June 11, 1940. H. C. GLITSCH ET AL 2,203,957

FLOW VALVE

Filed April 26, 1937 3 Sheets-Sheet 1

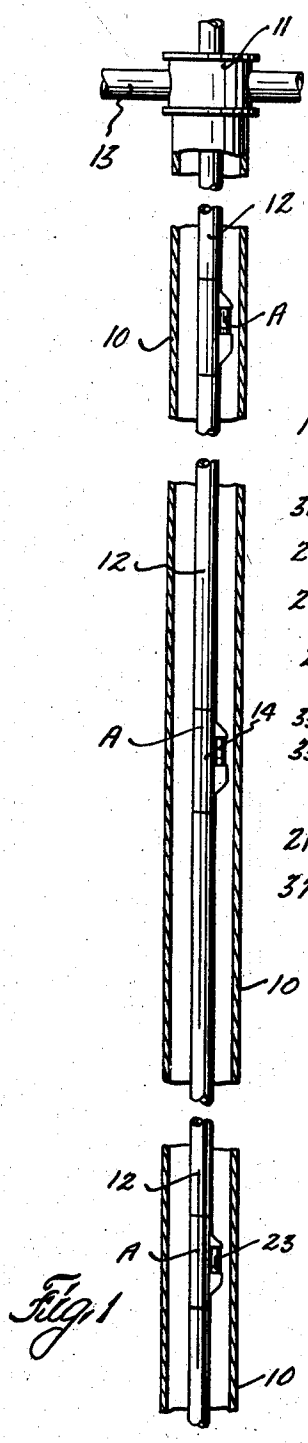


Fig. 1

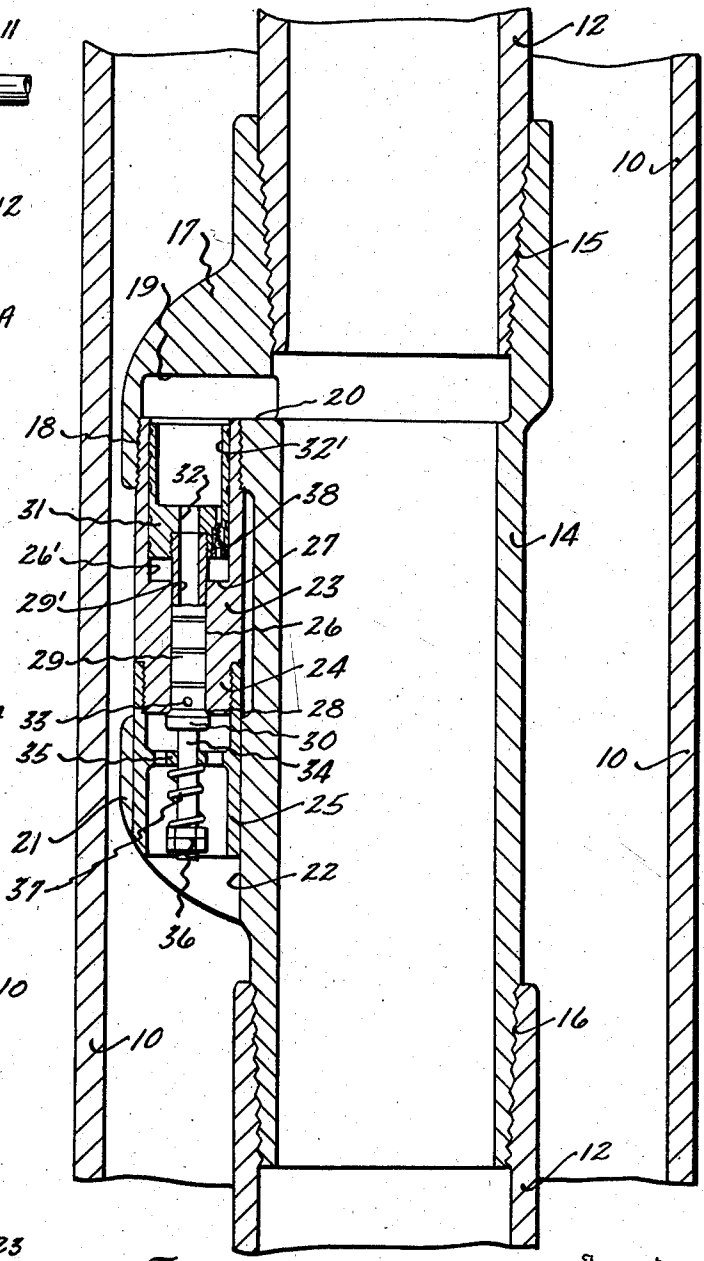


Fig. 2

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FLOW VALVE

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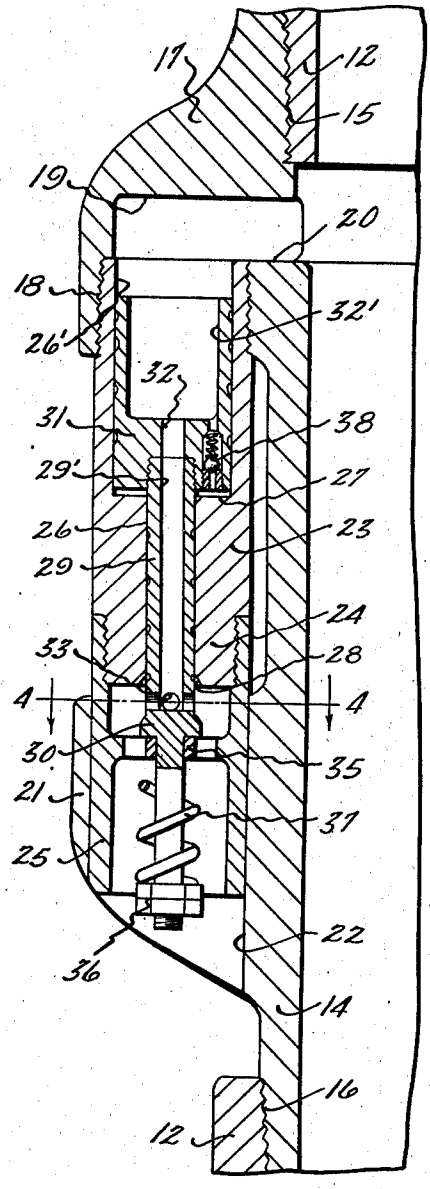


Fig. 3

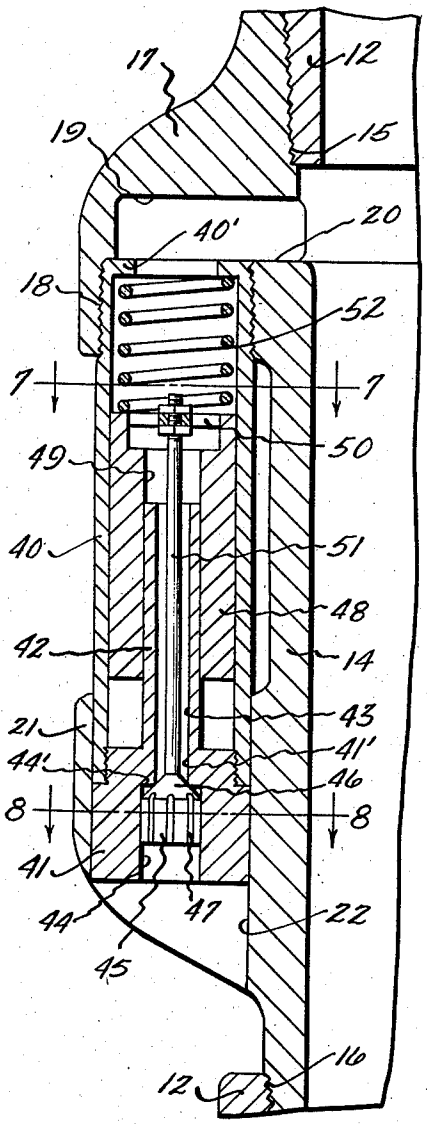


Fig. 5

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FLOW VALVE

Filed April 26, 1937 3 Sheets-Sheet 3

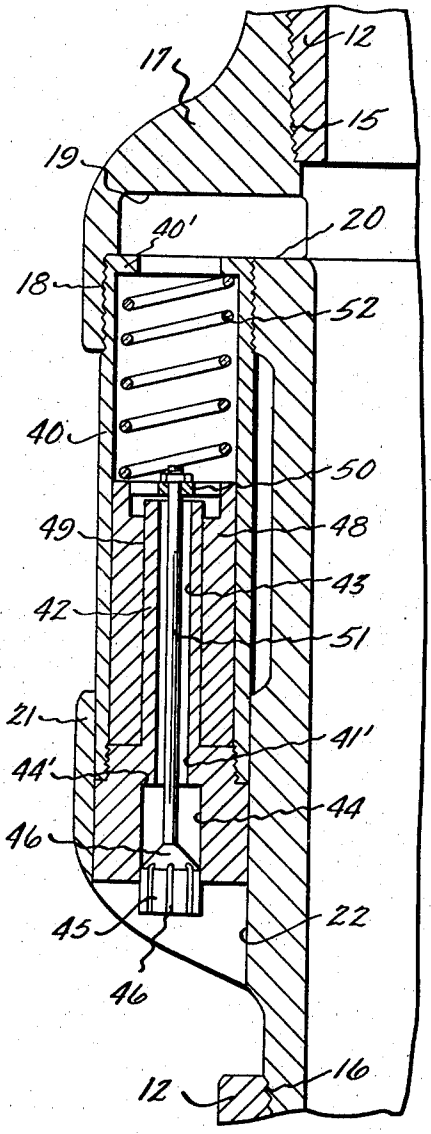


Fig. 6

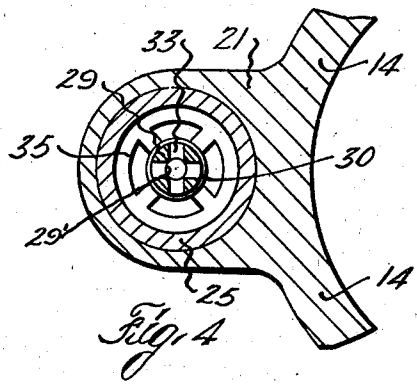


Fig. 4

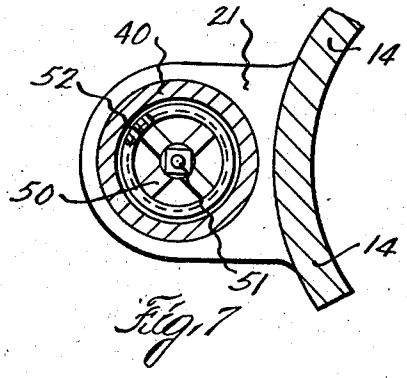


Fig. 7

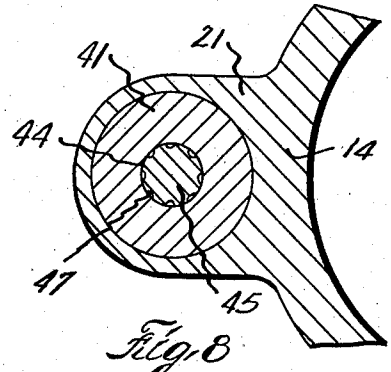


Fig. 8

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Patented June 11, 1940 2,203,957

UNITED STATES PATENT OFFICE

2,203,957

FLOW VALVE

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Application April 26, 1937, Serial No. 138,920

16 Claims. (Cl. 103—232)

This invention relates to new and useful improvements in flow valves.

One object of the invention is to provide an improved valve for controlling the admission of a lifting fluid into a well tubing to raise the liquid in said tubing to the surface, said valve being automatic in its operation.

An important object of the invention is to provide an improved flow valve including a plunger for controlling the admission of lifting fluid to the well tubing, said plunger having one side exposed to the lifting fluid pressure and its opposite side exposed to the pressure of the well liquid, whereby the plunger is operated by the differential in said pressures.

Another object of the invention is to provide an improved flow valve having a plunger which has one end of larger cross-sectional area than the opposite end, the greater area being exposed to the well liquid while the smaller area is exposed to the lifting fluid, whereby the pressure of lifting fluid must be several times greater than the pressure of the liquid before the plunger is moved, which makes the valve particularly adaptable for use in low pressure wells and assures that the lifting fluid can lift the column of liquid built up.

A further object of the invention is to provide an improved plunger for controlling the admission of a lifting fluid into a well tubing to lift the liquid, said plunger being tubular to provide a passage for the flow of incoming fluid, whereby the velocity of the admitted fluid acts directly on said plunger to aid in moving it to its closed position.

Still another object of the invention is to provide an improved plunger of the character described, the actuation of the plunger being controlled by the differential in the pressure of the lifting fluid and the pressure of the well liquid, with auxiliary resilient means capable of adjustment for positively actuating said plunger when a predetermined pressure differential is reached.

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 view partly in elevation and partly in section showing a plurality of flow valves, constructed in accordance with the invention connected in a well tubing,

Figure 2 is a transverse vertical sectional view taken through the flow valve and showing the same in its closed position,

Figure 3 is a similar view showing the valve in its open position,

Figure 4 is a horizontal cross-sectional view taken on the line 4—4 of Figure 3,

Figure 5 is a view similar to Figure 3 showing another form of the invention in a closed position,

Figure 6 is a view similar to Figure 5, with the valve open to permit admission of a lifting fluid into the well tubing,

Figure 7 is a horizontal cross-sectional view taken on the line 7—7 of Figure 5, and

Figure 8 is a horizontal, cross-sectional view, taken on the line 8—8 of Figure 5.

In the drawings, the numeral 10 designates a well casing which is provided with the usual casing head 11 at its upper end. The well tubing 12 extends axially through the well casing in the usual manner and connected therein at predetermined points, are a plurality of flow valves A. A lifting fluid such as gas or air is admitted to the well casing through an inlet pipe 13 which connects in the casing head 11 and manifestly, said lifting fluid fills the annular space between the casing and the tubing. Each flow valve assembly is arranged to admit the lifting fluid from the annular space into the tubing in order to lift the well liquid which rises in said tubing. The position of the valves A in the well tubing is, of course, dependent upon the particular condition of the well.

Each valve assembly A includes an elongate sleeve 14 which has its upper end internally threaded at 15, whereby it may be connected into the tubing string. The lower end of the sleeve 14 is provided with external screw-threads 16 which threads receive the upper end of a section of the tubing 12. A radially extending boss 17 is preferably formed integral with the upper end of the sleeve 14 at one side thereof and said boss is provided with an internally screw-threaded bore 18 at its lower end. A recess or chamber 19 is formed within the boss above the bore 18 and this recess communicates through a radial port 20 with the interior of the sleeve 14 and therefore, with the interior of the well tubing 12. A similar boss 21 is provided near the lower end of the sleeve 14 being located in vertical alinement with the boss 17. The boss 21 is provided with a vertical opening 22 which is substantially the same diameter as the bore 18.

A cylinder 23 has its upper end screw-threaded into the bore 18 of the boss 17 and when so connected in the boss the upper end of said cylinder

terminates in horizontal alinement with the bottom of the port 20. The lower end of the cylinder 23 is formed with a reduced externally screw-threaded nipple 24, on which an elongate collar or sleeve 25 is threaded. It is pointed out that the external diameter of the collar 25 is substantially the same as the external diameter of the cylinder 23, whereby said collar forms a continuation of the cylinder. The collar is inserted into the opening 22 in the lower boss 21 and preferably has a snug fit therein. Obviously, the collar 25 serves to brace and support the lower end of the cylinder 23. It is pointed out that said collar could be made integral with said cylinder, but for purposes of assembly and dis-assembly, it is preferable to make the two parts separate.

The cylinder 23 is formed with an axial bore 26 which extends from the lower end of said cylinder to a point substantially mid-height thereof. The upper end of the bore 26 is enlarged as shown at 26' whereby an internal annular shoulder 27 is formed within the cylinder 23. The extreme lower end of the bore 26 is provided with an annular bevel or seat 28, as is clearly shown in Figures 2 and 3.

A plunger or piston 29 has a sliding fit within the bore 26 of the cylinder 23 and is formed with a head 30 at its lower end. When the plunger is in a raised position within the cylinder, as shown in Figure 2, the head 30 is arranged to engage the seat 28 at the lower end of the bore 26, whereby a flow of fluid from the annular space between the casing 10 and tubing 12 through the collar 25 and bore 26, is prevented. The upper end of the plunger 29 is externally screw-threaded and a piston 31 is connected thereto. The piston is slidable vertically in the enlarged portion 26' of the bore of the cylinder and said piston has an axial bore 32 into which the upper end of the plunger 29 is threaded. The bore 32 of the piston is enlarged as shown at 32', whereby an upstanding collar or flange is, in effect, provided at the upper end of said piston.

The plunger 29 is provided with an axial bore 29' which is substantially of the same diameter as the bore 32 of the piston, whereby it forms a continuation of said bore. The bore 29' extends from the upper end of the plunger to a point just above the head 30 at the lower end of said plunger. Radial ports 33 located above the head 30 extend inwardly through the wall of the plunger 29 and communicate with the lower end of the axial bore 29' of said plunger. By observing Figure 2, it will be seen that when the plunger is in its raised position the ports 33 are within the lower end of the bore 26 of the cylinder and therefore the lifting fluid such as gas or air which is present in the annular space between the casing 10 and the tubing 12 cannot flow into the ports 33. However, when the plunger 29 is moved to its lower position as shown in Figure 3, the ports 33 are moved out of the bore 26 of the cylinder 23 and into the elongate collar 25. When in this position the lifting fluid may enter the ports 33 and flow upwardly through the bore 29' of the plunger, then through the bores 32 and 32' of the piston 31, after which it may enter the chamber 19 and flow through the port 20 into the interior of the well tubing 12. Thus, the position of the plunger positively controls the admission of the lifting fluid to the interior of the tubing.

For guiding the plunger 29 in its vertical movement within the cylinder 23, a depending stem 34 is preferably made integral with the head 30 of the plunger 29. This stem extends through a spider 35 which is disposed transversely within the interior of the elongate collar 25. The extreme lower end of the stem 34 is screw-threaded to receive a pair of nuts 36 and a coiled spring 37 is interposed between the spider 35 and the nuts 36. This spring surrounds the stem and exerts its pressure to constantly urge the plunger 29 and piston 31 downwardly within the cylinder 23. The tension on the spring 37 may of course, be varied by merely adjusting the nuts 36 on said stem.

Assuming the parts to be in the position shown in Figure 2 with the annular space between the well casing 10 and the tubing 12 filled with the lifting fluid such as gas or air, and with no well liquid within the tubing 12, it will be manifest that the lifting fluid will act upon the cross-sectional area of the head 30 of the plunger 29, to hold the plunger and the piston 31 connected therewith in its raised position against the tension of the coiled spring 37. The parts will remain in this position until such time as the well liquid builds up in the tubing to a point above the port 20. The pressure of this liquid within the tubing is of course exerted on the upper end of the piston 31 through the port 20 and chamber 19. Since the cross-sectional area of the piston 31 is greater than the cross-sectional area of the head 30, it will be obvious that when the liquid within the tubing builds up to a predetermined proportion of the pressure of the lifting fluid, said liquid will tend to move the piston 31 and plunger 29 downwardly. Therefore, if the pressure of the lifting fluid in the well casing 10 is 300 pounds, the cross-sectional areas of the piston 31 and head 30 may be of such size that a 50-pound pressure of the well liquid within the tubing 12 will start the plunger downwardly. It is not necessary for the well liquid to build up a pressure in excess of the pressure of the lifting fluid but, by properly arranging the areas, any desired pressure of the liquid may open the valve. This makes the valve particularly adaptable for use in wells having a low pressure or a low liquid level.

When the pressure of the liquid within the tubing reaches a predetermined proportion of the pressure of the lifting fluid, the piston 31 and plunger 29 are moved downwardly whereby the ports 33 at the lower end of the plunger 29 are moved out of the bore 26 of the cylinder 23. When this occurs the lifting fluid from within the casing 10 will flow upwardly through the collar 25 into the ports 33, upwardly through the plunger and piston, and finally into the well tubing through the port 20. This admitted lifting fluid will of course lift the well liquid upwardly within the tubing.

Since the lifting fluid is flowing through the plunger 29, it will be manifest that the velocity of the flow of this fluid will act on said plunger and will tend to raise the plunger upwardly. As soon as the load of the liquid column is lightened due to the admission of the lifting fluid, the pressure above the piston 31 is reduced which changes the differential across the piston and plunger. Since the pressure of the lifting fluid is constant in the well casing, said lifting fluid acting against the cross-sectional area of the head 30 will move the plunger to its raised position. This movement will of course be assisted by the velocity of the fluid flowing through the plunger bore 29' for naturally as the load is lightened the velocity of flow of the lifting fluid through the plunger bore will be increased. As the plunger moves to

its upper position, the head 30 engages the seat 28 to again cut off the flow of the lifting fluid. The parts remain in this position until such time as the liquid again builds up a sufficient pressure to move the plunger downwardly. In the event that any fluid or liquid should become trapped below the piston 31 and above the shoulder 27 upon operation of the valve, upon the next movement of the piston and plunger, this trapped liquid or fluid may escape from beneath the piston through a spring-operated check valve 38 which is formed in the lower end of the piston at one side thereof. It is pointed out that the coiled spring 37 aids the liquid pressure in moving the valve to its open position and therefore by increasing or decreasing the pressure of the spring, the pressure of the liquid necessary to actuate the piston and plunger may be varied within certain limits. However, it has been found that the spring 37 may be entirely eliminated, and the plunger and piston will operate efficiently simply by the differential of the well liquid and the lifting fluid pressures.

In Figures 5 to 8, another form of the invention is shown. In this form the sleeve 14 is connected in the tubing string 12 and is provided with the upper boss 17 and the lower boss 21. In place of the cylinder 23 and its associate parts, a cylinder 40 has its upper end threaded into the bore 18 of the upper boss. The lower end of the cylinder 40 is inserted into the vertical opening 22 of the lower boss 21 and the open end of the cylinder is closed by a cap member 41 which member is threaded into said lower end. The diameter of the cap member is substantially the same as that of the cylinder 40 whereby it forms a continuation thereof and fits snugly within the opening 22. The cap member 41 is provided with an axial sleeve or stem 42 which extends upwardly therefrom into and axially of the cylinder 40. This sleeve or stem is preferably formed integral with the cap and is provided with an axial bore 43 extending throughout its length. The bore 43 is of the same diameter as the upper portion of the bore 41' of the cap 41 whereby it is a continuation thereof. The lower end of the bore 41' of the cap 41 is enlarged as indicated at 44 whereby an internal annular shoulder 44' is formed within the cap 41.

A valve member 45 is slidable vertically in the enlarged portion 44 of the bore and is provided with a conical face 46 at its upper end, which face is arranged to engage the shoulder 44'. The valve member 45 is provided or formed with a plurality of vertical grooves or channels 47 so that when said valve is in its lowered position as shown in Figure 6, the lifting fluid within the well casing may enter the bore 44 of the cap 41, from where it may flow upwardly through the bore 43 of the axial sleeve 42. Of course when the valve member 45 is engaging the shoulder 44', a flow of the lifting fluid through the bore 43 is prevented.

An elongate piston 48 is movable vertically within the cylinder 40 and has an axial bore 49 through which the sleeve 42 extends. Manifestly the vertical movement of the piston 48 is guided by the axial sleeve. A transverse web or spider 50 extends across the upper end of the piston 48 and an elongate stem 51, which is preferably made integral with the valve member 45 and which extends upwardly through the bore 43 of the sleeve 42, has its upper end secured to the central portion of said web, whereby the web and valve member 45 are fastened together. A coiled spring 52 has its lower end engaging the piston 48 and is confined between the piston and an overhanging annular flange 40' which is formed at the upper end of the cylinder 40. The spring 52 acts to exert its pressure at all times downwardly on the piston 48 and valve head or member 45 whereby it is tending at all times to urge the valve member to its open position.

The operation of this form of the invention is substantially the same as the operation of the form shown in Figures 1 to 4. With the parts in the position shown in Figure 5 the fluid pressure in the well casing is acting against the cross-sectional area of the valve member 45 to hold said valve member against the seat 44', whereby admission of the lifting fluid to the well tubing 12 is prevented. As the well liquid column builds up in the tubing, the pressure of said liquid acts through the port 20 and chamber 19 and the boss 17 and downwardly against the top of the piston 48 as well as against the cross-sectional area of the valve face 46 which is exposed through or within the bore 43 of the guide sleeve 42. The combined area of the piston, stem and valve face 46 is of course much greater than the cross-sectional area of the valve member 45 and therefore the pressure of the liquid is acting against a much greater area than the area against which the lifting fluid is acting. Therefore as soon as the pressure of the liquid builds up a predetermined proportion of the lifting fluid pressure, the piston 48 and spider 50 will be moved downwardly within the cylinder 40. As this occurs the valve member 45 will also be moved downwardly because of the connection of the spider with said member through the stem 51. As the valve is unseated, the lifting fluid will flow upwardly through the vertical grooves 47 in the periphery of the member 45, after which it will flow through the sleeve 42 into the upper end of the cylinder, and finally through the port 20 into the well tubing, whereby the liquid within said tubing is lifted. The valve member 45 will remain in this position until such time as the load in the tubing is lightened and the pressure above the piston 48 decreased. When said pressure decreases to a predetermined point, the lifting fluid pressure in the casing acting against the underside of the valve member 45, will immediately move the valve member to its seated position to cut off further flow of the lifting fluid.

It is pointed out that in both forms a most simple structure for controlling the admission of the lifting fluid is provided. Assembly or disassembly of the valve is readily made for the purposes of repair or for other reasons. In both instances a single member controls the flow of the lifting fluid to the tubing and also in both instances, the liquid is acting against a greater cross-sectional area than is the lifting fluid. With such arrangement, it is not necessary for the liquid to build up an excessive pressure within the tubing before the lifting fluid is admitted and therefore assurance is had at all times that the lifting fluid will be sufficient to raise the column of liquid which has built up in the tubing.

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

1. A flow valve including, a tubular body adapted to be connected in a tubing string and having a passage for establishing communication between the interior and exterior of the tubing, a member movable within the passage and having one end exposed to the pressure in the interior of the tubing and its opposite end exposed to the

pressure exterior of the tubing, said ends being of different cross-sectional areas, whereby said member is moved by a predetermined differential in such pressures to control the flow through the passage, and resilient means for urging the member to its open position and arranged to add its pressure to the pressure within the tubing and acting therewith against the exterior pressure.

2. A flow valve including, a tubular body adapted to be connected in a tubing string and having a passage for establishing communication between the interior and exterior of the tubing, a member movable within the passage and having one end exposed to the pressure in the interior of the tubing and its opposite end exposed to the pressure exterior of the tubing, said ends being of different cross-sectional areas, whereby said member is moved by a predetermined differential in such pressures to control the flow through the passage, resilient means for urging the member to its open position and arranged to add its pressure to the pressure within the tubing and acting therewith against the exterior pressure, and means for adjusting said resilient means to control within certain limits the differential necessary to impart movement to the member.

3. A flow valve including, a tubular body adapted to be connected in a tubing which extends axially within a well casing, said body having a port establishing communication between the interior of the tubing and the interior of the casing, a cylinder mounted on the side of the body and having its upper end communicating with the port and its lower end communicating with the interior of the well casing, and a movable member mounted in the bore of the cylinder for closing the lower end thereof and having one end exposed to the pressure in the tubing and its opposite end exposed to the pressure in the casing, said ends having different cross-sectional areas whereby when the pressure in the tubing reaches a predetermined proportion of the pressure in the casing said member is actuated to establish communication between the interior of the tubing and the interior of the casing.

4. A flow valve including, a tubular body adapted to be connected in a tubing which extends axially within a well casing, said body having a port establishing communication between the interior of the tubing and the interior of the casing, a cylinder mounted on the side of the body and having its upper end communicating with the port and its lower end communicating with the interior of the well casing, a movable member mounted in the bore of the cylinder for closing the lower end thereof and having one end exposed to the pressure in the tubing and its opposite end exposed to the pressure in the casing, said ends having different cross-sectional areas whereby when the pressure in the tubing reaches a predetermined proportion of the pressure in the casing said member is actuated to establish communication between the interior of the tubing and the interior of the casing, and resilient means acting on said member to aid the pressure within the tubing in acting against the pressure within the casing.

5. A flow valve including, a tubular body adapted to be connected in a tubing which extends axially within a well casing, said body having a port establishing communication between the interior of the tubing and the interior of the casing, a cylinder mounted on the side of the body and having its upper end communicating with the port and its lower end communicating with the interior of the well casing, a movable member mounted in the bore of the cylinder for closing the lower end thereof and having one end exposed to the pressure in the tubing and its opposite end exposed to the pressure in the casing, said ends having different cross-sectional areas whereby when the pressure in the tubing reaches a predetermined proportion of the pressure in the casing said member is actuated to establish communication between the interior of the tubing and the interior of the casing, resilient means acting on said member to aid the pressure within the tubing in acting against the pressure within the casing, and means for adjusting said resilient means to vary the pressure differential necessary to actuate the valve.

6. A flow valve including, a tubular body adapted to be connected in a well tubing having a well influent inlet and extending axially of a well casing, means for introducing a lifting fluid into said casing, said body having a port establishing communication between the interior of the well tubing and casing, a cylinder on the body having a bore which communicates with the port, and a tubular plunger slidable within the bore and adapted to cut off flow therethrough when raised and to permit flow therethrough when lowered and having its upper end exposed to the pressure of the well influent and its lower end exposed to the lifting fluid, said upper end being of greater cross-sectional area than the lower end whereby when the influent pressure reaches a predetermined proportion of the lifting fluid pressure the plunger is moved to permit a flow of lifting fluid through the tubular plunger and into the tubing to lift the influent therein.

7. A flow valve including, a tubular body adapted to be connected in a well tubing having a well influent inlet and extending axially of a well casing, means for introducing a lifting fluid into said casing, said body having a port establishing communication between the interior of the well tubing and casing, a cylinder on the body having a bore which communicates with the port, and a tubular plunger closing the lower end of the bore of the cylinder and having radial inlet ports at its lower end which ports are closed by the cylinder wall when the plunger is in a raised position, said plunger having its upper end exposed to the pressure of the influent and its lower end exposed to the pressure of the lifting fluid, the upper end being of greater cross-sectional area than the lower end, whereby, when the pressure of the influent reaches a predetermined proportion of the lifting fluid, the plunger is moved downwardly to uncover the inlet ports and permit a flow of lifting fluid through the tubular plunger cylinder bore and into the interior of the tubing to raise the influent therein.

8. A flow valve including, a tubular body adapted to be connected in a well tubing having a well influent inlet and extending axially of a well casing, means for introducing a lifting fluid into said casing, said body having a port establishing communication between the interior of the well tubing and casing, a cylinder on the body having a bore which communicates with the port, a tubular plunger closing the lower end of the bore of the cylinder and having radial inlet ports at its lower end which ports are closed by the cylinder wall when the plunger is in a raised position, said plunger having its upper end exposed to the pressure of the influent and its lower end exposed

to the pressure of the lifting fluid, the upper end being of greater cross-sectional area than the lower end, whereby, when the pressure of the influent reaches a predetermined proportion of the lifting fluid, the plunger is moved downwardly to uncover the inlet ports and permit a flow of lifting fluid through the tubular plunger cylinder bore and into the interior of the tubing to raise the influent therein, and resilient means for constantly urging the plunger to its lowered position and aiding the influent pressure to overcome the lifting fluid pressure.

9. A flow valve including, a tubular body adapted to be connected in a well tubing having a well influent inlet and extending axially of a well casing, means for introducing a lifting fluid into said casing, said body having a port establishing communication between the interior of the well tubing and casing, a cylinder on the body having a bore which communicates with the port, a tubular plunger closing the lower end of the bore of the cylinder and having radial inlet ports at its lower end which ports are closed by the cylinder wall when the plunger is in a raised position, said plunger having its upper end exposed to the pressure of the influent and its lower end exposed to the pressure of the lifting fluid, the upper end being of greater cross-sectional area than the lower end, whereby, when the pressure of the influent reaches a predetermined proportion of the lifting fluid, the plunger is moved downwardly to uncover the inlet ports and permit a flow of lifting fluid through the tubular plunger cylinder bore and into the interior of the tubing to raise the influent therein, resilient means for constantly urging the plunger to its lowered position and aiding the influent pressure to overcome the lifting fluid pressure, and means for adjusting said resilient means to vary the pressure differential necessary to move the plunger.

10. A flow valve including, a tubular body adapted to be connected in a well tubing having a well influent inlet and extending axially of a well casing, means for introducing a lifting fluid into said casing, said body having a port establishing communication between the interior of the well tubing and casing, a cylinder on the body having a bore which communicates with the port, a closure for the lower end of the cylinder and having an axial bore establishing communication between the well casing and cylinder, a valve member for closing the axial bore of the closure and subjected to the pressure of the lifting fluid within the casing, a piston having a greater cross-sectional area than the member and exposed to the pressure of the well fluid, and means for connecting the piston with the member, whereby the piston and member are moved to open the bore of the closure when the pressure of the well influent reaches a predetermined proportion of the pressure of the lifting fluid to permit a flow of lifting fluid from the well casing through the bore of the closure and through the cylinder into the interior of the tubing to lift the influent therein.

11. A flow device including, a tubular body adapted to be connected in a tubing which extends axially within a well casing, said body having a port establishing communication between the interior of the tubing and interior of the well casing, a sleeve mounted on the side of the body and having communication with the port and having its lower end communicating with the interior of the well casing, a pressure responsive means mounted in the bore of the sleeve and exposed to the pressure in the tubing, and a valve head having a fixed connection with the pressure responsive means for closing the lower end of the bore and exposed to the pressure in the casing, said means and valve head having different cross-sectional areas, whereby when the pressure in the tubing reaches a predetermined proportion of the pressure in the casing, said means is actuated to move said head and establish communication between the interior of the tubing and the interior of the casing.

12. A flow device including, a tubular body adapted to be connected in a well tubing having a well influent inlet and extending axially of a well casing, means for introducing a lifting fluid into said casing, the body having a port establishing communication between the interior of the well tubing and casing, a sleeve on the body having a bore which communicates with the port, a closure on the sleeve for the lower end of the sleeve and having an axial bore establishing communication between the well casing and sleeve, a valve head for closing the axial bore of the closure and subjected to the pressure of the lifting fluid within the casing, a pressure responsive means having a greater cross-sectional area than the head and exposed to the pressure of the well influent, and means for rigidly connecting the pressure responsive means with the head, whereby the means and the head are moved simultaneously to open the bore of the closure when the pressure of the well influent reaches a predetermined proportion of the pressure of the lifting fluid to permit a flow of lifting fluid from the well casing through the bore of the closure and through the sleeve into the interior of the tubing to lift the influent therein.

13. A flow device including, a tubular body adapted to be connected in a tubing string and having a passage for establishing communication between the interior and exterior of the tubing, a valve having a by-pass therethrough within the passage and arranged to be moved to open and close the by-pass to control the admittance of a lifting fluid to the tubing, said valve having one side exposed to the lifting fluid pressure, and a piston slidable in the passage and having connection with the valve and exposed to the pressure in the interior of the tubing, said piston being of a different area than the valve, whereby the piston and valve are moved by a predetermined differential in such pressures to control the flow through the passage.

14. A flow device including, a tubular body adapted to be connected in a tubing string and having a passage for establishing communication between the interior and exterior of the tubing, a valve member having a sliding fit within the passage for controlling the admittance of a lifting fluid to the tubing and having one side exposed to the lifting fluid pressure, and a piston slidable in the passage having connection with the valve and exposed to the pressure in the interior of the tubing, said piston being of a different cross-sectional area than the valve, whereby the piston and valve are moved by a predetermined differential in such pressures, the piston having a by-pass for the lifting fluid, which by-pass is opened and closed by the position of the valve, whereby said valve controls the admittance of the lifting fluid through the by-pass and into the tubing.

15. A flow device including, a tubular body adapted to be connected in a tubing which ex-

tends axially within a well casing, a sleeve mounted on the side of the body and having communication with the interior of the well tubing and casing, means for controlling the flow through the passage to control the admittance of a lifting fluid to the tubing and having one side exposed to the lifting fluid pressure, and a piston slidable within the sleeve and having connection with said control means and exposed to the pressure in the interior of the tubing, said control means and piston having a by-pass for by-passing the fluid therethrough when the means is in an open position, the by-pass being closed when the control means is in a closed position, said piston being of a different cross-sectional area than the control means, whereby said piston and means are moved by a predetermined differential in such pressures to control the flow through the passage.

16. A flow device including, a tubular body adapted to be connected in a tubing which extends axially within a well casing, a sleeve removably mounted on the side of the body and having communication with the interior of the well tubing and casing, a valve having a sliding fit in the passage for controlling the flow therethrough to control the admittance of a lifting fluid to the tubing and having one side exposed to the lifting fluid pressure, and a piston slidable in the bore of the sleeve and having connection with said valve and exposed to the pressure in the interior of the tubing, said piston having a by-pass for by-passing the lifting fluid therethrough when the valve is in an open position, said piston being of a different cross-sectional area than the valve, whereby said piston and valve are moved by a predetermined differential in such pressures to control the flow through the passage.

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