April 16, 1946. W. E. HALBERT 2,398,527

MEANS FOR FLOWING WELLS

Filed April 6, 1944 2 Sheets-Sheet 1

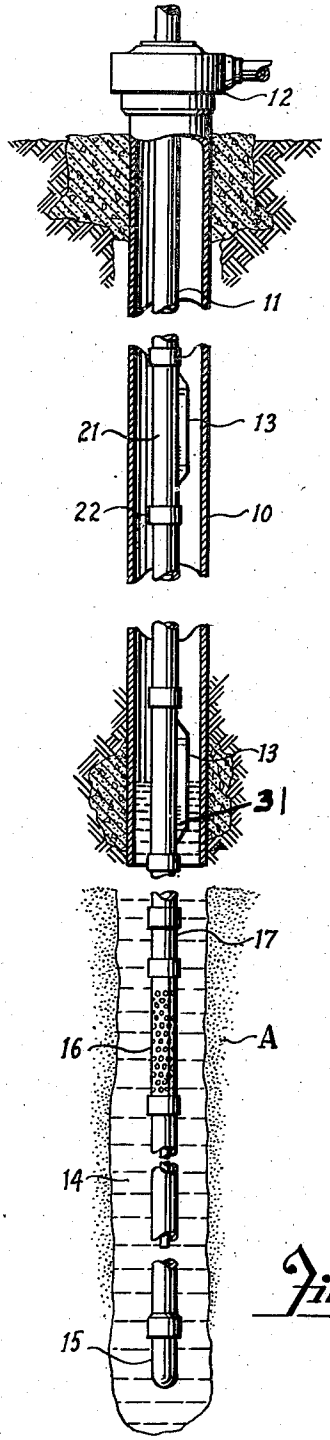


Fig. 1

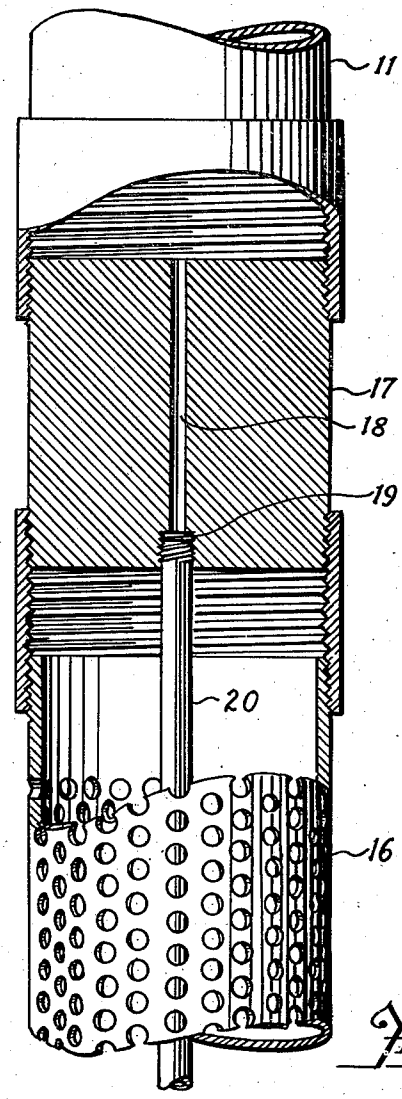


Fig. 2

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MEANS FOR FLOWING WELLS

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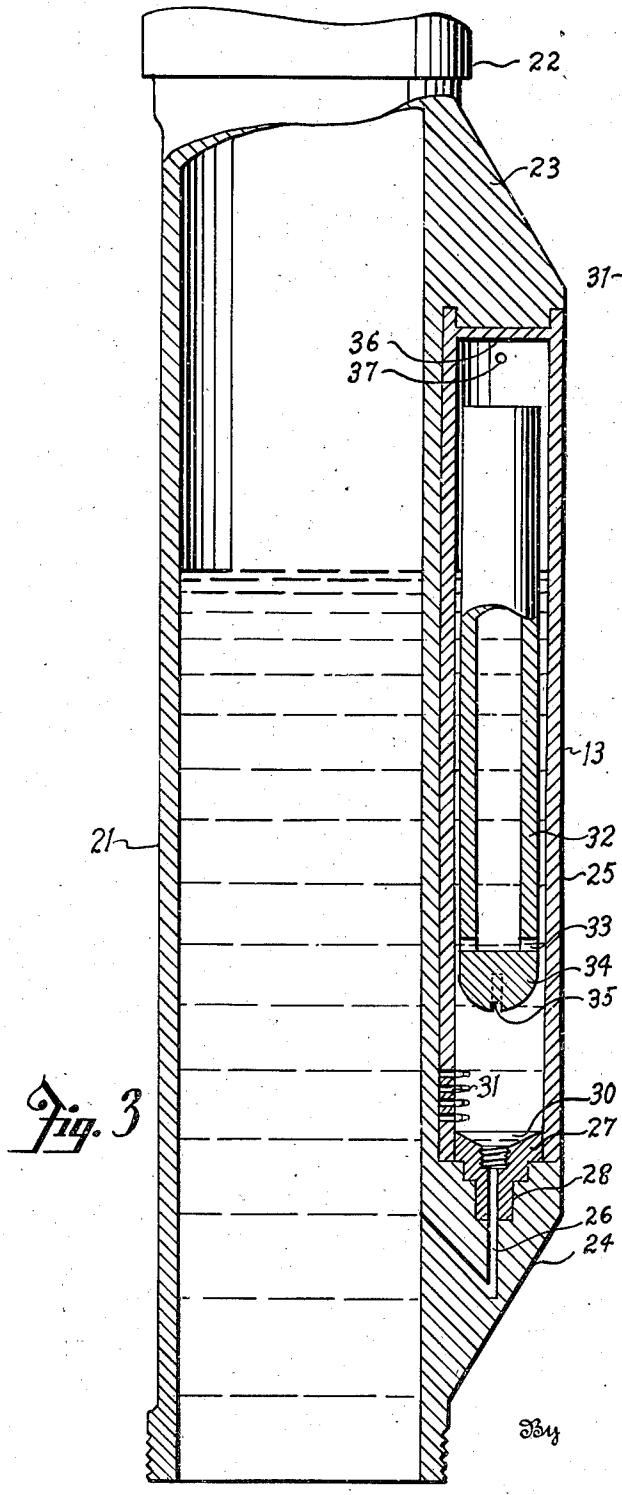


Fig. 3

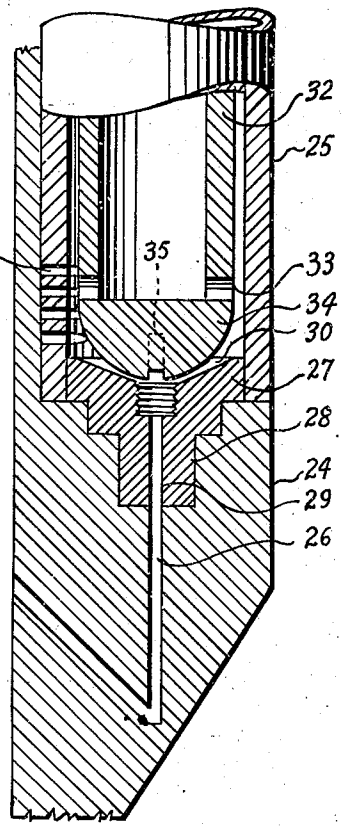


Fig. 4

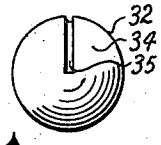


Fig. 5

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2,398,527

UNITED STATES PATENT OFFICE

2,398,527

MEANS FOR FLOWING WELLS

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Application April 6, 1944, Serial No. 529,710

5 Claims. (Cl. 103—231)

This invention relates to new and useful improvements in means for flowing wells.

One object of the invention is to provide improved means for flowing wells so as to prevent the production of an excessive volume of gas, the improved flowing means being particularly adapted to use in wells having a high oil/gas ratio.

An important object of the invention is to provide improved means for flowing wells having a casing head pressure substantially equal to the pressure of the producing formation, which pressure may be relatively low, and including the step of utilizing the well liquid to seal the gas off from the flow conductor whereby the pressure of said gas may be employed to lift said liquid without the usual excessive production of gas and rapid depletion of the formation pressure.

A particular object of the invention is to provide improved well flowing means, of the character described, wherein the flow of liquid through the well conductor is restricted so as to maintain the liquid seal and thereby hold the production of gas to a minimum, the gas being admitted to said conductor at spaced points to assist in lifting the liquid to the surface.

Another object of the invention is to provide improved means for flowing wells from formations having a relatively large volume of gas which includes means associated with the flow conductor for establishing a liquid seal to prevent the entrance of gas into said conductor, together with means for restricting the flow of liquid through the conductor so as to maintain the liquid seal, whereby the production of gas is reduced to a minimum.

A further object of the invention is to provide an improved well flowing apparatus for use in high oil/gas ratio wells having its flow conductor extending below the natural level of the well liquids to provide a liquid seal for trapping the gas thereabove and preventing the same from entering said conductor, there being a choke connected in the conductor for restricting flow therethrough to maintain the liquid seal, together with valves in said conductor at spaced intervals for admitting the trapped gas thereinto to assist in lifting the liquids when the same reach predetermined levels, whereby the pressure of said gas is fully utilized to lift said liquids to the surface without an excessive production of gas and dissipation of the well 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, wherein an example of the invention is shown, and wherein:

Figure 1 is an elevation of an apparatus constructed in accordance with the invention and shown connected in the tubing of a well,

Figure 2 is an enlarged view, partly in section and partly in elevation, showing the choke and its connection to the gas anchor,

Figure 3 is an enlarged, vertical, sectional view of one of the valves in its open position,

Figure 4 is a similar view of the lower portion of the valve shown in its closed position, and

Figure 5 is an end elevation of the lower end of one of the floats, showing its kerf.

In the drawings, the numeral 10 designates the usual well casing which has a flow conductor or well tubing 11 extending axially therethrough. A casing head 12 is connected to the upper end of the well casing for supporting the tubing 11 in the usual manner, said tubing having a plurality of valves 13 connected therein at spaced intervals. The lower end of the tubing depends past the casing into the open well bore 14 which has been illustrated as extending into the producing formation A. A suitable bull plug 15 closes the lower end of the tubing and a perforated section or screen 16 is connected in said tubing at a point in the open well bore 14 intermediate the bull plug and the lowest valve 13. Thus, the well liquids may flow from the formation A through the openings of the perforated section 16 into the tubing so as to be conducted to the surface.

The foregoing represents a typical installation commonly used in flowing wells. However, it has been found that such installations are unsatisfactory in wells having a high oil/gas ratio which is usually caused by the producing formation containing a large volume of gas relative to the quantity of liquid or oil. This results in an excessive casing head pressure which frequently equals or is substantially equal to the bottom hole or formation pressure and such a condition may occur even when the latter pressure is normal or not excessive. It has heretofore been impossible to produce from such a formation without obtaining a relatively large volume of gas which must subsequently be returned to the formation in order to prevent depletion of the formation pressure. Since this return of the gas to the formation is not always possible or practicable, the pressure of said formation has been conserved by the proration authorities placing a limit on the volume

of gas which may be produced in a given period of time. Manifestly, this restriction necessitates the frequent shutting in of wells having a high oil/gas ratio, whereby the pressure of the gas forces the liquid or oil back into the formation so as to leave only a small quantity of liquid in the lower end of the well bore 14. In order to flow a maximum quantity of liquid from wells of the character described hereinbefore and at the same time maintain or conserve the formation pressure, the novel method and apparatus to be hereinafter set forth have been conceived and developed.

As is clearly shown in Figure 2, a choke 17 is connected in the tubing 11 above the perforated section 16 and has a small axial orifice or bore 18 for restricting the flow through said tubing. The lower end of the orifice 18 is enlarged and screw-threaded as shown at 19 for receiving the upper end of an elongate, cylindrical gas anchor or tube 20 which has its bore communicating with said orifice, the bore being of a substantially equal or slightly greater diameter. The tube 20 depends axially through the perforated section 16 with its open lower end terminating at a suitable point below said section, whereby the well bore is shut off from direct communication with the orifice 18 and the well tubing thereabove. Obviously, the liquids within the well bore, after flowing through the perforations of the section 16, must flow downwardly within the annular space between the tubing and the tube 20 to the open lower end of said tube and then through the bore of the tube in order to flow through the choke orifice and into the upper portion of said tubing. Since the well liquids will be standing within the well bore at substantially the level shown in Figure 1, said liquids will seal the lower end of the tube and prevent the gas from entering said tube. Thus, a liquid seal for trapping the gas within the well bore is provided and said gas will remain in the formation or collect within the annular space between the tubing and casing. The pressure of the trapped gas will force the well liquids through the tube 20 and choke orifice 18 into the upper portion of the tubing and said liquids will contain little or no gas, although some gas will naturally be entrained, whereby the pressure of the gas is utilized to lift the fluids without materially depleting such pressure. In the event that the liquid level drops below the lower end of the tube 20 so as to break the liquid seal, the gas may freely enter said tube; however, such an occurrence is normally prevented by the choke 17 which restricts the flow through the tubing and which has its orifice 18 of a diameter sufficient to accommodate a flow within the producing capacity of the formation. In other words, the diameter of the choke orifice may vary from well to well and is provided for the purpose of restricting the flow so as to maintain the liquid seal. If the rate of flow decreases after installation of the apparatus, flow through the tubing may be restricted by the usual surface choke (not shown).

As has been hereinbefore set forth, the gas flowing from the formation A is trapped within the well bore and casing above the liquid level which may vary from time to time. The pressure of this gas may be utilized to assist in lifting the well liquids through the tubing by means of the valves 13 as well as for forcing said liquids through the tube 20 and choke orifice 18. Each valve 13 is of a construction similar to that shown in United States Letters Patent No. 2,089,477, issued to me on August 10, 1937, and includes a tubular body or sleeve 21 which is connected in the tubing 11 by means of suitable coupling collars 22. An upper boss 23 and a vertically-alined, spaced lower boss 24 are made integral with the exterior of the sleeve 21 and have tapered outer surfaces which merge into the end portions of said sleeve. As is clearly shown in Figure 3, a tubular float chamber or casing 25 is mounted longitudinally of the sleeve against the exterior thereof between the bosses. The lower boss 24 is formed with a substantially V-shaped duct 26 which establishes communication between the sleeve and the interior of the chamber 25. A shouldered valve-seat bushing 27 is pressed into a complementary socket 28 formed at the upper end of the lower boss and has an axial bore 29 which registers with the duct 26. The bushing 27 preferably extends above the lower boss and is of such diameter as to fit snugly within the lower end of the chamber 25. A bevelled valve seat 30 is formed in the upper surface of the bushing by enlarging and tapering the upper end of the bore 29. If desired, the upper portion of the bore adjacent the seat 21 may be screw-threaded to permit pulling of the bushing by a suitable tool (not shown). A plurality of parallel, horizontal slits or narrow slots 31 are formed in the lower portion of the chamber wall adjacent the seat 30 for establishing communication between interior of said chamber and the annular space between the well tubing and casing. It is pointed out that the slits 31 are disposed adjacent the sleeve 21 to prevent clogging of said slots upon lowering of said sleeve through the well casing and are relatively narrow so as to prevent the passage of sand or other debris therethrough.

A hollow, cylindrical float 32, of plastic or other suitable material, is disposed within the chamber 25 and is of a diameter sufficient to assure clearance for free upward and downward movement thereof. In order to prevent collapsing of the float, a plurality of radial ports 33 are formed in the lower portion of said float so as to establish communication between the interior thereof and the chamber. The lower extremity of the float is rounded to provide a semi-spherical valve head 34 which is adapted to engage the valve seat 30 as shown in Figure 4 and close the bushing bore 29 and duct 26 so as to shut off communication between the sleeve and chamber. For permitting flow between the sleeve and the chamber when the valve head 34 is engaging its seat, a minute radial kerf 35 is cut in said valve head and extends from the periphery to the axis thereof as is best shown in Figure 5. A suitable transverse partition 36 closes the upper end of the chamber 25, which upper end is fastened to the boss 23 in any suitable manner. Just below the partition, a vent opening 37 is provided.

As has been hereinbefore set forth, a plurality of valves 13 are connected in the tubing 11 at spaced intervals and the lowermost valve may be below the liquid level upon installation as shown in Figure 1. However, the liquid level is subject to variation and is normally below the lowermost valve during flow of the well. The gas trapped within the well bore and casing above the liquid level will, of course, flow through the slits 31 into the chamber 25 and a small portion of the same may escape into the tubing by means of the kerf 35, bushing bore 29 and duct 26 without disturbing the float 32 or moving its head 34 out of engagement with its seat 30. When the liquid level within the tubing 11 rises sufficiently to lift the

float as shown in Figure 3, the pressure of the gas within the well casing will act upon the liquid within the chamber 25 so as to force the same through the bushing bore 29 and duct 26 into the sleeve 21 and thereby elevate the liquid within the tubing. Although the float will fall so as to move its valve head 34 into engagement with the seat 30 when there is no liquid present within the chamber 25, sufficient gas will enter the sleeve prior to this closing action to assist in lifting the liquid within the tubing. Also, the gas which constantly seeps into the tubing due to the provision of the kerf 35 will aerate the liquid column and thereby aid in lifting the well liquids. With the exception of the gas which is entrained in the well liquids, only a very small volume of gas actually enters or escapes through the tubing.

From the foregoing, it is manifest that a simple, efficient, and economical apparatus for carrying out the invention has been provided. The gas is effectively sealed off from the tubing by the provision of the liquid seal, although its pressure is utilized to force the liquid through the tubing and assist in elevating the same. The use of the improved method and apparatus described herein permits the flow of a well having a high oil/gas ratio in a substantially continuous manner without the necessity of frequently shutting the well in. Manifestly the flow may be adjusted not only to the capacity of the well but also to a prorated allowable by varying the diameter of the choke orifice 18.

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 I claim and desire to secure by Letters Patent is:

1. An apparatus for flowing wells from formations having a large volume of gas including, a flow conductor extending axially through the well bore to a point below the natural liquid level of the well, the lower end of the conductor being closed against direct communication with said well bore, means for admitting the well liquids to said conductor above its lower end, means within the conductor extending below the admitting means for causing said well liquids to flow downwardly within said conductor toward its lower end before flowing upwardly therein, whereby a liquid seal is provided for trapping the gas above the well liquids so that the pressure of said gas may be utilized to force said well liquids into the conductor without the gas entering said conductor, and float-actuated means for admitting small quantities of the trapped gas to the flow conductor at spaced intervals to aerate and elevate the liquid column therein.

2. An apparatus for flowing wells from formations having a large volume of gas including, a flow conductor extending axially through the well bore to a point below the natural liquid level of the well, the lower end of the conductor being closed against direct communication with said well bore, means for admitting the well liquids to said conductor above its lower end, means within the conductor extending below the admitting means for causing said well liquids to flow downwardly within said conductor toward its lower end before flowing upwardly therein, whereby a liquid seal is provided for trapping the gas above the well liquids so that the pressure of said gas may be utilized to force said well liquids into the conductor without the gas entering said conductor, float-actuated means for admitting small quantities of the trapped gas to the flow conductor at spaced intervals to aerate and elevate the liquid column therein, and means for restricting the flow through the conductor in accordance with the liquid-producing capacity of the well so as to maintain the liquid seal.

3. An apparatus as set forth in claim 1 wherein each float-actuated means includes a valve chamber communicating with the flow conductor and a float within the chamber for controlling the communication between said chamber and conductor.

4. An apparatus as set forth in claim 1 wherein each float-actuated means includes a valve casing open to the trapped gas and having a port communicating with the flow conductor so as to receive well liquids therefrom, a float disposed within the casing and responsive to the well liquids therein for controlling communication between said casing and conductor through the port.

5. An apparatus as set forth in claim 1 wherein each float-actuated means includes a valve casing open to the trapped gas and having a port communicating with the flow conductor so as to receive well liquids therefrom, a float disposed within the casing and responsive to the well liquids therein for controlling communication between said casing and conductor through the port, the float having means permitting the bleeding of minute quantities of gas from the casing to the conductor through said port when the latter is closed by said float.

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