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GAS LIFT VALVE

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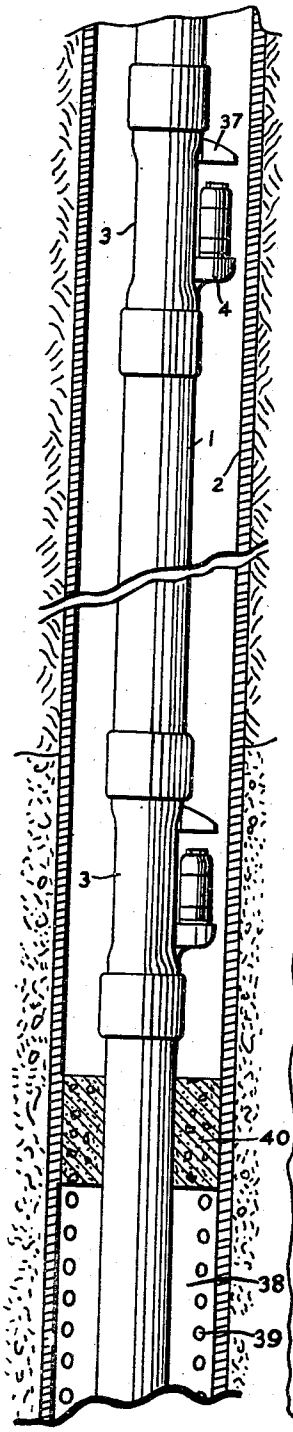


FIG. 1

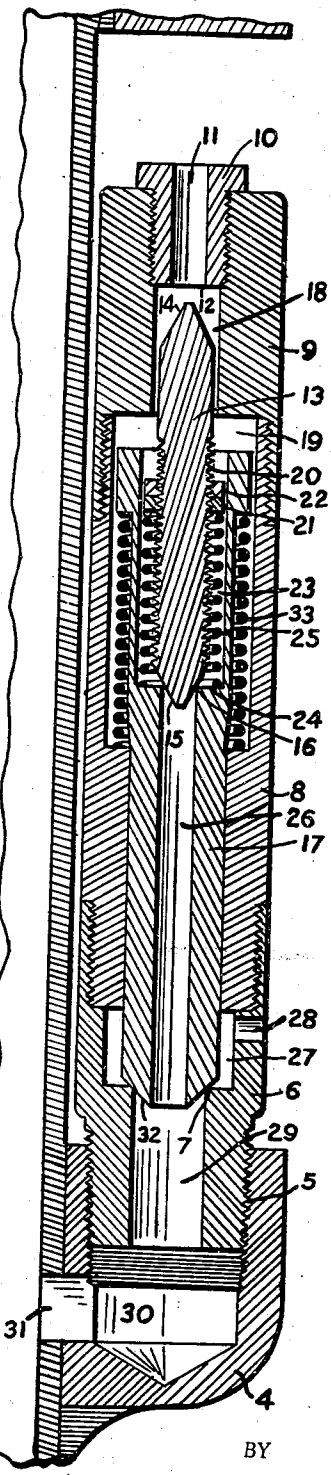


FIG. 2

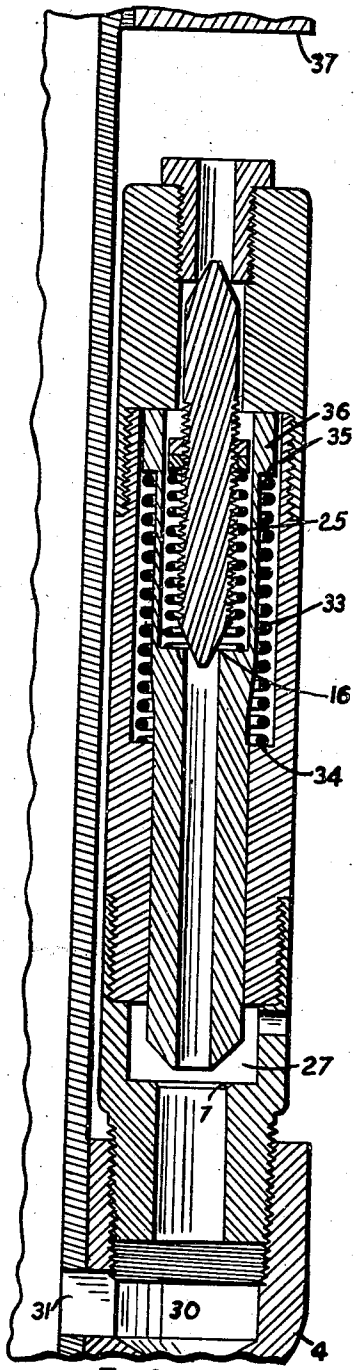


FIG. 3

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GAS LIFT VALVE

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12 Claims. (Cl. 103—232)

The object of this invention is to improve and simplify the structure shown in my co-pending application, Serial Number 104,613, filed October 8, 1936 which application has now matured into Patent No. 2,204,834, issued June 18, 1940. In the said application, I showed a mechanism relating to that type of device for flowing liquids from wells customarily referred to as gas lifting devices, and more particularly I had reference to a mechanism whereby the admission of gas or air to a column of liquid within a well may be controlled.

The invention shown in the said Patent 2,204,834, as well as in the present application, provides a valve for controlling the admission of gas or air to a column of liquid within a well in which a main valve for controlling said admission is controlled by a pilot valve mechanism. The object of the pilot valve mechanism is to control the operation of the main valve so that the gas or air will not be admitted to the column of liquid within the well until the column of liquid shall have attained a predetermined pressure at the point where the valve is situated.

Another object of the invention is to provide controlled means for both the pilot valve and the main valve so that the aerating gas will be prevented from entering the column of fluid until the pressure of the fluid has increased to a predetermined point below the pressure of the gas, and when this pressure has been reached, the pilot valve will be actuated so as to release the main valve by relieving the pressure on one end of the main valve so that the said main valve will be opened and the gas forced into the column of fluid.

Another object of the invention is to provide means whereby the tension exerted on the pilot valve can be regulated.

Other objects and advantages of the invention will become apparent from the following description taken in connection with the accompanying drawing, it being understood that such drawing and description are by way of example and illustration only and are not to be taken by way of limitation. I realize that many changes may be made in the form of the invention as shown in this application without departing from the spirit thereof, and I therefore reserve to myself the right to make all such changes as may fairly fall within the scope of the appended claims.

In the drawing, Fig. 1 is an elevational view partly in cross-section showing in outline the valves placed one above the other.

Fig. 2 is a vertical cross-sectional view showing the valves in position so that air is excluded or prevented from going into the column of liquid.

Fig. 3 is an elevational cross-sectional view showing the position of the valve when there is no operative pressure either in the casing or the tubing and also the position of the parts when the pressure in the tubing has risen to a point somewhat below the pressure in the casing so that the air would pass into the column of fluid.

The tubing 1 within the well casing 2 is provided with sections 3 having a laterally extending member 4. It is of course understood that there will be as many valve mechanisms as there are sections 3. The laterally extending member 4 is internally screw threaded at 5 and the member 6 is screw threaded into the member 4. The member 6 is provided with a main valve seat 7. A tubular section 8 is operatively connected with a top section 9 as well as with the member 6, and in the upper end of the top section 9 is received a thimble 10 through which passes a centrally disposed bore 11, which at its lower end provides a pilot valve seat 12.

The pilot valve member 13 is tapered at its upper end forming a valve 14 and at its lower end is tapered forming a valve 15 which may engage the valve seat 16 forming a part of the main valve member 17. The pilot valve member 13 extends into a bore 18 of the top section 9, which bore communicates with the central bore 11 of the thimble 10 and also communicates with a pressure chamber 19 within the upper part of the tubular section 8. The pilot valve member is screw threaded at 20, and a collar 21 and lock nut 22 are screw threaded onto said screw threads 20. The main valve member 17 is provided at its upper portion with a centrally disposed chamber 23 which communicates with the pressure chamber 19, and in fact forms a part thereof. At the lower end of the chamber 23 is a shoulder 24, and a spring 25 extends from the said shoulder to the collar 21, which spring serves as a means to urge the pilot valve upwardly as shown in the drawing so as to disengage the valve 15 from the valve seat 16 and to engage the valve 14 with the valve seat 12.

The main valve member 17 is provided with a central bore 26 which communicates with the central chamber 23 and which also communicates at its lower end with a chamber 27 in the member 6. The chamber 27 has a laterally extending port 28 which communicates with the space between the tubing and the well casing. The cham-

ber 27 communicates with a vertically extending bore 29 which extends to the lower portion of the member 6 and communicates with a chamber 30, which in turn communicates with a laterally extending port 31 which extends through the tubing and communicates with the space within the tubing.

The lower end of the main valve member 17 is provided with a valve 32, which may be seated on the main valve seat 7 as shown in Fig. 2, but which may be raised from engagement therewith as shown in Fig. 3 by means of a spring 33, which at its lower end is seated on a shoulder 34 forming a part of the tubular section 8 and at its upper end underlies a shoulder 35 carried by an enlargement 36 at the upper end of the main valve member 17.

A shield 37 is carried by the section 3 and extends radially outwardly and overlies the upper end of the valve housing so that as the tubing string is pulled out of the well the valve mechanism would be shielded or protected in case it met any obstructions.

In operation the tubing string is inserted in the casing so as to communicate with the space 38 adjacent perforations 39 in the oil stratum, and a packer 40 is placed above the perforations so that the pressure in the space between the tubing and casing above the packer would not be communicated to the space 38 below the packer. The oil would therefore pass into the lower end of the tubing and would rise to whatever height to which it was forced by the natural pressure in the well. The sections 3 should be so spaced as to lie below the point to which the oil would naturally be forced by the oil well pressures. When placed in the well, the valve mechanism would occupy the position shown in Fig. 3. Any gas, such as air, would be forced into the well so as to create a pressure above the packer and between the casing and tubing. As this air pressure is built up the air would pass through the port 28, into the chamber 27 and upwardly through the central bore 26 in the main valve member 17, and since the valve 15, as shown in Fig. 3, is open the air would pass into the chamber 23 so that there would tend to be the same pressure in the chamber 23 as there is outside the tubing. The air in the chamber 27 would also move downwardly by the valve seat 7, into the bore 29, chamber 30 and port 31, thereby relieving the pressure on the bottom of the main valve member 17. It therefore results that we have a higher pressure on the top of the pilot valve 13 than we have on the bottom thereof, for the reason that the bottom pressure has been reduced by the air passing into the tubing. There being a greater pressure on the top of the pilot valve 13 than on the bottom thereof, the pilot valve is moved against the tension of the spring 25 so that the valve 15 seats on the valve seat 16. Since the valve 14 is now unseated from the valve seat 12 the casing pressure, that is the pressure between the casing and the tubing, passes downwardly through the central bore 11 into the bore 18 and the pressure chamber 19 so that the main valve member 17 now has a greater pressure on its upper end than it has on the lower end, and the main valve member is therefore moved against the tension of the spring 33 into the position shown in Fig. 2, thereby bringing the valve 32 against its seat 7 and preventing further air passing into the tubing. In other words, when the air pressure in the casing is built up to a point to overcome the tension of the springs, the parts will be moved from the position shown in Fig. 3 to that shown in Fig. 2.

If the oil is now forced through the perforations 39 into the tubing so that it rises a considerable distance above the section 3 it creates a pressure induced by the height of the oil, which pressure is exerted through the port 31, chamber 30, and bore 29, against the lower end of the main valve member. This pressure, when it becomes sufficiently great, will move the pilot valve from the position shown in Fig. 2 to that shown in Fig. 3, and the air trapped in the chamber 19 will then pass downwardly through the central chamber 23, central bore 26, bore 29, chamber 30, and into the tubing through the port 31 thereby relieving or reducing the pressure in the pressure chamber 19, so that the spring 33 will move the main valve member 17 into the position shown in Fig. 3. The air under pressure in the casing will now pass through the port 28, chamber 27, bore 29, chamber 30 and port 31 into the tubing, aerating the oil in the tubing. It will therefore be noted that I have provided an automatic valve which is controlled by the differential in the pressures existing in the casing and in the tubing and is also controlled by the tension of the springs. It is also to be noted that it is the pilot valve that controls the operation of the main valve member.

As the oil is aerated and expelled, the pressure in the tubing will of course fall and the reverse of the above described operations would take place, so that the parts would be moved from the position shown in Fig. 3 to that shown in Fig. 2. Of course if the well were left standing indefinitely so that the air or gas pressures in the casing were greatly reduced, the parts would again assume the positions shown in Fig. 3, and it is possible that some oil would bleed through the port 31 and eventually through the port 28 into the space between the tubing and the casing, but this would be immaterial, for when it was desired to operate the well again any such oil that had thus by-passed would be blown into the tubing in the reverse order from which it entered the casing, so that there would be no harmful results.

Having now described the preferred embodiment of my invention, I claim:

1. In combination with a flow line positioned in a well, a gas lift pumping device, including a pressure operated main valve member to open or close a passageway leading into the flow line for controlling the admission of gas into the flow line, a spring tending to open said main valve member, said main valve member being provided with a shoulder and a longitudinally extending vent opening into the passageway, a pilot valve seated on said shoulder and controlling the gas pressure acting on said main valve member, and spring means seated on said shoulder and tending to move the pilot valve away from said main valve member so as to open said vent to release gas trapped between the main and pilot valves.

2. In combination with a flow line positioned in a well, a gas lift pumping device, including a pressure operated main valve member to open or close a passageway leading into the flow line for controlling the admission of gas into the flow line and provided with a vent opening into the passageway and a valve seat, and a pilot valve movable by a differential in pressure in the flow line and outside thereof so as to engage the said valve seat and close said vent or to disengage the said valve seat and open said vent.

3. In combination with a flow line positioned in a well, a gas lift pumping device, including a pressure operated main valve member to open or close a passageway leading into the flow line for controlling the admission of gas into the flow line and provided with a valve seat and a vent opening into the passageway and extending through the main valve member, a pilot valve movable by a differential in pressure in the flow line and outside thereof so as to engage the said valve seat and close said vent or to disengage the said valve seat and open said vent, and means tending to move said pilot valve away from said seat so as to open said vent and release gas trapped between said main and pilot valves.

4. In combination with a flow line positioned in a well, including a pressure operated main valve member provided with a valve at one end to open or close a passageway leading into the flow line for controlling the admission of gas into the flow line and a valve seat in a chamber at the other end, said main valve having a longitudinally extending vent opening into the passageway, a pilot valve extending into said chamber and adapted to be engaged by or disengaged from said valve seat so as to open or close said vent depending on differentials of pressures in the flow line and outside thereof exerted on the opposite surfaces of the pilot valve, and means constantly urging said main valve member so as to open its valve.

5. In combination with a flow line positioned in a well, a gas lift pumping device, including a pressure operated main valve member to open or close a passageway leading into the flow line for controlling the admission of gas into the flow line and provided with a chamber and a vent opening into the passageway, and a pilot valve extending into said chamber and adapted to open or close said vent to control the pressure acting on said main valve member.

6. In combination with a flow line positioned in a well, a gas lift pumping device, including a pressure actuated main valve member to open or close a passageway leading into the flow line for controlling the admission of gas into the flow line, and a pilot valve for controlling the pressure acting on said main valve member to actuate the same, said pilot valve being exposed to the variations in pressure in said flow line depending on the varying height of the oil therein and being partly housed within the said main valve member so as to make a compact structure.

7. In combination with a flow line positioned in a well, including a housing, a pressure operated main valve member to open or close a passageway leading into the flow line for controlling the admission of gas into the flow line and a pilot valve member extending longitudinally of said housing, said pilot valve member extending partly within said main valve member so as to make a compact structure, said pilot valve member controlling the pressure acting on said main valve member.

8. In combination with a flow line positioned in a well, including a pressure actuated main valve member to open or close a passageway leading into the flow line for controlling the admission of gas into the flow line, a pilot valve for controlling the pressure acting on said main valve to actuate the same, said pilot valve being exposed to the variations in differential between the pressure of gas to be admitted into said flow line and the pressure within the flow line itself, said pilot valve member being partly within said main valve member so as to make a compact structure.

9. In combination with a flow line positioned in a well, a gas lift pumping device, including a pressure operated main valve member to open or close a passageway leading into the flow line for controlling the admission of gas into the flow line, a valve seat carried by said main valve member and a vent opening into the passageway and extending longitudinally through the main valve member, a pilot valve coacting with said valve seat for controlling the pressure acting on the main valve member, and spring means urging said pilot valve away from said valve seat so as to open said vent to release gas trapped between the main and pilot valves.

10. In combination with a flow line positioned in a well, a gas lift pumping device, including a main valve member to open or close a passageway leading into the flow line for controlling the admission of gas into the flow line, a valve seat carried by said main valve member and a vent opening into the passageway and extending longitudinally through the same, a pilot valve coacting with said valve seat for controlling the pressure acting on the main valve member, spring means urging said pilot valve away from said valve seat so as to open said vent to release gas trapped between the main and pilot valves, and means to adjust the tension of said spring.

11. In combination with a flow line positioned in a well, a gas lift pumping device including a pressure actuated main valve to open or close a passageway leading into the flow line for controlling the admission of gas into the flow line, a spring tending to open said main valve and a pilot valve for controlling the pressure acting on said main valve to govern the actuation thereof, said pilot valve being partly housed within the main valve so as to make a compact structure.

12. In combination with a flow line positioned in a well, a gas lift pumping device including a housing, a main valve member having a valve to open or close a passageway leading into the flow line to control the admission of gas into the flow line, means tending to open said valve, said valve member being provided with a longitudinally extending bore opening into said passageway and extending throughout the length of the main valve member, a shoulder on said valve member adjacent the intermediate part of said bore, a pilot valve partly within said bore so as to extend to or adjacent to said shoulder, a valve seat carried by said housing and communicating with said bore and a valve seat at said shoulder on the said main valve member, and means tending to urge said pilot valve away from the valve seat at the shoulder and toward the valve seat carried by the housing.

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