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FLOW REGULATOR FOR PLUNGER LIFT DEVICES

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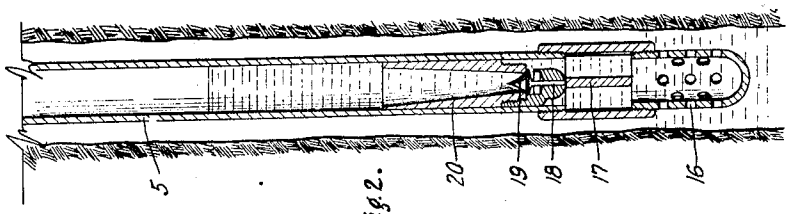

Fig. 2.

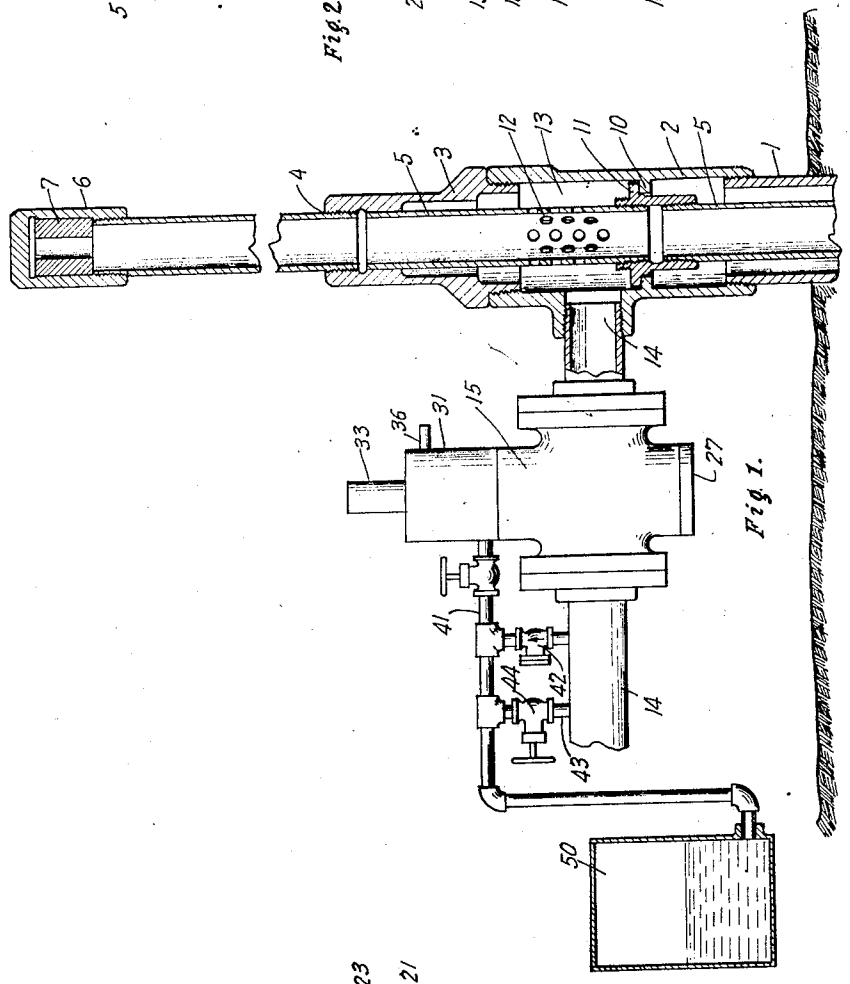

Fig. 1.

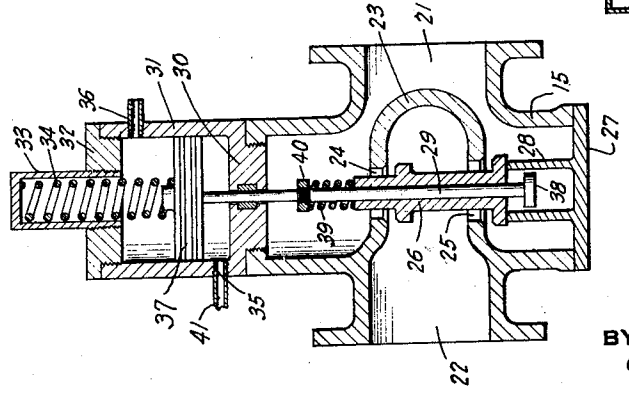

Fig. 3.

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FLOW REGULATOR FOR PLUNGER LIFT DEVICES

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7 Claims. (Cl. 103—52)

My invention relates to plunger lift devices by means of which liquid is raised from deep wells through the operation of a swab plunger actuated by air or gas pressure.

It is an object of the invention to control the flow of pressure fluid from the well so that the plunger may operate most effectively. I desire to provide an apparatus whereby the fluid raised by the plunger may be discharged from the well and the discharge passage then closed off until the plunger has had an opportunity to drop on its down stroke.

The invention contemplates the provision of an automatically operating valve which will be operated through the liquid being pumped to close for a predetermined time to allow the plunger to drop and to again automatically open to allow the escape of the pressure fluid in the eduction tube.

Invention resides generally in the provision of an automatically operating valve in the flow line to regulate the discharge of fluid from the well.

In the drawing herewith, Fig. 1 is a side view partly in central vertical section illustrating a plunger lift device with my invention installed thereon.

Fig. 2 is a central vertical section through the lower end of the well with the plunger lift device therein.

Fig. 3 is a central vertical section through the automatic valve employed with my apparatus.

In carrying out my invention I employ a plunger lift installation of ordinary construction. There is a casing 1 extending downwardly into the well for any desired depth. The upper end of the casing is equipped with a casing head 2, the upper end of which is closed by a bonnet 3 about the extension 4 upon the eduction tube 5. A fluid tight engagement is made with the extension 4 and the upper end of said extension is closed by a cap 6 forming a housing for a tubular buffer 7 of rubber or other similar material against which the plunger engages.

Within the casing head 2 is an interior flange 10 upon which is supported the head 11 upon the eduction tube 5. Said head makes a tight seal with the casing at this point and closes the passage of gas or other fluid through the casing head. Above the head the tube is formed with openings 12 through which the fluid may discharge into the inner chamber 13 of the casing head. From this chamber the fluid finds an outlet through a flow line 14 leading by way of my regulating valve 15 to some place of storage not shown.

The lower end of the eduction tube 5 is extended below the surface of the liquid being pumped and is formed with a strainer plug 16 thereon. Above said plug is a cross shaped stop member 17 against which the valve stem 18 upon a valve 19 in the plunger 20 may contact to close said valve.

This structure so far described is the usual plunger lift equipment and need not be further described.

The flow of the fluid from the well is regulated by the automatic valve 15. The construction of this valve will be understood best from Fig. 3. The body of the valve comprises a cross shaped housing 15 having an inlet opening 21 and an outlet opening 22 for the fluid passing therethrough. A diaphragm 23 which tends to close the passage through the valve has valve openings 24 and 25 therein, and a double ended valve 26 of ordinary construction is arranged to fit within said openings. The seat 25 is slightly larger than the seat 24, so that there is normally a preponderance of pressure tending to close the valve.

The lower side of the housing 15 is closed by a plate 27, having a central hollow post 28 thereon to guide the valve stem 29 and also serve as a stop for the valve 26.

The valve 26 is mounted upon the valve stem 29 which extends upwardly through the valve seat 24 and through the lower wall 30 of the cylinder chamber 31. Said chamber is closed at its upper end by a plug 32 having a central opening to receive the tubular housing 33 for the spring 34.

The valve stem 29 extends through the closure wall 30 and has at its upper end a piston 37 fitting closely within the cylinder 31 mounted upon the upper end of the valve. Said valve stem 29 has a seal in the wall 30 and the cylinder 31 has an inlet port 35 at its lower end and a vent 36 at the upper end. The spring 34 bears against the upper end of the piston 37 and tends to move it downwardly.

The valve stem 29 has a sliding engagement with the valve 26 and its lower end extends below the valve and has a head 38, working in the guide 28. Above the valve is a spring 39 which engages the valve 26 at its lower end and bears against a nut 40 on the valve stem at its upper end. It tends to move the valve 26 downwardly upon the stem against the upper end of this stop formed by the guide 28.

The port 35 has a connection through a pipe 41 with the flow line 14 beyond the automatic valve 15. There is a one way check valve 42 in

this line which allows the fluid under pressure from the well to enter below the piston 37 when the load of liquid is being discharged. The pipe 41 has a second connection at 43 with the flow line. A valve 44 in this branch may be adjusted to allow exhaust of fluid from below the piston 37 at a predetermined rate.

The line 41 also has a connection with a small reserve tank 50 in which fluid from the flow line may be accumulated at the time of each discharge so as to assure sufficient flow of fluid to the cylinder 31 to raise the piston and close the valve, and to retain the valve closed until the load is discharged.

In the operation of my device the plunger in the eduction tube will be forced upwardly with its load of liquid by the gas pressure in the well and will discharge its load of liquid through the openings 12 to the flow line 14. The plunger will then pass upwardly above the openings and tend to allow the discharge of the gas behind the plunger outwardly through the flow line.

As the fluid is forced outwardly through the valve member 15, and into the line beyond, it will also exert a pressure in that line tending to force the fluid upwardly past the check valve 42 into the reserve chamber 50 and into the cylinder 31 below the piston 37. This will force the piston upwardly and raise the valve stem and finally bring the valve to closed position. The operation of the valve will be delayed by the lost motion in the valve stem before the head 38 on the stem engages the lower end of the valve. This delay is sufficient to permit the discharge of the load of liquid before the valve closes. I contemplate so calibrating this device that the valve will close within a predetermined time sufficient to allow the passage of the liquid above the plunger, but before the gas has been allowed to exhaust following the passage of the liquid, the valve will then close, thereby stopping the escape of the liquid and gas from the well. The gas in the well will then become static and will not interfere with the dropping of the plunger to the bottom of its stroke.

When the passage of the pressure fluid through the flow line 14 after the valve is closed is thus abruptly checked, the result will be to shut off the excess of pressure through the check valve 42 and the pipes 41 and 43 so as to relieve the pressure in the cylinder 31 and allow the spring 34 acting on the plunger to move the piston down and the valve to be forced back thus opening the passage through the valve. This opening will be delayed, however, due to the effect of the choke in the valve 44 so that the valve will not open until the piston 37 has nearly reached the lower end of its stroke. The spring 39 on the valve stem will be compressed first and when the pressure becomes sufficient the valve will be snapped open quickly. The opening of the valve will allow the escape of the gas above the plunger relieving the pressure in the eduction tube and the plunger will then be in position for a repetition of this operation. The reserve chamber 50 in the line 41 is to assure sufficient pressure in that line following the closing of the valve to slow down the operation of the valve until the plunger has dropped down toward the lower end of the eduction tube. It is to be understood that the depth of the well varies largely with different installations, and in some cases the plunger may have to drop for a distance of a mile or more before reaching the liquid level above the lower end of the tube. The adjustment of this device will be so arranged as to accommodate the distance through which the plunger has to fall. The reserve gas will have to exhaust to relieve the pressure below the piston 37 before it can move down.

It will be seen that with my automatically operated valve I will be enabled to regulate the passage of fluid from the well so as not to interfere with the discharge of the liquid and also to allow the plunger to fall on its down stroke without being impeded in its fall through the rush of gas to the outlet. This exhaust of the gas only takes place after the plunger has fallen through the larger part of its down stroke. It does not, therefore, interfere with the free falling of the plunger, and will thus not only prevent the failure of the plunger to operate properly through the opening of the valve therein, but will speed up the operation of the pump by allowing the free falling of the plunger in the manner described.

What I claim as new is:

1. In a plunger lift device, an eduction tube having an upper outlet, an extension above said outlet, a plunger movable from the lower end to the upper end of said tube, a flow line connected with said outlet, and an automatic valve in said flow line actuated by the flow of fluid in said line to close off the exit of fluid therethrough after a predetermined time interval.

2. In a plunger lift device, an eduction tube having an upper outlet, an extension above said outlet, a plunger movable from the lower end to the upper end of said tube, a flow line for liquid and gas connected with said outlet, and an automatic valve in said flow line to close off the exit of fluid therethrough after a predetermined time interval after the flow of fluid is initiated.

3. In a plunger lift device, an eduction tube having an upper outlet, an extension above said outlet, a plunger movable from the lower end to the upper end of said tube, a flow line connected with said outlet, and an automatic valve in said flow line to close off the exit of fluid therethrough after a predetermined time interval, said valve being constructed to again open to allow exhaust of fluid after a further time interval.

4. In a plunger lift device, an eduction tube, an outlet for fluid therefrom, a flow line connected with said outlet, a plunger in said tube actuated by gaseous fluid pressure to raise a load of liquid to said outlet, means in said flow line actuated by the flow of fluid therein to stop the flow of fluid when said load of liquid has passed, so as to allow said plunger to drop in said tube.

5. In a plunger lift device, an eduction tube, an outlet for fluid therefrom, a flow line connected with said outlet, a plunger in said tube actuated by gaseous fluid pressure to raise a load of liquid to said outlet, means in said flow line actuated by the flow of fluid therein to stop the flow of fluid when said load of liquid has passed, so as to allow said plunger to drop in said tube, said means being releasable to open said flow line after a predetermined time interval.

6. A plunger lift device including an eduction tube, a flow line connected near the upper end thereof, a plunger in said tube actuated by gaseous fluid pressure to elevate a load of liquid from the lower end of said tube to said flow line, in combination with a valve in said flow line, means operated by fluid pressure in said line in a predetermined time to move said valve to closed position, said valve being adapted to open again

after a predetermined time interval when said flow of fluid in said flow line is stopped.

7. A plunger lift device including an eduction tube, a flow line connected near the upper end thereof, a plunger in said tube actuated by gaseous fluid pressure to elevate a load of liquid from the lower end of said tube to said flow line, in combination with a valve in said flow line, means operated by fluid pressure in said line in a predetermined time to move said valve to closed position, means to dampen the closing of said valve, said valve being adapted to open again after a predetermined time interval when said flow of fluid in said flow line is stopped.

SETH EVANS.