

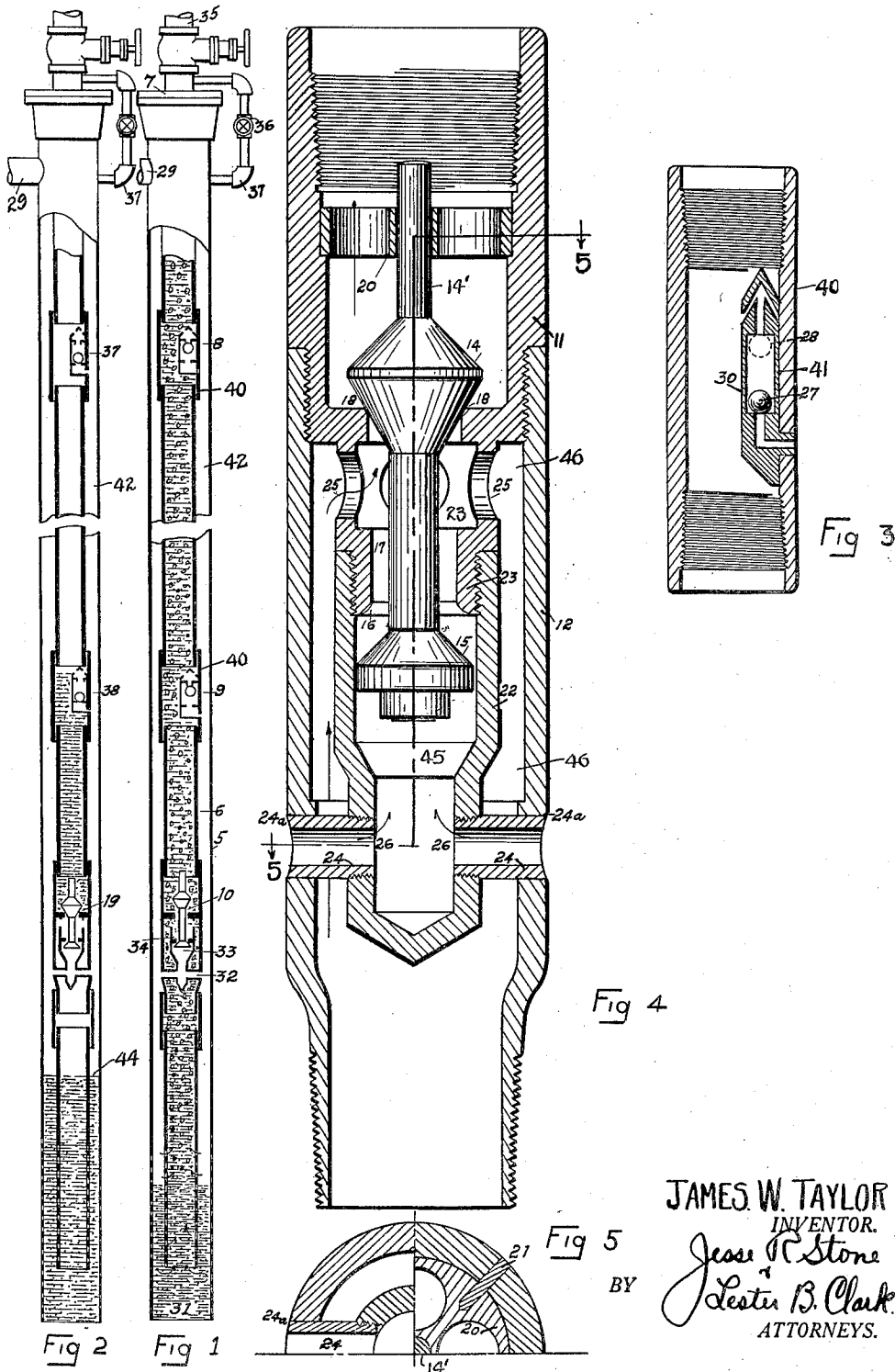
Dec. 3, 1935.

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2,022,749

WELL FLOWING DEVICE

Filed March 22, 1933



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UNITED STATES PATENT OFFICE

2,022,749

WELL FLOWING DEVICE

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Application March 22, 1933, Serial No. 662,156

11 Claims. (Cl. 103—232)

The invention relates to an improvement in well flowing devices, particularly of the type wherein the pressure fluid is automatically controlled by the operation of valves and wherein a check valve is operated by the pressure differential obtained due to the friction of the flow in the tubing.

It is one of the objects of the invention to provide a well flowing device wherein a valve controlling the inlet of liquid is manipulated by the difference in pressure between the casing and the tubing which is caused by the friction of liquid in the tubing.

Another object of the invention is to provide a method of flowing wells wherein all of the entry valves in the system can be opened or closed simultaneously by equalizing the pressure between the casing and the tubing.

Another object of the invention is to provide a hook up for well flowing devices wherein the tubing may be closed and the pressure from the casing admitted to the tubing in order to cause a reversal of the position of all of the valves in the system.

Another object of the invention is to provide a check valve for well flowing devices which is held in open position by the pressure differential required to force the liquid through the tubing.

Still another object of the invention is to provide a check valve to control the entrance of liquid into the pumping system, which valve remains open so long as liquid is flowing into the pump tubing so that there is no wear upon the valve structure.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawing wherein:

Fig. 1 is a vertical sectional view showing a diagrammatic illustration of an oil well equipped with the present invention and showing the parts in operating position with the liquid being raised from the well.

Fig. 2 is a vertical section similar to Fig. 1, but showing the parts disposed in the well before the pumping action has begun.

Fig. 3 is an enlarged detail sectional view of one of the entry valves.

Fig. 4 is an enlarged detail sectional view of the check valve and its associated parts, which is used to control the entrance of liquid into the pumping system.

Fig. 5 is a sectional view taken along the line 5—5 of Fig. 4.

Figs. 1 and 2 show the general assembly of the parts and in Fig. 2 the parts are arranged as they are inserted in the well. In this figure the well casing is indicated at 5, and is disposed in the well bore in the usual manner. Inserted in this casing 5 is the pump tubing or flowing line 6, which is provided with a plurality of couplings such as 40, one of which is shown in section in Fig. 3. Each of these couplings is arranged to contain the entry valve 41 and it is to be understood that these couplings may be provided in any desired number and spaced as may be necessary to adapt the flowing device to any particular well condition.

In order that pressure may be applied to the well the area or chamber 42, between the tubing 6 and the casing 5, is known as the pressure fluid reservoir. This reservoir is provided by virtue of the casing head seal 7, which serves to form a tight closure around the tubing or flow line and is connected to the casing. An inlet pipe 29 is provided at the top of the casing and below the casing head in order that pressure fluid may be injected into the casing. It is to be understood that this pipe extends to any suitable source of fluid under pressure, such as a compressor or a storage of other fluid which may be taken from adjacent wells or any other suitable source.

Admission of the liquid to be raised is controlled by what may be termed a check or control valve, the entire assembly of which is shown in Figs. 4 and 5. The valve member is indicated at 14. This valve is disposed within a housing made up of tubular members 11 and 12, which may be threaded together or otherwise connected.

It is believed that the manner of flowing oil wells by means of fluid pressure entering the pump tubing or flow line at a plurality of elevations by automatically operable valves is well understood, the basic patent disclosing such construction being that to Greenlee, No. 1,310,615, granted July 22, 1919. The present invention, however, is somewhat similar to the invention set forth in my Patent No. 1,738,974, granted December 10, 1929. It is contemplated, however, that various improvements have been incorporated in the construction and their operation will now be described.

It is intended that the check valve 14 will be operated by the pressure differential between the reservoir 42 and the pressure within the pump tubing 6. It is to be understood that there is a pressure differential between these two locations due to the frictional resistance of the travel of

the liquid upwardly in the pump tubing. As an illustration of this pressure differential it may be assumed that the pressure in the casing and reservoir 42 is one hundred pounds per square inch and that the resistance offered by the flow of liquid in the pump tubing 6 between the bottom of the tubing, as at 31 in Fig. 1, and the point 32, where the pressure fluid is permitted to enter the tubing, is four pounds per square inch. In other words, there is a friction loss of four pounds, so that the pressure exerted on the surface of the liquid at 44, in Fig. 1, is one hundred pounds per square inch, whereas the pressure of the liquid traveling upwardly in the pump tubing 6, adjacent the point 32 or the check valve 14, would be but ninety-six pounds.

In order to take advantage of this pressure differential the housing 12 is provided with the inlet passages or pipes 24. In the present construction two of these pipes are shown as being connected at 24a to the outer housing 12 and are also attached to the inner housing 22 of the valve construction. These passages enter the housing 22, as at 26, so that the pressure in the reservoir 42 is also available in what might be termed the pressure chamber 45 inside of the housing 22. As seen in Fig. 4, the housing 22 is suspended from the entry member 23, which is in turn connected or made integral with the housing 11.

As will be readily apparent from Fig. 4 of the drawing, the liquid passing upwardly from the point 31 in the tubing passes into the area 46 between the housings 12 and 22 and is adapted to flow into the entry chamber 23 and past the valve seat 18 and thence upwardly into the pump tubing. The valve member 14 has an enlarged tapered portion which engages the seat 18 in order to cut off the entrance of liquid to the pump tubing. As previously stated, it is intended to control the movement of this valve 14 by this pressure differential between the casing and the tubing. The one hundred pound pressure previously mentioned as an example is therefore exerted in the chamber 45 against the lower valve head 15. This pressure differential tends to raise the valve head 15 so that it will engage the seat 16 on the lower end of the entry member and in this manner close the passage 17 so that there can be no escape of pressure fluid into the pump tubing around the head 15. It is contemplated that the valve member 14 and its head 15 will be made of any suitable material, preferably of a rather light construction so that the valve member will be raised by the difference in pressure applied to the head 15 and applied to the exposed upper surface of the stem 14', and the valve member proper 14. Thus, as an example, if a pressure of two pounds per square inch is necessary to raise the valve member 14 and its head 15 and there is available a pressure of four pounds per square inch, it seems obvious that the head 15 will move upwardly so as to open the entry passages 25 and permit a flow of liquid upwardly through the entry member and into the pump tubing. The stem 14' is held in position by a guide or spider 20, which is located in the housing 11 and locked in position by the pin 21.

It will be readily understood that when liquid is flowing past the seat 18 there will be some frictional engagement with the valve proper 14, which force also assists the pressure differential in maintaining the valve in raised position. The valve when once raised will remain in open and

stationary position so long as there is a flow of liquid and a pressure differential present. This is of advantage because the valve member will not become worn by such operation. It is believed that the construction and operation of the entry valves 40 are well understood, because the same have been disclosed in my prior patent mentioned. This entry valve comprises a ball valve shown at 27 in Fig. 3, which is free for movement within the valve chamber 30. When the pressure in the casing or reservoir 42 exceeds the pressure in the pump tubing, then the ball 27 will be raised due to the inflow of pressure. The ball 27 is of less diameter than the chamber 30 so that a considerable flow of fluid can be had when the valve is raised from its lowermost position. In other words, so long as there is a small flow of fluid through the chamber 30, the ball 27 will float on the fluid. When, however, the pressure in the tubing 6 drops to a point where it is considerably below the pressure in the reservoir 42, then the flow of fluid through the chamber 30 increases to such an extent that the ball 27 is carried upwardly to the position shown in dotted lines in Fig. 3, as at 28. This closes the outlet from the chamber 30 and prevents any further inflow of pressure fluid. It is well understood that the pressure drop in the tubing 6 is caused by the removal of the heavier liquid from the elevation at which the entry valve is located.

When the pump assembly is positioned in the well the parts will assume the position shown in Fig. 2 with the valve 14 in closed position as indicated at 19. This will of course trap any liquid in the tubing 6 above the valve and so long as there is no pressure in the reservoir 42 there will be no pressure available to raise the valve 14. The entry valves will be in their lowermost position, as seen in Fig. 2, at 37 and 38. When, however, pressure is applied to the reservoir 42 through the pipe 29 this pressure will act on the surface 44 of the liquid in the well so that this liquid will be depressed and caused to enter the lower end of the pump tubing 6. This same pressure is, of course, available through the openings 24 against the head 15 to cause raising of the check valve 14 and permit the entry of liquid into the pump tubing. The check valve is shown in open position as at 10 in Fig. 1. If the liquid extends above the entry valve 8, then the pressure of this liquid exerted in the chamber 30 would cause the valve 27 to move to its lowermost position until such time as the pressure in the reservoir 42 exceeded the pressure of the liquid in the tubing. When this condition occurs the valve 27 would move upwardly and pressure fluid would begin to enter the tubing and aerate the liquid above the valve 8 to such an extent that the liquid would be raised from the tubing. When, however, the weight of the liquid and accordingly the pressure on the valve 8 was reduced to such an extent that the valve 27 floated upwardly to the dotted line position of Fig. 3, then the valve would close. The valve is shown as closed at 8 in Fig. 1 and the liquid above the valve is shown as aerated by the fluid bubbles present in the liquid.

The same occurs in connection with the valve 9 and a continuous flow is thus obtained from the well, it being understood that the valves 8 and 9 open and close automatically depending upon the pressure differential between the tubing and the casing and the rate of flow of the fluid through the valve. It is contemplated that so

long as the pressure differential is present on the head 15 that the valve 14 will remain open.

In some instances the liquid is practically all removed from the well by the entrance of the pressure fluid. In some instances also it is desirable to reverse the position of the valves and the check member in order to allow liquid to accumulate in the wells. To accomplish this, the bypass line 37 has been provided between the casing 5 and the pump tubing 6. In order to take advantage of this construction and to reverse the position of the entry valves and the check valve, the gate valve 35 on the top of the tubing 6 may be closed. This, of course, cuts off the escape of both the pressure fluid and liquid from the tubing so that there will be no further flow of pressure fluid through the entry valves 8 and 9. Obviously the ball 27 in each of these valves will then fall by gravity to its lowermost position. The flow of fluid through the tubing 6 will stop immediately and the heavier liquid will settle down in the tube and cause a pressure on the valve 14. At the same time the valve 35 is closed the valve 36 in the bypass line 37 can be opened. The construction and operation just described can be used in heading a well because when the head is blown off the entry valve will close and then if the gate valve in the tubing is closed to equalize the casing and tubing pressures the position of the valves will be reversed and there will be no further escape of pressure fluid through the valves until the well heads up again. This operation results in an enormous economy of pressure fluid. This operation has been designated as "rocking" the well.

This bypass tends to equalize the pressure between the reservoir 42 and the top of the pump tubing. The opening of this valve 36, of course, balances the two pressures, so that there is no longer any pressure differential available against the head 15 of the valve 14. The valve will then move by gravity to its closed position, which is shown in Fig. 2, and also in Fig. 4. As soon as this has occurred and the valves have been reversed the valve 36 may then be closed and the valve 35 opened so that the liquid having accumulated in the well will again be forced into the tubing and upwardly from the well. It is contemplated, of course, that if desired the valves 35 and 36 may be automatically operated by a diaphragm or other mechanism which can in turn be manipulated by the pressure present in the pump tubing. Thus if all of the liquid is driven from the pump tubing this control device would be operated to close the valve 35 and open the valve 36 so that there would be an accumulation of liquid occurring in the tubing and a reversal of the valves so that they would be ready to again raise the accumulated liquid from the well.

It is, of course, apparent that there can be no escape of pressure fluid downwardly into the tubing 6 past the head 15 when the valve is open, because the valve 15 is raised into engagement with the seat 16.

With the foregoing method and construction any accumulated amount of liquid can be readily raised from the well; the well can be operated either continuously or periodically as desired and complete control is obtained with only a single moving part in the valve construction. This part remains stationary so long as the well is being flowed and is therefore not subject to excessive wear and closed by gravity as soon as the pressure differential is eliminated.

What is claimed is:

1. A well flowing device including a well casing having a pump tubing therein, means to seal said casing and tubing to form a pressure fluid reservoir, a check valve carried by said tubing, a valve head thereon, means to apply the pressure of the reservoir against said head to cause lifting thereof for the entry of liquid, said check valve being adapted to close by gravity.
2. A well flowing device including casing and tubing forming a pressure fluid reservoir, a normally closed entrance valve for the liquid into said tubing, and means whereby said valve will open when the differential pressure between said casing and said tubing is greater in the casing.
3. A well flowing device including casing and tubing forming a pressure fluid reservoir, an entrance valve for the liquid into said tubing, means whereby said valve will open due to the differential pressure between said casing and said tubing, and a by pass from said casing to said tubing to equalize the pressure whereby said valve will close.
4. A check valve for well flowing devices including a housing, a valve member seated in said housing, a pressure chamber opening to the outside of said housing, and means in said chamber and connected to said valve member whereby the pressure differential between the outside and the inside of said housing is exerted thereon to cause opening of said valve member.
5. A gravity closing valve to control the entrance of liquid to a well flowing device which embodies a closed casing, and a tubing therein supporting such valve and including a valve seat, a valve member normally seated thereon, and means operable in response to the pressure differential between the closed casing and the tubing to raise said valve member.
6. A well flowing apparatus comprising, a tubing having an influent inlet and a lifting fluid inlet thereabove, a valve for the influent inlet located in the tubing between the inlets, and operating means for the valve exposed on one side to the submergence pressure of the influent and on the other side to the pressure of the lifting fluid.
7. In a well flowing device embodying a casing and a tubing forming a pressure fluid reservoir, a check valve adjacent the lower end of said casing and normally closed, a valve head below said valve, means opening to said valve for a flow of liquid, means opening to said head for pressure fluid to enter from the reservoir to raise said head and open said valve, and a plurality of automatically operable entry valves disposed along said tubing to raise the flow of liquid past said check valve.
8. In the process of flowing fluid from a well, the method of reversing the position of the valves in an automatically operating system which embodies a closed casing and a tubing with valves controlling the flow of pressure fluid into the tubing, the step of cutting off the flow of liquid from the system and balancing the pressure causing the elevation of the liquid with the column of liquid being elevated so that the valves will move to opposite positions.
9. A method of controlling the operation of a well flowing assembly made up of a flow tubing and pressure fluid inlet valves in said flow tubing, including the steps of applying fluid pressure to open the valves to start the flow of fluid from the well, continuing the pressure until the column of liquid is aerated, discontinuing the application of

fluid pressure, closing off the outlet of the well so that the pressure therein will be equalized with the applied pressure to reverse the valves from the inlet to closed position.

- 5 10. In combination in a well, a casing, a tubing therein, a plurality of automatically operable entry valves on said tubing to admit pressure fluid from the casing to the tubing, a check valve adjacent the lower end of the tubing, a valve to close the top of said tubing, and means to conduct
10 pressure fluid into said tubing below said last valve to equalize the tubing and casing pressure and reverse the position of said entry valves.

11. In a well flowing assembly wherein pressure fluid is disposed between the casing and tubing, an entry valve on the tubing to admit the pressure fluid to the tubing, a valve member in said entry valve, upper and lower seats therefor, said member normally seating on said lower seat but adapted to engage said upper seat when the entry of pressure fluid exceeds a predetermined amount, and means to equalize the casing and tubing pressures so that said member will
5 fall by gravity to the lower seat. 10

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