Jan. 16, 1968 K. KELLEY ET AL 3,363,581

GAS LIFT VALVE

Filed May 16, 1966 2 Sheets-Sheet 1

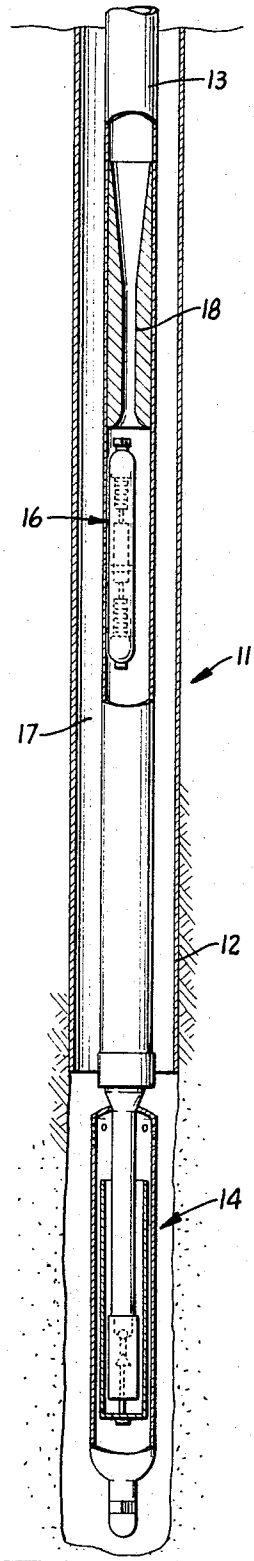


FIG. 1.

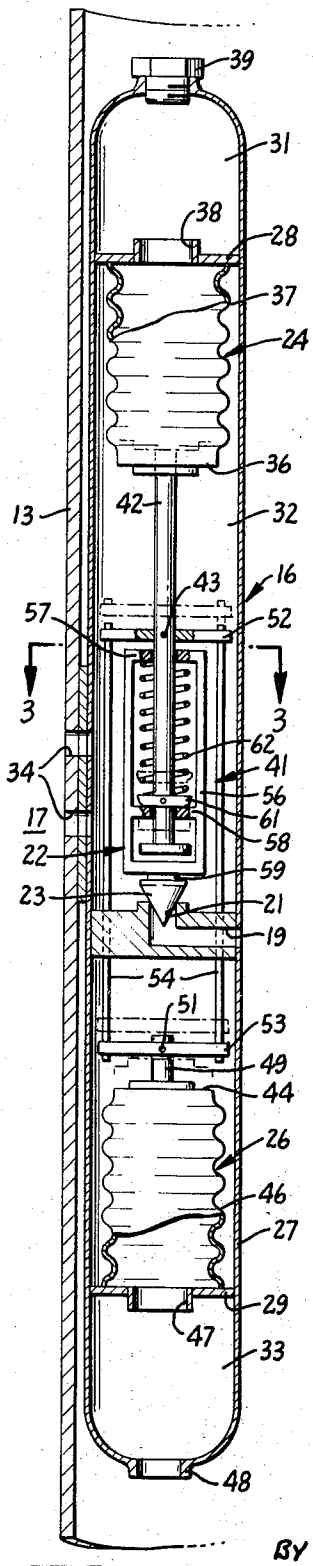


FIG. 2.

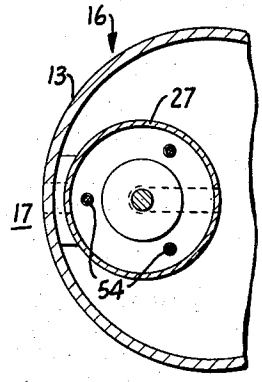


FIG. 3.

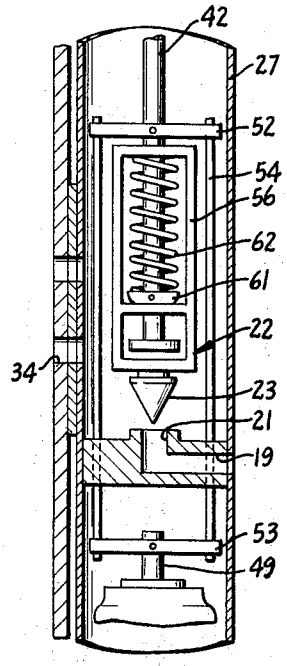


FIG. 4.

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GAS LIFT VALVE

Filed May 16, 1966 2 Sheets-Sheet 2

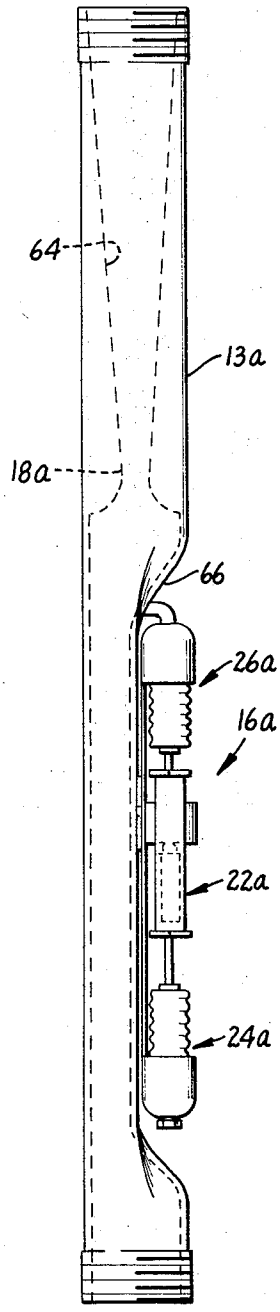


FIG. 5.

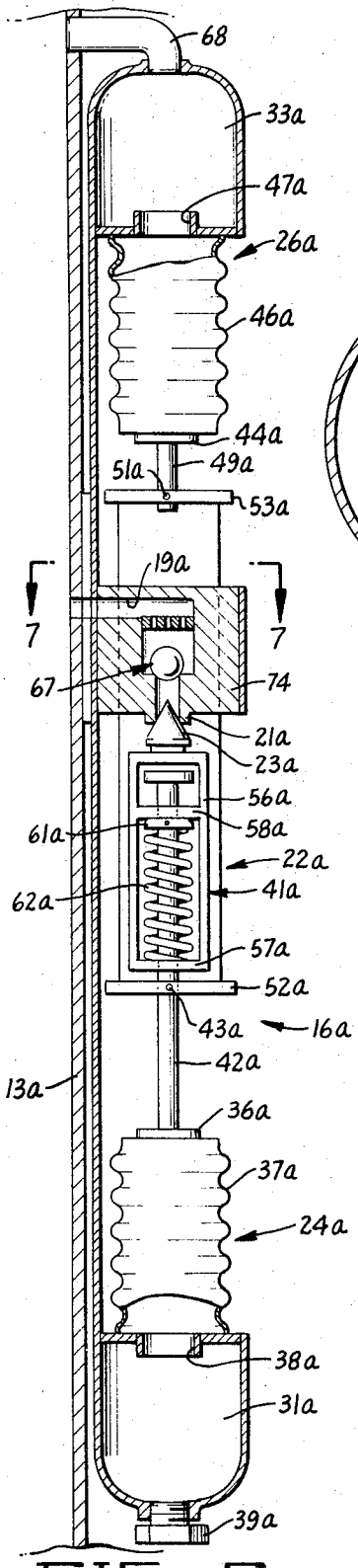


FIG. 6.

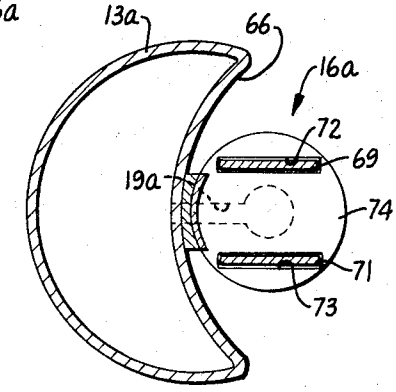


FIG. 7.

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GAS LIFT VALVE

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14 Claims. (Cl. 103—232)

The present invention relates to improvements in a gas lift valve, and more particularly to a pressure-balanced, quick and full-opening gas lift valve.

It is well known in the oil and gas well art to utilize gas lift valves for the purpose of removing liquids as they accumulate in the well tubing by utilizing gas under pressure to lift slugs of liquid in the tubing. These gas lift valves function to operate automatically whenever a pre-adjusted head of liquid is formed above the valve lift position, and when the valve is actuated it allows gas to flow into the tubing and force this liquid out through the end of the tubing at the surface. When the liquid is thus expelled, the pressure is released, and the lift valve automatically closes until the next cycle of operation.

While the gas lift valves on the market are suitable to achieve the desired function, it is found that certain faults are present in the most commonly used valves, and that the operating characteristics are not as good as is desired. For example, it is found that where lift valves are provided and adjusted to operate with a given working gas pressure present in the annular space outside of the well tubing and within the well casing, changes in the gas pressure in the annular space can cause faulty or improper operation of the valve. Since many gas wells and oil wells are subjected to changes in this pressure, these discrepancies can become serious, and it is desirable to provide means for overcoming this problem.

Another problem which has been quite serious is that of providing the necessary quick response so that when the valve is supposed to open it opens quickly and, conversely, when the valve is supposed to close, it closes quickly. In addition, certain other problems are encountered and the present invention provides a device which solves these and other problems.

Thus, it is a primary object of this invention to provide a gas lift valve which is operative to provide the desired pre-set opening and closing characteristics in accordance with the predetermined setting thereof, even with substantial variations in casing pressure.

Another object of the invention is to provide a gas lift valve of the character described in which means is provided for assuring quick opening and closing of the valve.

A further object of the invention is to provide a gas lift valve installation in which means is provided to assure efficient lifting by the gas entering the tubing and prevent channeling thereof.

Still another object of the invention is to provide an improved gas lift valve of the character described which is highly efficient in operation and yet relatively simple in construction.

Further objects and advantages of the invention will be apparent as the specification progresses, and the new and useful features of the gas lift valve will be fully defined in the claims attached hereto.

In general, the invention provides a gas lift valve, comprising walls defining a passage extending between the well tubing and the annular space within the casing and having a valve seat therein, a valve member mounted for axial movement between an open and closed position in said seat, means for moving the valve member, including a valve closing means operatively connected to the valve member for urging it toward the closed position with a pre-determined force, and valve opening means operatively connected to said valve member for urging it toward

the open position in response to fluid pressure. The valve closing means and valve opening means are located on each side of the valve member in balanced fashion so that the casing pressure which is exerted against each of these members provides a balancing factor. In this way, the valve closing force is operated against the fluid pressure within the tubing, which operates the valve opening means, so that the valve operation is substantially unaffected by changes of working pressure of the gas in the well casing.

The gas lift valve also is preferably constructed to provide quick opening and quick closing by virtue of its construction in which the valve member itself is mounted for restricted axial movement within a carriage, which in turn is operatively connected to the valve closing means and valve opening means so that the carriage and operative elements of the closing means and opening means move as a unit and carry the valve member in gross. The valve member then has some slight movement on the carriage and remains closed until clearance is provided. After such clearance, a spring normally forcing the valve member toward the open position is operated to effect a quick opening. The spring does not urge the valve member with as much force as the force exerted on the valve tip by the gas pressure around the casing. With this construction the working pressure will hold the valve in tightly closed position until the gross movement of the carriage is such that it starts to move the valve away from the seat. When this happens, the spring operates immediately to provide a quick opening. When the liquid which operates the valve opening means is ejected from the well, the pressure in the valve opening means is suddenly relieved, allowing the valve to close quickly without reference to the casing pressure itself.

In its preferred form, the invention provides a venturi or constricted area within the tubing just above the gas lift valve so that all of the gas passing through the gas lift valve will form a gas piston and lift the liquid within the tubing as a slug, thereby avoiding possibilities of channeling and malfunction of the lift operation.

The preferred forms of the invention are illustrated in the accompanying drawings, forming a part of this description, in which:

FIGURE 1 is a generally diagrammatic view of a section of a gas well having a string of tubing therein equipped with one or more valves constructed according to the invention, as it may be used for removal of water from the gas well;

FIGURE 2, an enlarged cross-sectional view of the gas lift valve illustrated in FIGURE 1 showing the internal parts;

FIGURE 3, a sectional view of the gas lift valve shown in FIGURE 2, taken substantially in the plane of line 3—3 thereof;

FIGURE 4, a fragmentary cross-sectional view of the lift valve shown in FIGURE 2, illustrating the valve while in the open position;

FIGURE 5, a diagrammatic view illustrating a section of well tubing equipped with an alternate form of the present invention;

FIGURE 6, an enlarged cross-sectional view of the gas lift of this invention shown in FIGURE 5; and

FIGURE 7, a cross-sectional view of the gas lift shown in FIGURES 5 and 6, as seen substantially in the plane of line 7—7 of FIGURE 6.

While only the preferred forms of the invention are shown, it should be understood that various changes or modifications may be made within the scope of the claims attached hereto without departing from the spirit of the invention.

Referring to the drawings in greater detail, and particularly to FIGURE 1, there is shown a diagrammatic

view illustrating a typical application in which the gas lift valve of this invention is utilized to remove liquid from gas or oil wells in accordance with the invention covered by the co-pending application of Kork Kelley and Robert K. Kelley (also inventors in the present application) entitled liquid control for gas wells, filed Apr. 27, 1965 under Ser. No. 451,187, now Patent No. 3,324,-803. In a specific application of that invention, accumulation of water is prevented in gas wells by providing a liquid-gas separator at the bottom of the string of tubing and removing the liquid from the tubing as it builds up therein by conventional gas lift valves. While the gas lift valve of the present invention is suitable for any of the known uses for gas lift valves, the present illustration will be considered in connection with the removal of water from gas wells where the working gas pressure is likely to vary from time to time.

Thus, in FIGURE 1, there is shown a gas well **11** in the form of a hole in the ground defined by a typical casing **12** and having a string of tubing **13** disposed therein, with the tubing having a gas-liquid separator **14** disposed at the bottom thereof and one or more gas lift valves **16** constructed according to the invention. In general, the gas lift valve **16** might be considered as a separate unit, but certain of the conventional structures of the well are required for the desired operation of the gas lift and certain of the claims attached hereto recite such structures in combination.

When used as a gas lift for removing liquid from oil or gas wells and the like, the well is adapted to receive a liquid within the central tubing string and contains gas under pressure in the annular space **17** between the tubing and the casing. In its broad aspect, any suitable tubing may be utilized, but in its preferred form, certain modifications are made in the tubing and these modifications are believed to be true combinations because they influence the function of the over-all lift operation. Thus, in the embodiment shown in FIGURE 1, the gas lift valve **16** is located inside of the tubing and the tubing is equipped with a restricted area **18** in the form of a venturi. In many applications, this venturi **18** is unnecessary because the slug of liquid will be pushed toward the surface by the gas without any problem. On the other hand, particularly where the tubing is of large diameter, the restricted area is preferred because the gas forms into a gas piston and channeling of the gas is minimized or avoided.

Other tubing configurations may be used such as in the embodiment shown in FIGURES 5 through 7, and these various shapes of tubing are all within the ambit of the invention. However, it will be appreciated that it is preferred to introduce the gas from the casing into a rather centralized portion of the tubing string in order to easily fill the entire cross-section of the tubing with gas and minimize the possibility of channeling mentioned above. Both of the embodiments shown in the drawings provide such entry.

Referring more particularly to the gas lift valve **16**, as best seen in FIGURES 2 and 3, there is shown a gas lift valve **16**, comprising a passageway **19** having a valve seat **21** therein for providing a valved communication between the interior of the tubing and the annular space, a valve member **22** mounted for axial movement between an open and closed position of a valve tip **23** in the seat **21**, valve closing means **24** operatively connected to said valve member for urging it toward the closed position with a predetermined force, and valve opening means **26** operatively connected to said valve member for urging it toward the open position in response to fluid pressure.

The passage **19** will form an operative connection between the space containing the valve opening means, valve member and valve closing means because these parts are all generally exposed to the gas pressure within the casing. Accordingly, the passage **19** is usually a short passage having one end in fluid communication to the inside of the tubing and the other end in fluid communication to a space in alignment between the valve opening means and the valve closing means, and containing the atmosphere of the annular space around the tubing. Thus, in the form shown in FIGURES 2 through 4, the gas lift valve contains a generally cylindrical housing **27** containing a pair of transverse walls **28** and **29** dividing the housing into three chambers **31**, **32** and **33**. Chamber **32** is pressurized constantly with the gas from the annular space through suitable ports such as ports **34**.

The valve opening means and the valve closing means are preferably constructed of similar parts having equivalent sizes so that a matched opposition is achieved. Thus, the valve closing means contains a movable element **36** in sealed fluid communication with the chamber **31** so that the fluid pressure within chamber **31** will urge the movable member **36** away from the chamber at a predetermined pressure. In order to positively prevent leakage, it is preferred that the movable member **36** be the front end of a bellows **37** which has an opening **38** into the chamber **31**. The chamber **31** is equipped with a suitable fitting **39** so that the atmosphere therein may be accurately pressurized to adjust the length of each slug of liquid to be removed.

In order to effect operative connection between the movable member **36** and valve member **22**, it is preferred to utilize a floating carriage **41** on which the valve member is mounted, and have the floating carriage **41** connected to movable member **36** through connecting rod **42** and a suitable attachment such as pin **43**.

The valve opening means **26** is similarly constructed to the valve closing means and formed for balanced, opposed movement. As best seen in FIGURE 2, the valve opening means contains a movable element **44** having one side exposed to a fluid pressure urging it toward the valve member from the opposite side so as to urge the valve member open. The opposed sides between movable element **36** and movable element **44** are within a common atmosphere and are constructed so as to have their operative surfaces substantially equal so as to balance out the effect of the internal atmosphere or casing gas pressure.

In order to assure positive sealing, the movable element **44** is preferably carried on a bellows **46** which is in fluid communication with chamber **33** through opening **47**. The chamber **33** contains an external opening **48** which is in communication with the interior of the tubing so that the pressure within bellows **46** is determined by the liquid pressure within the tubing and thereby variable according to the head of liquid. The movable element **44** has a suitable connecting rod **49** attached thereto which provides operative connection between the movable element in carriage **41** by suitable fastening such as pin **51**.

Thus, it is seen that the valve opening means and valve closing means are constructed in opposed relationship and operative on a common carriage so that the fluid pressure within chamber **33** is in opposition with the fluid pressure within chamber **31**. Since the pressure within chamber **31** is accurately regulated, the valve member will move when the pressure in chamber **33** becomes higher or lower than the pressure in chamber **31**. Thus, when the valve is closed, as shown in FIGURE 2, the pressure in chamber **31** will exceed the pressure in chamber **33**. However, as liquid rises within the tubing, the pressure in chamber **33** will increase until it exceeds the pressure in chamber **31** and forces the carriage upwardly. The carriage will then carry the valve into the open position, as shown in FIGURE 4. After the liquid is removed from the tubing, the pressure in chamber **33** will be quickly released and the valve will return to the closed position. Since the element **36** and element **44** are in opposition and exposed to the same conditions, variation of these conditions will not seriously influence the valve operation and the present structure solves one of the serious problems in prior gas lift valves.

The floating carriage **41** may be constructed in any suitable manner so as to tie the movable members **36** and **44** together through their connecting rods or any other suitable device so that the carriage and the movable elements of the valve opening and closing means operate together as a unit. As here shown, the carriage comprises a cross piece **52**, cross piece **53**, and connecting yoke **54**. The connecting yoke **54** is composed of three longitudinal rods and the cross pieces **52** and **53** are each cross pieces which may be in the form of frame members or plates and equipped for attachment to the associated connecting rod. Generally, the yoke members will be symmetrical and may contain two, three or more rods attached to the cross piece at each end so as to provide a sturdy unit and connect everything together in a manner that will clear the housing for the passage **19**. Preferably, the valve member itself is mounted on the carriage for limited axial movement with respect to the carriage, whereby the carriage can move to an open position while the valve member is seated in the closed position and allow a quick opening of the valve at a given operative opening position of the carriage.

A typical mount is shown in FIGURES 2 and 4, with FIGURE 2 showing the valve in closed position and the movement that takes place prior to opening in phantom, while FIGURE 4 shows the valve in open position. The valve member is carried in telescoping fashion over a suitable rod that moves with the carriage and an extension of connecting rod **42** may be used for this purpose. Thus, the valve member **22** contains a frame or housing **56** having transverse members **57** and **58** each equipped with a suitable bore for providing a bearing surface and allowing the valve to slide over the extension of rod **42**. The axial movement of the valve member with respect to the carriage is limited by suitable limiting means incorporated into the structure.

Thus, the upward and downward movement of the valve member is restricted by stem washer **61**, which is located on the extension of connecting rod **42** between the journals of transverse members **57** and **58**. The upward movement of the valve member is limited by this stem washer abutting the transverse member and the downward movement is restricted by reaching total compression of a spring **62** which is disposed between transverse member **57** and stem washer **61** and in surrounding relation to the rod **42**. Thus, on compression of the spring **62**, the spring tends to urge the valve member upwardly or toward an open position.

The operation of the valve member of this invention is such as to provide a quick opening of the valve by virtue of the fact that the valve tends to remain seated or in the closed position due to the higher pressure of gas from the annular space around the pipe. As the unit tends to open, the spring moves into compression with the valve remaining seated because of this gas pressure tending to hold the valve closed. However, when the spring reaches a sufficient point of compression or total compression, it causes the valve member to lift from its seat. The effect of the closing pressure is then broken, and the spring quickly urges the valve to a completely open position. In this way, the valve tends to effect a quick opening which is highly desirable for gas lifts.

A typical example of the operation of the gas lift valve shown in FIGURES 1 through 4 will now be given to illustrate how the particular embodiment shown works, but this illustration should not be construed to limit the invention in any way. Prior to installation, the pressurized bellows is pressurized with gas or nitrogen to a predetermined pressure, depending upon the height of the slugs of liquid to be removed. In other words, the height of liquid above the tubing bellows or the valve opening means should match the pressure in the pressurized bellows or valve closing means when operation of the valve is to take place and the fluid above the valve passage **19** is removed.

With the pressurized bellows pressurized to the desired extent and the gas lift installed in place, it is ready to operate when the head of liquid within the tubing reaches the height mentioned above and over-balances the closing force of valve closing means **24**. Referring particularly to FIGURE 2, there is shown the valve in the closed position, where the bellows of the valve closing means has the carriage pushed downward and the valve member is in the closed position. When the valve opening means equalizes and then slightly exceeds the pressure of the valve closing means, the movable elements of each bellows and the carriage moves upwardly as shown in phantom in FIGURE 2. This phantom movement causes compression of spring **62**, but does not pull the valve out of its seat initially because the working pressure on the gas side of the valve seat exceeds the liquid pressure within and tends to hold the valve closed.

The spring is generally designed to compress to the full extent without exceeding this pressure, but may provide, say, a four-pound force thereon, when a typical pressure on the valve trip would be about 9.8 pounds. This 9.8 pounds would be created by using a quarter-inch seat together with a casing pressure or working pressure within the valve of 200 pounds. When the carriage has reached the position shown in phantom, the spring is fully compressed or, alternatively, the pressure within passage **19** plus the force on the spring is sufficient to push the valve tip into an open position. As soon as the valve tip cracks into an open position, the working pressure is equalized on both sides and the spring immediately decompresses to force the valve suddenly open, as seen in FIGURE 4. With the valve in the full open position, gas enters the tubing through passage **19**, passes into the casing, and enters the narrow neck of the venturi tube, where it forms a defined gas-liquid interface.

As the gas pushes upwardly, it passes via the cone shape of the venturi tube into the full opening of the tubing, while retaining the full gas-liquid interface so that the entering gas forms a solid gas piston. This gas piston drives the column of liquid up the tubing and out at the surface of the well. When the liquid is so discharged, the pressure created by the column of liquid upon the tubing bellows suddenly drops. This drop in pressure allows the pressurized bellows to depress with full force and drive the valve member and its tip with full force against the seat to form a tight shut-off. When sufficient liquid reaccumulates in the tubing to overcome the pressure in the pressurized bellows, the cycle repeats itself and another slug of liquid is discharged up through the tubing. It may be noted that the valve tip is shown in conical form, and this configuration is preferred to assure alignment when the valve is closed.

From the above example, it is apparent that the gas lift valve is operative over a large range of conditions, and that it functions quickly and reliably even with rather wide variations in the casing gas pressure. In addition, it is seen that the gas lift valve opens and closes quickly and accurately and that means is provided for positively assuring that the gas brought into the casing will form a piston and drive out a slug of liquid as required.

In FIGURES 5 through 7, an alternate embodiment of the invention is shown in which the gas lift valve is placed on the outside of the tubing, the positions of the valve opening means and valve closing means are reversed, and a check valve is provided in addition to the structure shown in the embodiment of FIGURES 1 through 4.

Thus in FIGURES 5 through 7, there is shown a gas lift valve **16***a* attached by welding or the like into a recessed portion **66** of tubing **13***a*. The tubing **13***a* is otherwise similar to the tubing **13** and contains a venturi **18***a* having upper conical walls **64** to provide a gradual passage from the constricted portion into the main tubing.

The gas lift valve **16***a* is thus located within the spacing between the well tubing and casing so that the open portions thereof are subjected to this gas pressure or

working pressure. The valve contains a passage **19***a* having a valve seat **21***a* at its terminal point in the casing atmosphere with the passage providing fluid communication from the casing atmosphere to the internal portion of the tubing. The passage **19***a* is similar to the passage **19** except that it also contains a ball check valve **67** which functions to prevent reverse flow of liquid from the well tubing into the casing and to provide constant pressure condition on the valve. The valve member **22***a* is similar in construction to valve **22** and contains a tip **23***a* which is preferably conical for self-aligned seating. The valve member **22***a* is also mounted on a floating carriage **41***a* for restricted axial movement, with the valve member **22***a* containing a frame **56***a* including transverse members **57***a* and **58***a* in which the valve rides axially on the extension of connecting rod **42***a*. The stem washer **61***a* and spring **62***a* are provided and function in the same manner as the equivalent structures in the embodiment of FIGURES 1 through 4.

It will be noted, however, that the valve member **22***a* is located on the lower side of the valve and for this reason the valve closing means **24***a* is also located on the lower side. This valve closing means **24***a* comprises a bellows **37***a*, connecting rod **42***a*, chamber **31***a* in fluid communication with the bellows through opening **38***a*, and fitting **39***a* equipped to allow a measured gas pressure to be put into chamber **31***a* and the associated bellows. The actual movement of the valve closing means is through the movable element **36***a* on the front of the bellows, with this member being urged by the pressure of gas within chamber **31***a*.

Valve opening means **26***a* is provided at the upper end and comprises bellows **46***a*, connecting rod **49***a*, chamber **33***a*, and opening **47***a* so as to maintain fluid pressure within the bellows and chamber at the same value. The chamber **33***a* is pressurized by fluid communication with the tubing which is effected through a conduit **68**. The valve opening means also has a movable element **44***a* which is influenced by the fluid pressure within chamber **33***a* to push the carriage and associated valve member toward the open position.

The movable elements of the valve opening means and valve closing means are internally opposed so that the effect of the gas pressure around the valve mechanism is cancelled out or equalized. In this way, accurate response between the pre-set pressure in chamber **31***a* and the fluid pressure caused by liquid within the tubing is maintained.

As here shown, the floating carriage **41***a* is similar in function to the carriage **41** and contains cross pieces **52***a* and **53***a* which are pinned to connecting rods **42***a* and **49***a* through pins **43***a* and **51***a*, respectively. The cross pieces are tied together by yoke members, which are in the form of plates **69** and **71**. As best seen in FIGURE 7, these plates fit through slots **72** and **73** in housing **74**, with the housing containing passage **19***a* and check valve **67**.

The operation of the device shown in FIGURES 5 through 7 is similar to the operation described for the embodiment of FIGURES 1 through 4, and need not be repeated. However, this device illustrates how the arrangement of parts may be changed without departing from the spirit and scope of the invention.

We claim:

1. A gas lift valve adapted for connection to a well tubing string comprising, an element having a passage therein and a valve seat in said passage, a valve member mounted for axial movement between an open and closed position in said seat, valve closing means comprising a first bellows means operatively connected to said valve member for urging it toward the closed position with a predetermined force, and valve opening means comprising a second bellows means operatively connected to said valve member for urging it toward the open position in response to differential fluid pressure.

2. The gas lift valve defined in claim **1**, in which a floating carriage is provided for connection between the valve closing means, the valve opening means, and the valve member whereby these three elements reciprocate together.

3. The gas lift valve defined in claim **2**, in which the valve member is mounted on the carriage for limited axial movement with respect to the carriage and valve opening and closing means whereby the carriage can move toward an open position while the valve member is seated in the closed position and allow a quick opening of the valve at a given operative opening position of the carriage.

4. The gas lift valve defined in claim **3**, in which a spring is provided for urging the valve member toward the open position and effecting the quick opening movement.

5. A gas lift valve for use with oil and gas wells and the like, in combination with a casing defining the well and tubing mounted concentrically within said casing, said gas lift valve comprising walls defining a passage extending through said tubing, a valve seat within said passage, a valve member mounted for axial movement between an open and closed position in said seat, valve closing means operatively connected to said valve member for urging the valve member toward the closed position, said valve closing means containing a movable element adapted to move axially with respect to the valve seat in response to the difference in pressure on each side of said element, means for providing a substantially constant predetermined pressure on the side of said movable element of the valve closing means operative to urge the valve member toward the closed position, valve opening means operatively connected to said valve member and constructed for urging the valve member toward the open position, said valve opening means containing a movable element adapted to move axially with respect to the valve seat in response to the difference in pressure on each side of said element, said element of the valve closing means and said element of the valve opening means having opposing sides in the same fluid atmosphere whereby the pressure of the operating atmosphere is balanced and does not effect movement of the valve member, and means for providing communication of the fluid pressure within the tubing against the other side of the element of the valve closing means whereby the fluid pressure within the tubing is opposed to the fixed fluid pressure provided in the valve closing means.

6. The gas lift valve defined in claim **5**, in which the valve closing means is in the form of a bellows, with the movable element thereof being a movable end of the bellows and having connecting means attached between it and the carriage, and the opposite end of said bellows being anchored and in communication with a chamber carrying a substantially fixed pressure of fluid, and said valve opening means being in the form of a bellows with the movable element thereof having means for connection to said carriage and containing a chamber which is in fluid communication to the inside of the tubing.

7. The gas lift valve defined in claim **6**, in which the valve member is mounted on the carriage for limited axial movement with respect to the carriage and valve opening and closing means, whereby the carriage can move toward an open position while the valve member is seated in the closed position and allow a quick opening of the valve at a given operative opening position of the carriage.

8. The gas lift valve defined in claim **7**, in which a spring is provided for urging the valve member toward the open position and effecting the quick opening movement, and in which the valve member is equipped with a conical tip for providing self-alignment in the valve seat on closure thereof.

9. The gas lift valve defined in claim **5**, in which the gas lift mechanism is disposed entirely within the well tubing and is constructed with walls defining a chamber in which the movable carriage, valve member and associated mechanism is carried, said chamber being in open

communication with the casing for providing the pressurized atmosphere of the casing in balanced relation against the internal parts of the valve mechanism.

10. The gas lift valve defined in claim **5**, in which the valve mechanisms are carried in the annular space between the tubing and the casing, with the internal parts of the valve mechanism being exposed to the atmosphere in said annular space.

11. A gas lift valve system for use with oil and gas wells and the like, including a casing defining the well and tubng mounted concentrically within said casing, in combination, a gas lift valve attached to said tubing in an operative position thereon, and a venturi within the tubing at a position above said lift valve, with the venturi containing a restricted area and a flared conical region above the restricted area providing a gradually increasing cross-sectional area until the main tubing area is reached, said gas lift valve comprising walls defining a passage extending through said tubing, a valve seat within said passage, a valve member mounted for axial movement between an opened and closed position in said seat, a carriage mounted for reciprocating axial movement in the same direction as said valve member and carrying the valve member thereon, said valve member being mounted on the carriage for limited axial movement with respect to the carriage whereby the carriage can move toward an open position while the valve member is seated in the closed position and allow a quick opening of the valve at a given operative opening position of the carriage, valve closing means operatively connected to said carriage for urging the carriage and valve member toward the closed position, said valve closing means containing a movable element adapted to move axially with respect to the valve seat in response to the difference in pressure on each side of said element, means for providing a substantially constant predetermined pressure on the side of said movable element of the valve closing means operative to urge the carriage and valve member toward the closed position, valve opening means operatively connected to said carriage and constructed for urging the carriage and valve member toward the open position, said valve opening means containing a movable element adapted to move axially with respect to the valve seat in response to the

difference in pressure on each side of said element, said element of the valve closing means and said element of the valve opening means having opposing sides in the same fluid atmosphere whereby the pressure of the operating atmosphere is balanced and does not effect movement of the valve member, and means for providing communication of the fluid pressure within the tubing against the other side of the element of the valve closing means whereby the fluid pressure within the tubing is opposed to the fixed fluid pressure provided in the valve closing means.

12. The gas lift valve defined in claim **11**, in which the valve closing means is in the form of a bellows, with the movable element thereof being a movable end of the bellows and having connecting means attached between it and the carriage, and the opposite end of said bellows being anchored and in communication with a chamber carrying a substantially fixed pressure of fluid, and said valve opening means being in the form of a bellows with the movable element thereof having means for connection to said carriage and containing a chamber which is in fluid communication to the inside of the tubing.

13. The gas lift valve defined in claim **11**, in which a spring is provided for urging the valve member toward the open position and effecting the quick opening movement, and in which the valve member is equipped with a conical tip for providing self-alignment in the valve seat on closure thereof.

14. The gas lift valve defined in claim **11**, in which a ball check valve is provided in said passage.

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