FIGS. **2A**, **2B** and **2C** are views in quarter section of a valve constructed in accordance with this invention with the valve closed, and with FIG. **2B** being a continuation of FIG. **2A** and FIG. **2C** being a continuation of FIG. **2B**;

FIGS. **3A** and **3B** are views in quarter section, with FIG. **3B** being a continuation of FIG. **3A** and showing the valve open;

FIG. **4** is a fragmentary sectional view illustrating relationship of parts with the valve waiting for the proper differential to open the valve; and

FIG. **5** is a view similar to FIG. **4** illustrating the relationship of parts at the moment of release of the latch.

FIG. **1** illustrates a well including casing **10** which has perforations **11** therein at the producing formation. A tubing **12** within the casing carries a plurality of gas lift valves **13***a*, **13***b* and **13***c*. The upper valves **13***a* and **13***b* may be of any conventional type for unloading the well. The lower valve **13***c* is constructed in accordance with this invention and acts as the working valve.

Referring first to FIGS. **2A**, **2B** and **2C**, the valve **13***c* includes a body made up of the following parts: Top plug **14**, top cap **15**, piston housing **16**, upper adapter **17**, latch housing **18**, inlet thimble **19**, and bottom cap **21**.

The housing has a flowway therethrough for introducing gas from the tubing-casing annulus into the tubing **12**. This flowway is provided by a plurality of circumferentially spaced

ports **22** in the inlet thimble **19**, the bore **23** in thimble **19**, the bore **24** through valve seat **25**, the bore **26** in inlet thimble **19**, the bore **27** through the bottom cap **21** and the outlet ports **28**.

An upper seal **29** and a lower seal **31** seal between the valve body and the side pocket mandrel in the tubing **12**, so that gas from the casing passes through the flow passageway into the tubing in the usual manner.

Valve means are provided for controlling flow through said flowway. This valve means includes the seat **25** and the main valve member **32**.

The main valve **32** is unseated by the effect of casing and tubing pressure and the main spring **33** in a manner to be more fully explained hereinbelow. Upon unseating, the main valve is held in open position by a latch assembly indicated generally at **34**. After a selected period of time, the latch assembly is rendered ineffective and the main valve is returned to its seat.

The latch means automatically latches the valve means in open position in response to movement of the valve means to open position. The main valve **32** is carried on a valve stem **35**. The valve stem **35** is provided with an enlarged cylindrical section **36** and a relatively smaller cylindrical section **37** adjacent thereto to provide therebetween a latch shoulder **38**.

The latch mechanism **34** includes a plurality of latch balls **39** which, when extended to engage the surface **37** of stem **35**, coact with the shoulder **38** to hold the main valve in open position. A latch body **41** is held between the inlet thimble **19** and the latch housing **18**. This latch body includes a port **42** to insure free passage of fluid through the latch body. A plurality of holes **43**, one for each ball **39**, are provided circumferentially about the latch body. The latch body section which provides the holes **43** has inturned lips **43***a* about the holes to limit inward movement of the balls when the latch assembly is not in assembled position. When in assembled position, the balls **39** are free to move out to a point where they engage the cylindrical surface **37** of the stem **35**.

The balls are held in inwardly extended position, when the valve is open, by the latch sleeve **44**. This sleeve has an inwardly projecting flange surface **45**, cylindrical in form, which holds the balls in extended position when the sleeve is in its upper position under the influence of compression spring **46**. In order to permit handling of the latch assembly as a unit, a stop washer **47** is carried in the upper section of the latch body and the stop washer is held in position by the snap ring **48**. Thus, when the assembly is out of the body, the stop washer will hold the latch sleeve on the latch body.

A first pressure responsive member provided by the piston assembly indicated generally at **49** effects opening and closing movement of the main valve **32**. The piston assembly includes a body **51** having a lower cylindrical section **52** and an upper outwardly turned frusto-conical section **53**. A piston ring **54**, preferably of Teflon, has an outer cylindrical wall to conform to the inner cylindrical wall of the piston housing **16** and an inner wall which conforms to the two surfaces **52** and **53** of the piston **51**. O-ring seals are provided at **55** between the piston housing wall **16** and the piston ring **54**, and at **56** between the piston ring **54** and the piston **51**. For a discussion of the advantage of this type of assembly, see the U.S. Pat. to Dudley No. 3,326,229.

The piston assembly **49** effects unlatching of the latch means when the piston assembly is moved downwardly by the time control means. A sleeve **57** depends from the piston assembly **49**. The lower extremity of the sleeve **57** terminates in a latch release bumper member **58**. The bumper member is threadedly secured to this sleeve **57**. Upon downward movement of the piston assembly **49**, the bumper **58** releases balls **39** and the main valve **32** is free to return to its seat.

The main valve is opened by a differential thereacross and spring force. To provide a main valve spring cage, the interior of the sleeve **57** is counterbored at **59**. The counterbore provides a shoulder **61** internal of the sleeve. A spring washer **62** abuts this shoulder and the main opening spring **33** is held between the spring washer **62** and one or more adjusting washers **63** which abut against the latch release **58**. The spring

33 is sized and the number of washers 63 are selected to provide the amount of spring force necessary to cooperate with the differential across the main valve to open the main valve member.

It is desired that the main valve member move to full open position with a snap action. For this purpose, the sleeve 57 has bore 64 to provide the shoulder 65. A snapper spring 66 is provided in the space between the valve stem 35 and the sleeve 57 and bears at its lower end on the spring washer 61 and at its upper end on a cylindrical snapper housing 67 having an inturned flange 67*a*. The upper end of the valve stem 35 has a stem nut 68 which is engaged by the snapper housing 67, or, if desired, by one or more washers 69 on top of flange 67*a* to control spacing.

From the description as it has thus far proceeded it will be apparent that casing pressure enters through port 22, passes up through the tubular body and is effective on the underside of the piston assembly 49. Above the normal travel of piston 49 the piston housing is provided with one or more ports 71. It will be noted that the port 71 is above the upper seal 29, and thus is exposed to tubing pressure. The casing-tubing differential across the piston assembly 49 causes the piston to move upwardly and compresses the springs 33 and 66 to store energy to be used in opening the main valve. In fully cocked position the spring 66 is compressed and placed under the desired compression. Of course, the washer 69 is in engagement with the stem nut 68 (see FIG. 4).

The piston assembly 49 carries a differential adjusting stem 72 which rests in a socket in the lower end of a spring stop 73. The spring stop is carried on piston stem 74 which in turn carries at its upper end a piston assembly indicated generally at 75. The casing-tubing differential across the piston assembly 49 will move the assembly upwardly until the piston 75 strikes the surface 15*a* on the top cap 15. This limits the upward movement of the piston assembly 49. It will be seen that the differential adjustment stem 72 provides for fine adjustment in the degree to which the spring 33 can be compressed, and thus complete, simple control is had over the amount of force which the spring 33 will exert in a valve-opening direction.

With the valve in the posture just explained, it is cocked and ready to open upon the tubing pressure increasing to an extent such that the tubing pressure acting through the ports 28 on the bottom of the main valve 32, together with the force exerted by springs 33 and 66, just exceeds the downward force exerted by casing pressure on the main valve member. When this occurs, the main valve member will crack off its seat. The ports 22 and the main valve and seat are so sized that the pressure drop of casing to tubing pressure across the valve seat 24 is taken at the valve seat. Thus, upon the main valve cracking off its seat, progressively greater areas of the main valve become exposed to casing pressure which tends to move the main valve upwardly. As the pressure differential across the main valve thus decreases, the two springs 33 and 66 expand and draw the main valve forcefully from its seat. The small spring 66 exerts only a small force, but has a substantial travel and thus insures that the main valve will snap to fully opened position.

Upon the main valve snapping to fully opened position, the latch assembly 34 is effective to latch the main valve in open position.

The main valve carries on its upper end a reversal valve 75. This valve has a spherical type seal surface 75*a* which cooperates with seat surface 41*a* on the lower face of latch body 41. This valve is designed to provide a "leaky" seal, and will be held against its seat due to abutment with the upper end of locknut 76 which locks the inner valve 77 onto the valve stem 35. The function of the inner valve 77 will be explained hereinafter. It should be noted that when main valve 32 is off its seat the inner valve 77 is off its seat 78 and fluid communication between the tubing and the area about the inner valve 77 is insured by slot 79 in the locknut 76. Thus, with the main valve member in open position tubing pressure will be present within the housing below the piston assembly 49. To insure that this is true tubing pressure, a probe 79 is carried on the lower end of the main valve member. A port 81 extends through the probe and, as the probe is considerably below the valve seat 24, it is insured that tubing pressure will be present throughout the housing below the piston assembly 49. Any leakage past the reversal valve 75 escapes through the probe 81.

As tubing pressure is also present above the piston assembly 49, it is apparent that tubing pressure has no effect on closing of the valve member. To insure that the main valve remains open and the reverse valve remains seated until the valve is closed by other means, the main valve seat 25 is of slightly larger size than the reversal valve seat 41*a*, and thus there is a slight force holding the main valve in open position.

During upward movement of the piston assembly 49 under the influence of the casing-tubing differential thereacross, the main closing control spring 82 was placed under compression storing energy to be used in closing the valve. Upon equalization of pressure across piston assembly 49, this spring 82 is free to exert its influence and expand and move the piston assembly downwardly. In so doing, the piston assembly moves the sleeve 57 down until the latch release 58 moves the upper end of latch sleeve 44 downwardly to a point to release the balls 39.

During downward movement the piston assembly 49 begins to exert a downward influence on the valve stem 35 which will close the main valve with a snap action motion upon release of the latch means. For this purpose, the sleeve 57 has a pair of opposing slots in its upper section, one of which is shown at 83. A closing spring retainer 84, which is annular in form, has a lock pin 85 extending therethrough. This lock pin extends through the slots 83. The lower end of the closing spring retainer 84 has an out-turned shoulder 84*a*. A closing spring 86 extends between the shoulder 84*a* and the piston assembly 49. The spring bears against a piston follower 87 which surrounds piston 51 and engages a washer 88. The washer 88 is held in place by a retainer ring 89. Thus it will be apparent that as the piston assembly 49 moves downwardly the lock pin strikes the top of the stem nut 68 and thereafter the spring 86 is compressed to exert a downward force on the valve stem 35 which, when the latch assembly 34 is released, moves the inner valve 77 downwardly to where it engages the seat 78 to close off communication with the tubing downstream of the main valve. At this time the leaky seal provided by the reversal valve permits leaking of casing pressure into the body of the valve and this casing pressure now becomes effective to move the inner valve and main valve assembly downwardly. The casing pressure as it builds up in the body above the main valve is thus effective over the entire area of the main valve member to move the main valve member forcefully onto its seat. The buildup of pressure accompanied by the force of the snapper spring 66 snaps the main valve onto its seat.

In order to control the time involved in opening the main valve and in closing the main valve, a suitable dashpot is provided which is effective to control movement of the piston assembly 49. This dashpot is provided by the piston indicated generally at 75. This piston assembly includes the piston proper 91 which has a sliding seal with the inner cylindrical wall of the piston housing 16. The seal is provided by the O-ring 92. The piston is hollow and the hollow section has a frusto-conical seat 93 with which the orifice check valve 94 cooperates. A suitable seal is provided by O-ring 95. An orifice seat 96 is provided within the hollow piston and held in place by the snap ring 97. A suitable O-ring 98 seals between the seat and the piston. A plurality of ports 99 extend through the orifice seat. The number and size of these ports will time the closing action of the main valve member. The check valve 94 also has a port 101 therein which times the cocking of the mechanism in preparation for opening of the valve. Thus as the piston assembly 49 moves upwardly, the orifice check valve seats and flow of liquid is through the port 101 and thence through the side port 102 into the chamber 103 below the piston. When the timing piston is in its uppermost position

and the piston assembly **49** begins its downward movement, the fluid will flow from chamber **103** through port **102**, past check valve **94** and one or more ports **99** as well as orifice **101** into the chamber **104** above the piston.

The dashpot chambers **103—104** are filled with a very viscous liquid which requires substantial time to pass through the several ports.

In accordance with this invention, the lower end of chamber **103** is closed by a second pressure responsive member or reservoir piston **105** which is free to move and change the size of the reservoir. The piston is suitably sealed against the stem **74** by an O-ring **106** and against the cylindrical wall of the piston housing **16** by seal **107**.

It will be noted that the spring **82** bears at its upper end against a shoulder **108** provided on the piston **105**.

The reservoir piston **105** is effective to substantially minimize, if not prevent, any chance of leakage of fluid past this piston. The spring **82** is a very long spring having a very low rate. This spring is always under compression in any operative position of the valve, and this compressive force is exerted on the piston **105**. This piston **105** is also always subject to tubing pressure. Thus the pressure within the dashpot will be equal to tubing pressure plus the pressure generated by the force of the piston spring **82**. As the pressure within the dashpot will thus always be greater than the outside pressure, there is no chance of contamination of the dashpot fluid by leakage of well fluids into the dashpot fluid. The well fluids will normally be gas or liquids which are much lighter than the liquid within the dashpot, and thus the timing function would be injured by any contamination of the dashpot fluid. Thus, by the arrangement of the spring-loaded floating piston, this undesirable possibility is prevented.

In the event there is any slight leakage of dashpot fluid past the reservoir piston, the spring **82** will expand to take up the space resulting from loss of fluid. As the spring is very long and has a very low rate, there will be very little effect on the timing function of the device resulting from loss of fluid from the dashpot.

In reviewing the operation of the valve, it will be assumed that the main valve **32** has just closed after delivering a slug of gas into the well. The parts of the valve are in the position shown in FIGS. 2A through 2C and casing pressure will be effective on the bottom of the piston assembly **49** to begin moving this assembly upwardly. To avoid any possibility of premature opening of the main valve at the time that the differential across the main valve would be such as to cause it to open if the springs **33** and **66** were permitted to immediately become effective, the dashpot restricts upward movement of the piston assembly **49** and may limit this movement to several hours. Also the lost motion connection between the piston assembly **49** and the valve stem **35** delays the effect of upward movement of assembly **49**. Thus the tubing pressure drops and the casing-tubing differential slowly moves the piston assembly **49** upwardly until the dashpot piston **75** strikes the top cap. At this time the two springs **66** and **33** are fully compressed and the parts are in the position shown in FIG. **4**. All during this time well fluids will have been entering the well and gradually rising in the tubing above the working valve **13***c*. When these well fluids rise to a sufficient head, they will exert a tubing pressure which relative to casing pressure will provide the desired differential across the main valve which, together with the force of the two springs **33** and **66**, will snap the main valve into open position. As the main valve comes off its seat, it is exposed to a greater area of casing pressure and this greater casing pressure, plus the spring action, moves the main valve upwardly. The long, small spring **66** insures that continued mechanical action is available to lift the main valve to full open position where the reversal valve **75** engages its seat. The inner valve spring **109** will also assist in moving the reversal valve toward its seat, but the purpose of this spring is primarily as a safety measure to prevent the valve hanging open as will be explained herein below. As the main valve moves to full open position, the balls **39** will move inwardly under the influence of the latch sleeve **44**. The latch sleeve is free to move upwardly because the piston assembly **49** has moved the latch release **58** out of the way. The main valve is thus locked in open position immediately upon opening. As the reversal valve **75***a* seats with a leaky seal, the pressure within the entire valve body, other than through the flow passageway from inlet ports **22** to seat **24**, is at tubing pressure and the probe **79** insures that tubing pressure will be bled into the valve body all the way up to the piston assembly **49**. As the pressure within the body above piston assembly **49** is always tubing pressure, there is immediately equalization of pressure across the piston assembly **49** and pressure no longer has any effect on this piston. At this time, the piston spring **82** is free to expand and move the piston assembly **49** downwardly. It might be noted that the reservoir piston will move only a slight amount due to the fact that the reservoir **104** occupies the entire bore of the piston housing **16**, whereas the reservoir portion **103** has the stem **74** therein. Of course, if there were a comparable stem extending upwardly into a seal section so that the reservoirs above and below the dashpot piston **75** were of equal size, then the reservoir piston would not move at all. In any event, there is very slight movement of this piston and it provides a fairly constant base from which the spring **82** may expand to drive the piston assembly **49** downwardly. The time required for this movement, of course, is controlled by the flow of fluid within the dashpot through the several ports **101** and **99**.

As the piston moves downwardly, the lock pin **85** engages the top of the stem nut **68** and the closing spring **86** begins to compress. Continued downward movement of the piston assembly **49** results in the latch release **58** engaging the latch sleeve **44** to move down to a position in which the balls **39** can retract and release the valve stem **35**. At this point the parts are in the position shown in FIG. **5**. When this occurs, the closing spring **86** is effective to move the inner valve **77** onto its seat as this valve is not subject to any pressure differential. Upon moving of the valve on its seat, access to downstream tubing pressure is closed off and the leaky seal provided by the reversal valve permits casing pressure to have access to the interior of the valve body above the inner valve **77** and below the piston assembly **49**. This casing pressure is thus exerted across the entire main valve member and stem and, as the center section of the main valve as represented by the area downstream from seat **24** is exposed to tubing pressure, the differential pressure across the main valve is now in a direction to move it to its seat, and this action rapidly occurs assisted by the closing spring **86** to close the valve. The valve then begins another complete cycle.

In the event of a loss of casing pressure followed by an increase in casing pressure, it might be possible for the valve to become locked in open position except for the provision of the inner valve sleeve spring **109**. This spring insures that if the main valve is open, the reversal valve will be held in its uppermost position and properly seated. This will cause the inner valve **77** to seat on seat **78** and thus casing pressure will be effective over the entire upper area of the main valve, valve stem, etc. Thus, due to pressure drop across the valve seat, the casing pressure would cause the main valve to close after the casing pressure had built up.

A further feature of the valve is that the long low rate spring **82** for moving the piston assembly **49** downwardly will continue to move downwardly after the latch means **34** has been released if the main valve for some reason does not close. The continued downward movement of the piston spring will carry the piston assembly **49** into contact with the lock pin **85** and thus the force of this spring will be exerted to urge the main valve onto its seat.

From the above discussion it is apparent that the spring which urges the reservoir piston **105** upwardly could be a separate spring from the spring **82**, as it is only necessary to exert a force on this piston to make certain that the reservoir pressure is higher than tubing pressure. The illustrated embodiment is preferred, as it simplifies the structure and reduces the number of parts. By the same token, this spring

could move from a fixed stop instead of the piston **105**, and accomplish its desired function of releasing the latch means **34**.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

We claim:

1. A gas lift valve comprising:
a housing having a flowway therethrough;
valve means controlling flow through said flowway;
means responsive to opening of said valve means for latching said valve means in open position;
means responsive to a differential in pressure thereacross for a selected period of time for storing energy to be used in opening the valve means and after said period of time opening the valve means in response to a selected differential across the valve means;
said means responsive to a differential also storing energy during said selective period of time to be used in unlatching said latching means and responsive to opening of said valve means unlatching said latch means a selected period of time after opening of the valve means; and
resilient means closing said valve means immediately after it is unlatched.

2. A gas lift valve comprising:
a housing having a flowway therethrough;
valve means controlling flow through said flowway;
pressure-responsive means responsive to the pressure differential across the valve means when closed for compressing first and second springs;
means connecting the first spring to the valve means for opening the valve means when the force exerted by the compressed first spring overcomes the pressure differential holding the valve means closed;
means for latching the valve means in open position upon opening thereof;
and means responsive to expansion of said second spring for unlatching said valve means a selective time after said valve means is opened;
resilient means closing said valve means immediately after it is unlatched; and
time means controlling the expansion of said second spring.

3. A gas lift valve comprising:
a housing having a flowway therethrough;
valve means controlling flow through said flowway;
pressure-responsive means responsive to the pressure differential across the valve means when closed for compressing first and second springs;
time control means controlling the rate of movement of the pressure-responsive member to compress said springs;
means connecting said first spring to the valve means for opening the valve means when the force exerted by the compressed first spring overcomes the pressure differential holding the valve means closed;
means for latching the valve means in open position upon opening thereof;
means responsive to expansion of said second spring for unlatching said valve means a selected time after said valve means is open;
resilient means closing said valve means immediately after it is unlatched; and
said time control means controlling the expansion of said second spring.

4. The gas lift valve of claim **3** wherein means are provided responsive to opening of the valve member for equalizing pressure across the pressure-responsive member.

5. The gas lift valve of claim **3** wherein resilient means are provided for snapping the valve means to full open position upon opening of the valve means, and additional resilient means are provided for snapping the valve means to full closed position upon release of the latch means.

6. A gas lift valve comprising:
a housing having a flowway therethrough;
valve means controlling flow through said flowway;
latch means for latching said valve means in open position in response to movement of said valve means to open position;
a first pressure-responsive member in said housing;
latch release means carried by said pressure-responsive member;
first resilient means compressed by movement of the first pressure-responsive member away from latch release position;
said first resilient means urging the valve means toward open position;
a dashpot including a piston movable in response to movement of said first pressure-responsive member;
a second pressure-responsive member forming a wall of said dashpot;
a second spring compressed between said first and second pressure-responsive members;
means exposing the space between said two pressure-responsive members to downstream pressure; and
means exposing the other side of the first pressure-responsive member to upstream pressure when the valve means is closed and to downstream pressure when the valve means is open whereby upon opening of the valve means the pressure across the first pressure-responsive member is equalized and the second spring is effective to move the first pressure-responsive member to latch release position.

7. The gas lift valve of claim **6** wherein means are provided for snapping the valve means to full open position upon opening of the valve means and for snapping the valve means to full closed position upon release of the latch means.

8. The gas lift valve of claim **6** wherein the valve means and means for exposing the other side of the first pressure-responsive member alternatively to upstream and downstream pressure include:
a main valve member having a port therethrough;
an inner valve member controlling flow through said port and opening said port when the main valve member is in open position and closing said port when the main valve member is urged toward closed position by said means for snapping the valve means to closed position;
a leaky check valve controlling admission of upstream pressure to said first pressure-responsive member, said leaky check valve seated when the valve means is open and unseated when the valve means is closed; and
said leaky check valve permitting buildup of upstream pressure behind said inner valve member upon closing of said inner valve member to assist in closing said valve means.

9. The gas lift valve of claim **6** wherein the second spring is a low rate spring.

10. A gas lift valve comprising:
a housing having a flowway therethrough;
valve means controlling flow through said flowway;
pressure-responsive means responsive to the pressure differential across the valve means when closed for compressing first and second springs;
a fluid type time control means controlling the rate of movement of the pressure-responsive member to compress said springs;
means connecting said first spring to the valve means for opening the valve means when the force exerted by the compressed first spring overcomes the pressure differential holding the valve means closed;
means for latching the valve means in open position upon opening thereof;
means responsive to expansion of said second spring for unlatching and closing said valve means a selected time after the valve means is open;
said time control means controlling the expansion of said second spring; and

said second spring being compressed between said pressure-responsive means and a second pressure-responsive means which forms a part of said time control means

whereby the fluid in the time control means is always pressure which is greater than the pressure acting on said second pressure-responsive member.