

Dec. 26, 1939.

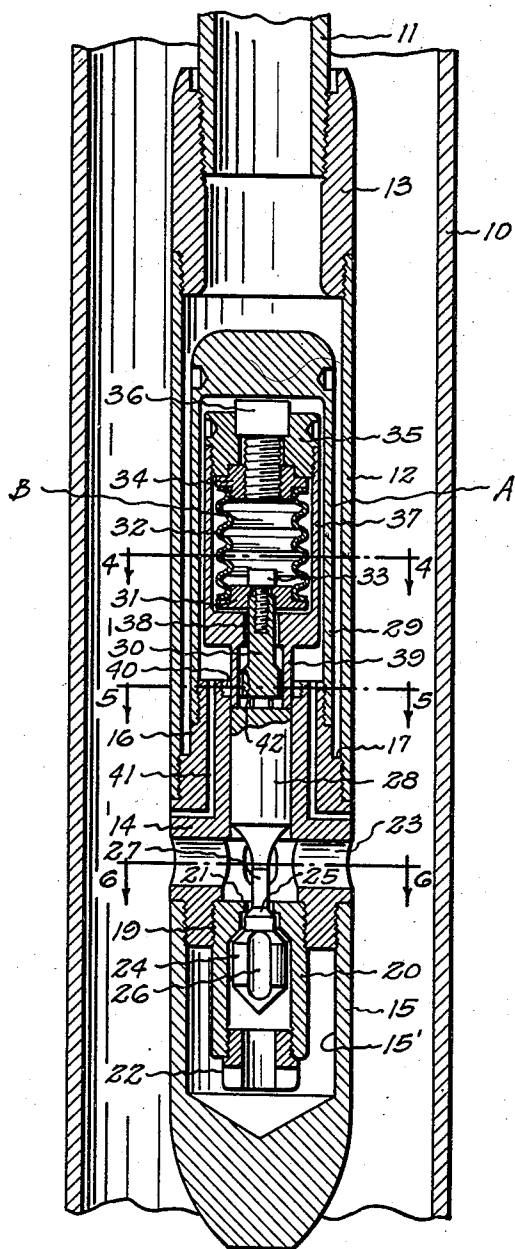
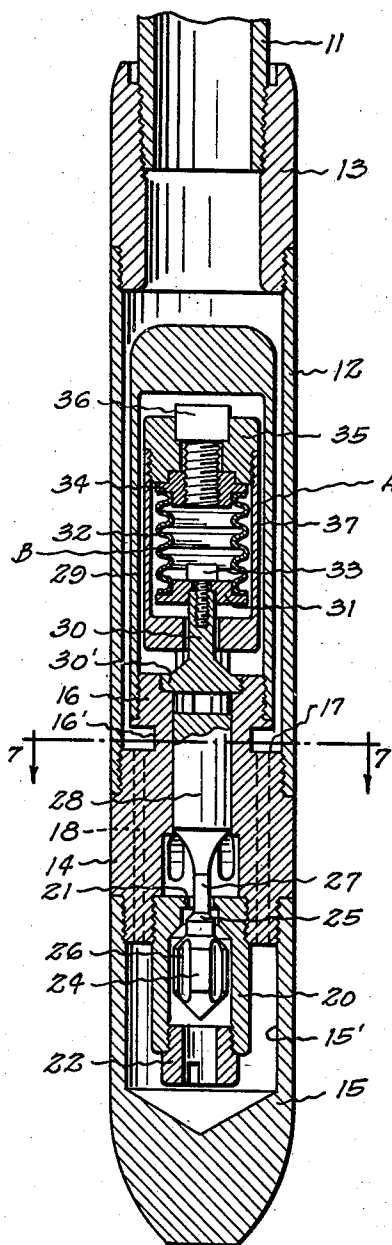
C. S. CRICKMER ET AL

2,184,636

WELL FLOWING DEVICE

Filed July 22, 1938

2 Sheets-Sheet 1



Inventors
Charles S. Crickmer
Hans C. Glitsch

Jack Ashley
Attorney

Dec. 26, 1939.

C. S. CRICKMER ET AL

2,184,636

WELL FLOWING DEVICE

Filed July 22, 1938

2 Sheets-Sheet 2

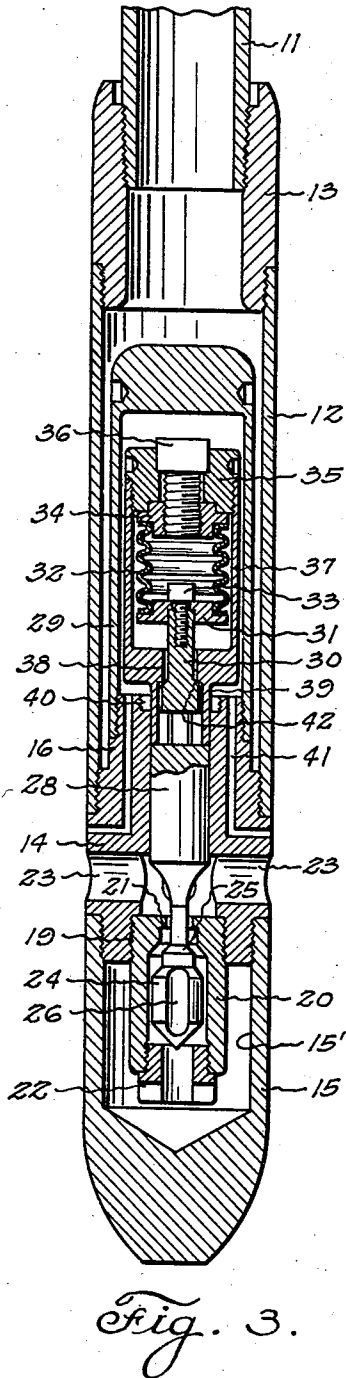
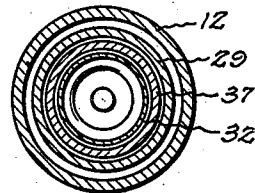


Fig. 4.

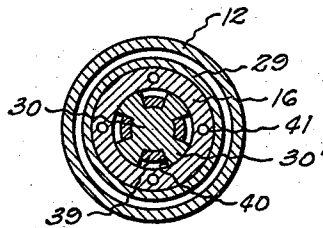


Fig. 5.

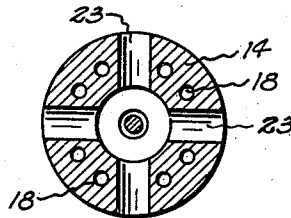


Fig. 6.

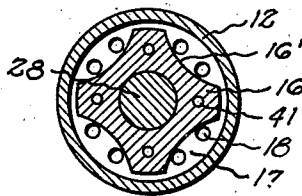


Fig. 7.

Inventors
Charles S. Crickmer
Hans C. Glitsch

Jack K. Kline
Attorney

UNITED STATES PATENT OFFICE

2,184,636

WELL FLOWING DEVICE

Charles S. Crickmer and Hans C. Glitsch, Dallas,
Tex., assignors to Merla Tool Company, Dallas,
Tex., a firm of Texas

Application July 22, 1938, Serial No. 220,608

11 Claims. (Cl. 103—232)

This invention relates to new and useful improvements in well flowing devices.

One object of the invention is to provide an improved means for lifting well liquids by means of an auxiliary lifting medium, such as gas or air.

An important object of the invention is to provide an improved well flowing device which is adapted to be connected in the tubing string and which is arranged to control the flow of a lifting medium from the tubing to the well liquid column in the well casing; the device being actuated by the differential in pressure between the well liquid and the lifting means and being constructed so that a low well liquid pressure will operate the same, whereby the liquid pressure need not exceed the lifting medium pressure at any time which makes the invention particularly adaptable for use on wells having a comparatively low standing liquid level and a resultant low pressure.

A particular object of the invention is to provide an improved well flowing device which includes a depressible pressure responsive means for actuating a gas admitting valve and being arranged so as to automatically and intermittently admit the lifting gas to the well liquid column, the admittance of the gas occurring when the well liquid pressure reaches a predetermined proportion of the pressure of the lifting gas, whereby said liquid pressure need not equal or exceed the gas pressure before the device is operated.

Another object of the invention is to provide an improved well flowing device for controlling the admittance of a lifting gas into the liquid column, wherein a depressible bellows, which is exposed to the pressure of the well liquid, is employed to control the gas admitting valve, together with means for preventing collapse of the bellows in the event the liquid pressure should build up in excess of the pressure which the bellows is capable of withstanding, whereby danger of rendering the device inoperative through destruction of the bellows by excess pressure is obviated.

A further object of the invention is to provide an improved device for controlling the admittance of a lifting gas to a liquid column which includes a valve member exposed to the gas pressure and a bellows having connection with the valve member and having a greater cross-sectional area than said member, the bellows being exposed to the liquid pressure, whereby the valve member is unseated to admit gas to the liquid column when the pressure of the liquid reaches a predetermined proportion of the pressure of the gas; the con-

nection between the bellows and valve member being such that said member may act as a check to prevent reverse flow of the well liquid into the gas conductor in the event the liquid pressure exceeds the gas pressure.

A construction designed to carry out the invention will be hereinafter described, together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, in which an example of the invention is shown, and wherein:

Figure 1 is a transverse, vertical, sectional view of a flow device, constructed in accordance with the invention, with the valve thereof in a closed position,

Figure 2 is a similar view, with the valve in a partially open position,

Figure 3 is a similar view with the valve in a completely open position,

Figure 4 is a horizontal, cross-sectional view taken on the line 4—4 of Figure 1,

Figure 5 is a horizontal, cross-sectional view taken on the line 5—5 of Figure 1,

Figure 6 is a horizontal, cross-sectional view taken on the line 6—6 of Figure 1, and

Figure 7 is a horizontal, cross-sectional view taken on the line 7—7 of Figure 2.

Reference is made to our co-pending application, filed November 11, 1937, Serial No. 173,305, which, while relating to the same subject matter, discloses a different and separate invention.

In the drawings, the numeral 10 designates the well casing of an oil well and the usual well tubing 11 extends axially therethrough. The lower end of the casing is open and the well liquid from the producing area enters said casing and rises to a level therein, which level varies with the particular conditions of the well. The lower end of the well tubing is preferably below the normal standing liquid level of the well and has a flow device A connected thereto. As will be explained, a lifting medium, such as gas or air is introduced into the tubing 11 and flows downwardly therethrough. The flow device A controls the admittance of this lifting medium into the liquid column standing in the well casing.

It is pointed out that the flow device A may be termed an intermitter as it is adapted to intermittently admit gas, as needed, to the liquid column. The conditions of the well may be such that a period of time is required for the well liquid to build up to a normal standing level and the device A is arranged to be actuated by the

differential in pressures between the gas in the tubing and the liquid in the casing, as will be explained, whereby a predetermined liquid level is necessary before gas is admitted to the liquid column to raise the same. After the column is raised, the device A shuts off the gas and the liquid level must again build up before the gas is again admitted. Since the device A is adapted to be connected to the lower end of the tubing 11, the same may be employed in wells having a relatively low liquid level.

The flow device A includes an elongate housing which comprises a sleeve 12 having its upper end internally screw-threaded, whereby it may be connected to a coupling collar 13 which is attached to the lower end of the well tubing 11. The lower end of the sleeve is threaded onto a nipple 14 and a hollow plug 15 depends from the nipple, having threaded connection therewith. The lower end of the plug is gradually reduced or tapered inwardly, whereby it acts as a guide during the lowering thereof through the well casing 10.

The nipple 14 has its upper portion reduced at 16 so as to form an external, annular shoulder 17. Vertical ports 18 are provided in the nipple and extend from the shoulder 17 to the bottom of the nipple. The reduced portion 16 of the nipple adjacent the ports 18 is cut away as shown at 16' in Figures 2 and 7, whereby an unobstructed flow from the tubing 11 and sleeve 12 and downwardly through the ports may be had. Since the ports extend entirely through the nipple, it will be seen that a flow through said ports will enter the hollow plug 15.

The lifting medium, which may be gas or air, is introduced into the well tubing and flows therethrough into the sleeve 12, from where it passes downwardly through the ports into the bore 15' of the plug 15 below the nipple. The nipple is formed with an axial bore 19 which extends vertically therethrough and an annular valve cage 20 is threaded into the lower end of this bore. The cage depends into the bore of the plug 15 and has an internal, annular valve seat 21 at its upper end. A bored cap nut 22 is threaded into the lower end of the cage.

Above the valve cage 20, the nipple is formed with a plurality of radial ports 23 which are spaced equally around the nipple, preferably being located diametrically opposite each other. As is clearly shown in Figures 1 and 6, the ports establish a communication between the bore 19 of the nipple and the exterior of said nipple. With such arrangement, the lifting gas or air which flows downwardly through the tubing 11, sleeve 12, ports 18 in the nipple, and into the bore 15' of the plug 15, travels upwardly through the valve cage 20 and the bore 19 of the nipple and then escapes through the radial ports 23 into the interior of the well casing 10.

For controlling the flow of gas past the valve seat 21, a cylindrical valve head 24 is confined within the cage between the nut 22 and valve seat 21. The head has a conical lower end which is arranged to seat on the nut 22 and its upper end is reduced and formed with an annular inclined shoulder 25, which shoulder is adapted to engage the seat 21 to prevent upward flow thereby. Vertical grooves or channels 26 are provided in the sides of the head 24 and permit an unobstructed flow past the head when the same is unseated. An axial stem 27 is made integral with the upper end of the head and extends upwardly therefrom. The upper end of the stem is secured

to the lower end of a piston 28 which is mounted to reciprocate within the upper portion of the bore 19 of the nipple above the radial ports 23. If desired, the lower end of the piston may be gradually reduced or tapered inwardly to the size of the stem, as shown in Figure 1.

When the piston 28 is in its uppermost position (Figure 1), its upper end is spaced from the top of the nipple 14 and the valve head 24 is engaging the seat 21, whereby a flow of gas from the tubing 11 to the casing 10 is prevented. When the piston moves downwardly, the valve head is unseated and gas from the tubing 11 may flow through the sleeve 12, ports 18, plug 15, valve cage 20, past the seat 21 and finally through the ports 23 into the well casing. Any liquid standing in the casing will be aerated and thus lifted to the surface. When the valve head 24 is in its seated position, it is manifest that the pressure of the lifting gas in the tubing, sleeve 12 and plug 15 is acting against the bottom of said head, thereby holding it in such seated position.

For unseating the valve head 24 when the liquid pressure in the well casing reaches a predetermined point, a bellows assembly B is disposed within the sleeve 12 above the nipple. This assembly is housed within a tubular jacket 29 which has its lower end threaded onto the reduced upper portion 16 of the nipple. The upper end of the jacket is closed, whereby the assembly B is not exposed to and is protected from the pressure of the lifting gas which passes through the sleeve 12. The bellows assembly includes an upright post 30 which has an enlarged base 30' and this base is externally threaded so that it may be screwed into the upper end of the bore 19 of the nipple. The base plate 31 of a depressible bellows 32 is fastened to the upper end of the post 30 by a headed screw 33, while the top plate 34 of said bellows is secured to the underside of a cap 35 by a screw 36. The cap is threaded into the upper end of a tubular housing 37 which surrounds the bellows 32. The bellows 32 is preferably constructed of a thin metal which has an inherent resiliency and when manufactured the bellows is constructed to resist a predetermined pressure. Although the bellows is preferably metallic, it could be made of other suitable material. The bottom of the housing has an axial opening 38 through which the upright post 30 extends and a plurality of lugs 39, which are preferably made integral with said bottom, depend therefrom. The lugs pass through radial slots 40 in the post 30 and its base and project into the bore 19 of the nipple, the extreme lower ends of said lugs engaging the top of the piston 28 which is movable within the bore 19.

It will be seen that the housing 37 is carried by the bellows 32 which is normally in an expanded position, as shown in Figure 1. The lower end of the bellows is fixed, being secured to the stationary post 30, and therefore, when a sufficient pressure is applied to the top of the housing 37 to depress the bellows, the housing moves downwardly with relation to the nipple, with the result that the depending lugs 39, which are in engagement with the piston 28, move said piston downwardly in the bore. Downward movement of the piston will unseat the valve, as explained. Manifestly, to unseat the valve head 24 which has the gas pressure acting thereagainst, it is necessary to overcome this gas pressure, as well as the inherent resistance of the bellows and, thus, the bellows is added to the gas pressure to resist opening of the valve. By varying the tension or resistance of the

bellows to depression, it is possible to vary the pressure which must be applied to the top of the housing and bellows to unseat said valve head.

For exposing the bellows 32 to the pressure of the liquid in the well casing 10, the nipple 14 is provided with a plurality of angular passages 41 which lead from the exterior of the nipple to the upper end thereof, whereby a communication between the well casing and the interior of the jacket 29 is established. The passages are located in vertical alinement with the radial gas outlet ports 23, which disposes said passages between the vertical ports 18 in said nipple (Figure 7). The liquid from the well casing may enter the interior of the jacket and may also flow past the depending lugs 39 and upwardly through the opening 38 in the housing 37 around the upright post 30, whereby it may enter the housing 37.

In operation, with the bellows expanded and the housing in a raised position, the liquid completely surrounds the bellows 32 and housing 37 and exerts its pressure thereon. Since the lower plate 31 of the bellows is fixed, it is manifest that the cross-sectional area of the bellows is the effective area on which the pressure is acting. Movement of the bellows is resisted at this time by the inherent tension of the bellows plus the pressure of the lifting gas which is acting against the housing 37 through the valve head 24 and piston 28.

The effective cross-sectional area of the bellows is much greater than the effective cross-sectional area of the valve head, on which the gas pressure is acting and, therefore, the liquid pressure need only be a predetermined proportion of the gas pressure in order to overcome the latter and move the valve head against such pressure. For example, assuming that the effective cross-sectional area of the bellows is four times as large as the effective cross-sectional area of the valve head, with the gas pressure at 200 pounds, it will be manifest that when the liquid pressure reaches 50 pounds, or one fourth of the gas pressure, the valve head is moved against the gas pressure. Of course, the resistance of the bellows must be overcome in addition to the gas pressure and the above figures are merely given for purposes of illustration, with no intention to limit the operation to such conditions. The bellows 32 may be readily removed and another bellows having a different resistance substituted therefor, in which instance the operating pressures would be changed to fit different well conditions.

From the foregoing, it will be seen that as soon as the pressure of the liquid acting against the upper end of the bellows reaches a predetermined proportion of the gas pressure, the bellows 32 is depressed with the result that the housing 37 attached to the upper plate 34 of said bellows is moved downwardly. Downward movement of the housing causes the depending lugs 39 to engage the top of the piston 28 and push the same downwardly in the bore 19 of the nipple 14, whereby the valve head 24 secured to the piston is moved off its seat 21. When the valve is unseated, the lifting gas from the tubing 11 may flow through the ports 23 into the liquid column in the well casing to aerate said column and lift the liquid to the surface.

If the liquid pressure acting against the bellows continues to build up, the bellows 32 is depressed until the bottom of the housing 37 strikes an external annular seat 42 formed on the stationary post 30 which extends upwardly from the nipple 14. When this occurs, further depression of the bellows is prevented and also the opening 38 in the

bottom of the housing is closed by the seat (Figure 3), whereby the liquid pressure cannot enter the housing 37 and the exterior of the bellows is no longer exposed to the liquid pressure. With this arrangement, all danger of rupturing or collapsing the bellows by excessive pressure is obviated.

As the liquid column is aerated, it begins its upward movement in the well casing and this movement results in a drop of pressure in the casing. As the liquid moves faster due to more gas being admitted, a suction is created on the passages 41 which tends to draw liquid from the chamber formed by the jacket 29 surrounding the bellows assembly, whereby a further reduction in pressure within said chamber occurs. When the pressure in this chamber drops below the predetermined or critical point, the gas acting against the valve head 24 and the tension of the bellows immediately returns the head 24, piston 28, housing 37 and bellows to the position shown in Figure 1. In such position, the valve head is seated and admission of gas to the well casing is cut off. The parts remain in this position until the liquid pressure again builds up to the necessary proportion of the gas pressure, at which time the valve head is unseated to again admit gas and repeat the operation, as described.

It is pointed out that the piston 28 is unconnected with the lugs 39 of the housing and is capable of an independent movement, whereby in the event that the liquid pressure exceeds the gas pressure, said liquid pressure acting against the valve head 24 through the ports 23 may force the head and piston downwardly. This may occur irrespective of whether or not the bellows 32 is operating. When the liquid pressure exceeds the gas pressure, it moves the valve head 24 downwardly and causes the conical lower end thereof to engage the top of the nut 22 which is threaded into the valve cage 20, whereby the bore of said nut is closed. The valve head thus acts as a check to prevent the liquid in the casing from flowing into the tubing.

The flow device is positive in its operation and is particularly adapted for use in wells having a comparatively low standing liquid level as only a relatively small liquid pressure is necessary to operate the valve against high gas pressures. The bellows assembly is such that when the pressure to which it is exposed builds up to a predetermined point, the pressure against the exterior of the bellows is shut off, thereby preventing rupturing or collapsing of the bellows. Although the device A has been shown as connected to the lower end of a well tubing 11, it is obvious that the same may be connected at any point in said tubing string; also, any desired number of devices, located at spaced points in the tubing string in the usual manner, may be employed.

The foregoing description of the invention is 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.

What we claim and desire to secure by Letters Patent is:

1. A flow device including, a well tubing, a tubular body adapted to be connected in the tubing string and having a passage for establishing communication between the interior and exterior of the tubing, means in the passage for controlling the admittance of a lifting fluid into the well liquid and exposed to the lifting fluid pressure, pres-

sure responsive means having connection with the control means and normally exposed to the pressure of the well liquid, whereby said control means is moved by a predetermined differential in the pressure of the lifting fluid and well liquid, and means for relieving the pressure responsive means of the well liquid pressure when said pressure reaches a predetermined point, whereby damage to said means by excessive pressure is obviated.

2. A well flow device including, a well tubing, a tubular body adapted to be connected in the tubing string and having a passage for establishing communication between the interior and exterior of the tubing, a valve for controlling the flow of a lifting fluid through said passage into the well liquid column and exposed to the lifting fluid pressure, pressure responsive means having connection with said valve and normally exposed to the pressure of the well liquid, said pressure responsive means being of a different cross-sectional area than the valve whereby said means and valve are moved by a predetermined differential in such pressure to control the flow through the passage, and means for relieving the pressure responsive of the well liquid pressure when said pressure reaches a predetermined point, whereby damage to said means by an excessive pressure is obviated.

3. A well flow device including, a well tubing, a tubular body adapted to be connected in the tubing string and having a passage for establishing communication between the interior and exterior of the tubing, a valve for controlling the flow of a lifting fluid through said passage into the well liquid column and exposed to the lifting fluid pressure, pressure responsive means having connection with said valve and normally exposed to the pressure of the well liquid, said pressure responsive means being of a different cross-sectional area than the valve whereby said means and valve are moved by a predetermined differential in such pressure to control the flow through the passage, and means actuated by a predetermined well liquid pressure for cutting off the application of the well liquid pressure to the pressure responsive means to prevent damage thereto by an excessive pressure.

4. A flow device including, a well tubing, a tubular body adapted to be connected in the tubing string and having a passage for establishing communication between the interior and exterior of the tubing, means in the passage for controlling the admittance of a lifting fluid into the well liquid and exposed to the lifting fluid pressure, pressure responsive means having connection with the control means and normally exposed to the pressure of the well liquid, whereby said control means is moved by a predetermined differential in the pressure of the lifting fluid and well liquid, and means actuated by a predetermined well liquid pressure for cutting off the application of the well liquid pressure to the pressure responsive means to prevent damage thereto by an excessive pressure.

5. A flow device including, a well tubing, a tubular body adapted to be connected in the tubing string and having a passage for establishing communication between the interior and exterior of the tubing, means in the passage for controlling the admittance of a lifting fluid into the well liquid and exposed to the lifting fluid pressure, depressible bellows having connection with the control means and normally exposed to the pressure of the well liquid, whereby said control means is moved by a predetermined differential in

the pressure of the lifting fluid and well liquid, and means for relieving the depressible bellows of the well liquid pressure when said pressure reaches a predetermined point, whereby damage to said bellows by excessive pressure is obviated.

6. A well flow device including, a well tubing, a tubular body adapted to be connected in the tubing string and having a passage for establishing communication between the interior and exterior of the tubing, a valve for controlling the flow of a lifting fluid through said passage into the well liquid column and exposed to the pressure of the lifting fluid, a depressible bellows having connection with said valve and normally exposed to the pressure of the well liquid, said bellows being of a different cross-sectional area than the valve whereby said bellows and valve are moved by a predetermined differential in the pressure of the lifting fluid and well liquid to control the flow through the passage, and means for removing the application of the well liquid pressure to the bellows when said pressure becomes excessive to prevent damage to said bellows.

7. A well flow device including, a well tubing, a tubular body adapted to be connected in the tubing string and having a passage for establishing communication between the interior and exterior of the tubing, a valve for controlling the flow of a lifting fluid through said passage into the well liquid column and exposed to the pressure of the lifting fluid, a depressible bellows having connection with said valve and normally exposed to the pressure of the well liquid, said bellows being of a different cross-sectional area than the valve whereby said bellows and valve are moved by a predetermined differential in the pressure of the lifting fluid and well liquid to control the flow through the passage, and a housing surrounding the bellows and movable by the well liquid pressure and arranged to completely enclose said bellows when the well liquid pressure reaches a predetermined point, whereby said bellows is protected from excessive pressure.

8. A well flow device including, a well tubing, a tubular body arranged to be connected in the well tubing and lowered therewith into a well casing and having a passage for establishing communication between the tubing and casing, means for supplying a lifting fluid under pressure to the tubing, a valve for controlling the flow of lifting fluid from the tubing to the well liquid column in the well casing and exposed to the pressure of said lifting fluid, a depressible bellows above the valve normally exposed to the well liquid pressure, means secured to and movable with the bellows and having connection with the valve whereby movement of said valve is controlled by the differential in pressure of the lifting fluid and well liquid, and means coacting with the movable means for shutting off the well liquid pressure to the bellows when said pressure exceeds a predetermined point.

9. A well flow device including, a well tubing, a tubular body arranged to be connected in the well tubing and lowered therewith into a well casing and having a passage for establishing communication between the tubing and casing, means for supplying a lifting fluid under pressure to the tubing, a valve for controlling the flow of lifting fluid from the tubing to the well liquid column in the well casing and exposed to the pressure of said lifting fluid, a depressible bellows above the valve normally exposed to the well liquid pressure, a housing surrounding the bellows and se-

cured thereto and having an inlet opening therein to permit the well liquid pressure to act on the exterior of the bellows, said housing having connection with the valve whereby movement of the valve is controlled by the differential in pressures acting on the bellows and on the valve, and means for closing the inlet opening of the housing when said housing has moved a predetermined amount, whereby the well liquid pressure to the bellows is cut off when said well liquid pressure exceeds a predetermined point.

10. A well flow device including, a well tubing, a tubular body arranged to be connected in the well tubing and lowered therewith into a well casing and having a passage for establishing communication between the tubing and casing, means for supplying a lifting fluid under pressure to the tubing, a valve for controlling the flow of lifting fluid from the tubing to the well liquid column in the well casing and exposed to the pressure of said lifting fluid, a depressible bellows above the valve normally exposed to the well liquid pressure, means secured to and movable with the bellows and having connection with the valve whereby movement of said valve is controlled by the differential in pressures of the lifting fluid and well liquid, and means coacting with the movable means for shutting off the well liquid pressure to the bellows when said pressure exceeds a predetermined point, the connection between the valve and said movable means being such that said valve is capable of independent movement, whereby in the event that the well liquid pressure exceeds that of the lifting fluid

pressure, the valve is moved to act as a check and prevent back flow through the passage.

11. A well flow device including, a well tubing, a tubular body arranged to be connected in the well tubing and lowered therewith into a well casing and having a passage for establishing communication between the tubing and casing, means for supplying a lifting fluid under pressure to the tubing, a valve for controlling the flow of lifting fluid from the tubing to the well liquid column in the well casing and exposed to the pressure of said lifting fluid, a depressible bellows above the valve normally exposed to the well liquid pressure, a housing surrounding the bellows and secured thereto and having an inlet opening therein to permit the well liquid pressure to act on the exterior of the bellows, said housing having connection with the valve whereby movement of the valve is controlled by the differential in pressures acting on the bellows and on the valve, and means for closing the inlet opening of the housing when said housing has moved a predetermined amount, whereby the well liquid pressure to the bellows is cut off when said well liquid pressure exceeds a predetermined point, the connection between the valve and said housing being such that said valve is capable of independent movement, whereby in the event that the well liquid pressure exceeds that of the lifting fluid pressure, the valve is moved to act as a check and prevent back flow through the passage.

CHARLES S. CRICKMER.
HANS C. GLITSCH.