April 27, 1937. W. L. CLARK 2,078,482

BOTTOM HOLE INTERMITTER

Filed Oct. 5, 1935 2 Sheets-Sheet 1

Fig. 1.

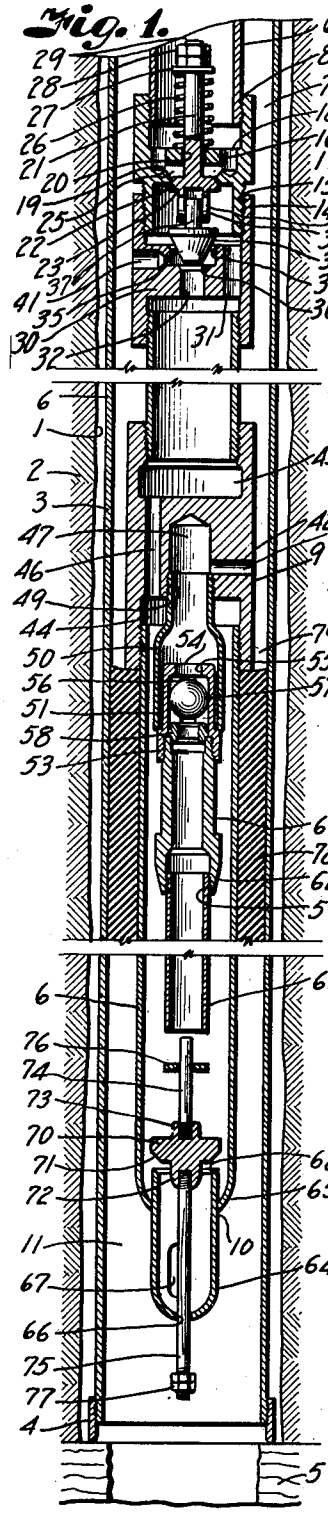

Fig. 2.

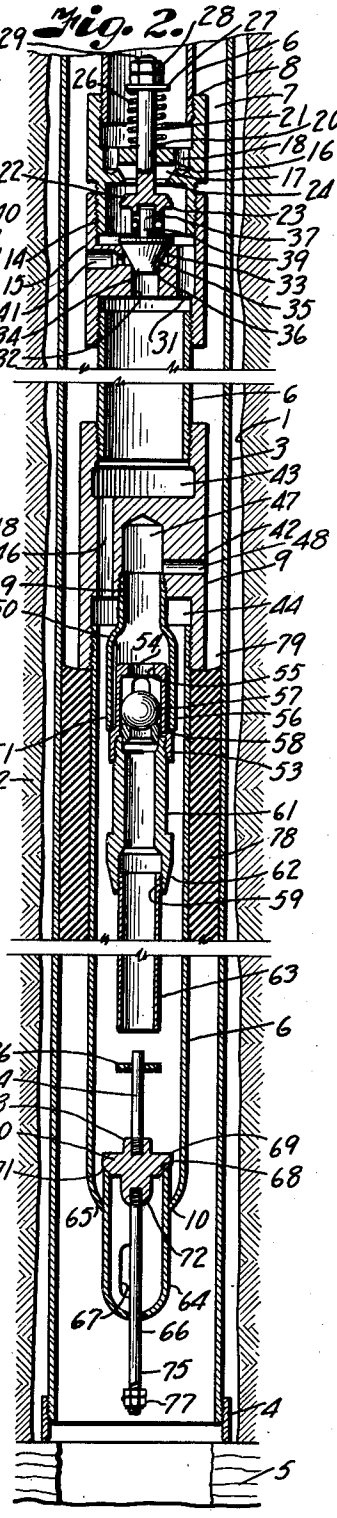

Fig. 3.

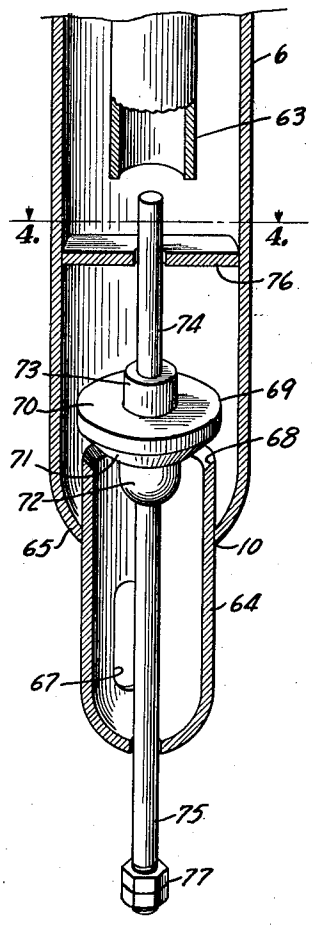

Fig. 4.

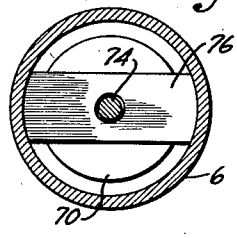

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Fig. 5.

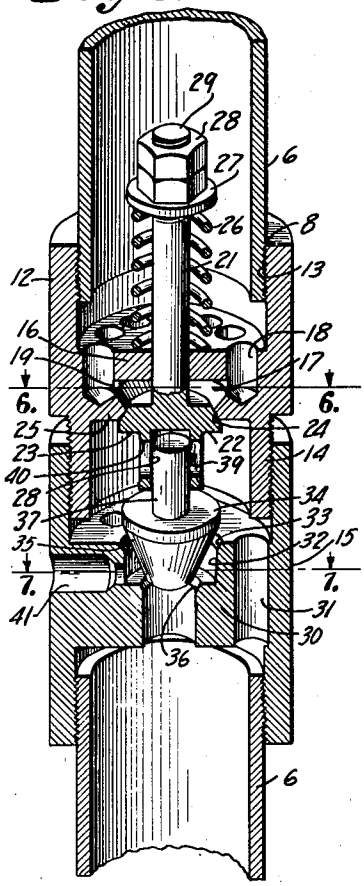


Fig. 6.

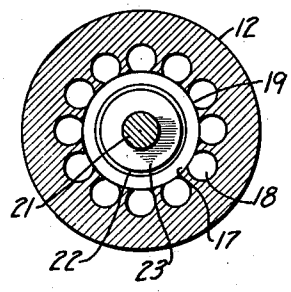


Fig. 7.

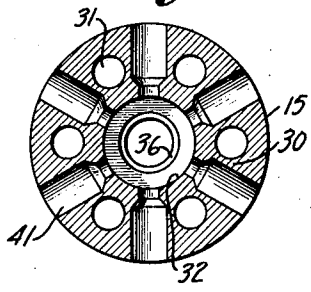


Fig. 8.

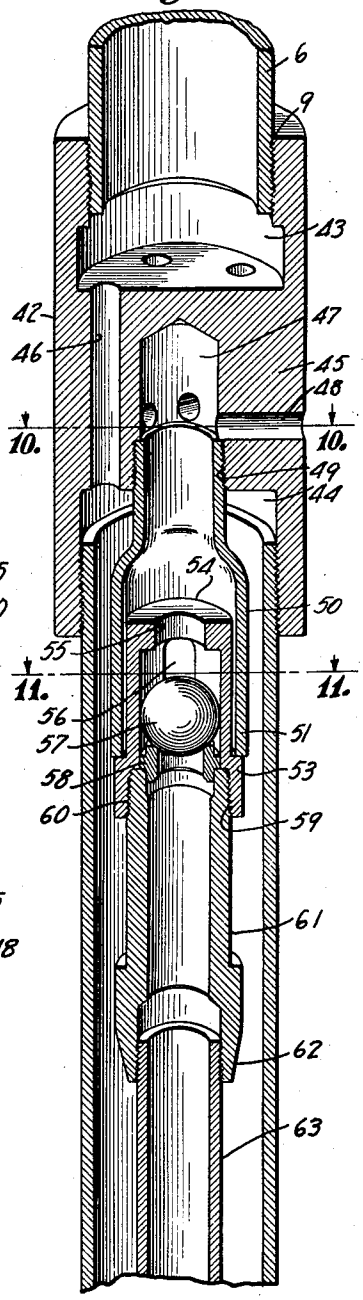


Fig. 9.

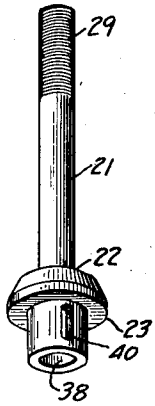


Fig. 10.

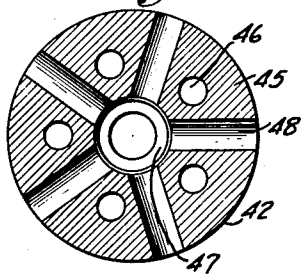
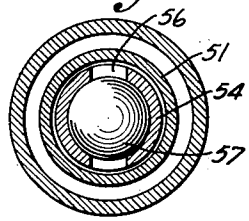


Fig. 11.



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UNITED STATES PATENT OFFICE

2,078,482

BOTTOM HOLE INTERMITTER

William L. Clark, Oklahoma City, Okla., assignor to Clark Bottom Hole Intermitter Company, a corporation of Oklahoma

Application October 5, 1935, Serial No. 43,796

7 Claims. (Cl. 103—234)

This invention relates to well flowing apparatus, and particularly to apparatus for introducing an artificial pressure medium, such as gas or air, to supplement the natural formation pressure in effecting flow of a well, or to effect flow in wells when the natural pressures have become weakened.

The principal object of the present invention is to provide an apparatus wherewith the artificial pressure is introduced without creating back pressure against flow of fluid from the formation.

Other important objects of the invention are to provide an improved apparatus for applying artificial pressure medium to fluid contained in the well; to provide improved controls for regulating application of pressure medium; to prevent slippage of fluid back into the formation; to provide a reservoir at an intermediate stage in the well, which, when filled with fluid, does not interfere with further flow of fluid from the formation; and to provide for diverting pressure medium to and from the stages of the well.

In accomplishing these and other objects of the invention, I have provided improved details of structure, the preferred form of which is illustrated in the accompanying drawings, wherein:

Fig. 1 is a vertical fragmentary section of a well equipped with apparatus embodying the features of the present invention and showing fluid being admitted to the bottom of tubing in the well.

Fig. 2 is a similar section showing the standing valve closed, the gravity valve closed and the artificial pressure inlet valve open for admitting pressure medium to lift the well fluid contained in the reservoir toward the top of the well.

Fig. 3 is an enlarged detail perspective view of the bottom of the tubing showing the standing valve and valve cage.

Fig. 4 is a horizontal section on the line 4—4, Fig. 3.

Fig. 5 is an enlarged detail perspective view of the gravity and artificial pressure inlet valves.

Fig. 6 is a horizontal cross-section on the line 6—6, Fig. 5.

Fig. 7 is a horizontal cross-section on the line 7—7, Fig. 5.

Fig. 8 is an enlarged detail perspective view of the injector mechanism.

Fig. 9 is an enlarged detail perspective view of the artificial pressure inlet valve and stem.

Fig. 10 is a horizontal section on the line 10—10, Fig. 8.

Fig. 11 is a horizontal section on the line 11—11, Fig. 8.

Referring more in detail to the drawings:

1 designates a well hole extending from the surface of the earth 2 to a subsurface fluid producing formation from which fluid flows into the bottom of the well hole by gravity or by the natural formation pressure.

The well hole is provided with the usual casing 3 having its lower end supported by a casing shoe 4 seated on a cap rock 5 above the fluid bearing formation (not shown). The end of the casing above the surface of the earth is provided with conventional mechanical means (not shown) for supplying fluid pressure into a string of tubing 6 for flowing or lifting a body or "slug" of well fluid, which collects in the annular space 7 between the casing 3 and tubing 6, to the surface of the earth as later fully described.

The tubing is provided with a fluid pressure medium control mechanism generally designated 8 and particularly shown in Fig. 5, which usually is coupled to the tubing about 1000 feet above the bottom of the well hole; an injector mechanism 9 particularly shown in Fig. 8, usually connected with the tubing in the casing preferably 200 feet above the bottom of the casing; and an inlet valve mechanism 10, particularly shown in Fig. 3, connected with the tubing and which is placed as close to the bottom of the well hole as is practicable. The tubing 6 is preferably suspended from above to support the inlet valve mechanism within the end of the casing 3 so that it is protected thereby. It is obvious, however, that should the well fluid supply be depleted or the formation pressure become insufficient to lift the fluid 11 into the casing, the tubing may be lowered in such a manner that the valve mechanism is retained in submerged condition relative to the well fluid issuing from the oil sands.

The fluid pressure mechanism includes a collar 12 having an internally threaded upper end 13 screwed onto the threads of one of the joints of tubing 6, and having an externally threaded lower end 14 to engage the internal threads of a coupling member 15 screwed onto the next lower joint of the tubing. Extending across the collar 12 substantially midway thereof, is a partition 16 having a recess 17 in its lower face, and which communicates with the upper portion of the tubing through a circular series of openings 18. The openings 18 are drilled from the upper face of the partition, and in intersecting relation to the

side wall of the recess, to provide ports 19 for passing a fluid pressure medium.

The partition 16 has a central bore 20 for passing the stem 21 of a valve 22. The valve is particularly shown in Fig. 9 and includes a head 23 bevelled at its upper edge to seat, when the valve is in closed position, against a corresponding bevelled edge 24 of an annular lip 25 extending circumferentially of the recess. The lip 25 has its upper edge bevelled downwardly from the ports 19 toward the valve seat so that the pressure medium is deflected with a jetting action against the valve head. The valve is normally retained in closed position by a coil spring 26 having its lower end bearing against the upper face of the partition 16 and its upper end bearing against a washer 27 held in place by lock nuts 28 screwed on the upper threaded end 29 of the valve stem 21. The spring may be adjustably tensioned to exert sufficient action to retain the valve 22 closed until a predetermined pressure has been built up above the valve, as later described.

The coupling member 15 has a central, horizontal partition 30, provided with a circular series of apertures 31 for passing the pressure medium to lower reaches of the well tubing when the valve 18 is opened. The partition 30 also has a central bore 32, enlarged at its upper end to form a valve seat 33 for a gravity valve 34. The gravity valve includes a tapering body 35 having its lower end of suitable diameter to also engage a seat 36 formed at the smaller portion of the bore. The valve body carries an upwardly extending stem 37 of such length as to engage within a socket 38 formed on an end depending from the head 23 of the valve 22. The stem 37 of the gravity valve carries a pin 39 that engages in slots 40 formed in the sides of the socket 38, the slots being of sufficient length to allow opening movement of the gravity valve when the valve 22 is open, but when the valve 22 closes under action of the spring the pin 39 engages the lower end of the slots to unseat the gravity valve. The gravity valve is thus under control of the valve 22, and is guidingly supported thereby in its upward travel in such a manner that it will not become completely disaligned with its seat.

Extending radially through the partition between the apertures 31 and terminating within the bore 32 at a point between the seats 33 and 36, are by-pass vents 41, particularly shown in Fig. 7, so that when the gravity valve is raised, pressure medium from above and below the partition 30 will escape through the vents to the top of the well.

As above pointed out, the control mechanism just described is connected with the tubing at preferably approximately 1000 feet above the bottom of the casing, and the tubing continues downwardly to the injector mechanism 9 that is applied therein at preferably about 200 feet above the bottom of the casing, as now described.

The injector mechanism includes a cylindrical block 42 having recessed ends 43 and 44 internally threaded to connect with joints of the tubing 6 at the desired elevation. The cylindrical block 42 has a central body portion 45 provided with a series of spaced channels 46 extending vertically therethrough in circumferential relation to a central chamber 47 opening upwardly from the lower recess 44, but terminating short of the upper recess 43, which chamber is connected with the annular space between the casing and tubing through radial outlet ports 48 located between the channels 46, for leading pressure medium to the annular space 7, and for permitting well fluid to accumulate therein, as later described.

Immediately below the outlet ports 48, the recessed end 44 is threaded as at 49, to receive a swedged nipple 50 having an enlarged skirt portion 51 welded or otherwise secured as at 52, to a slightly enlarged rim 53 of a valve cage 54. The cage 54 has a port 55 in its upper end, and slots 56 in its sides for passing pressure medium and well fluid to the outlet ports 48. The cage 54 retains a ball 57 that seats by gravity on a valve seat 58 for preventing back flow when pressure below the valve is reduced.

The lower end of the valve cage 54 is internally threaded, as at 59, to receive the upper external threads 60 of a connection 61. The connection 61 is of cylindrical shape and is provided with an enlarged lower end which is slightly tapered as at 62, to reduce resistance to flow up the tubing, and which is internally threaded to receive the upper end of an externally threaded line of inner tubing 63, for a purpose later described.

The cage 64 of the oil inlet valve mechanism 10 (Fig. 3), is secured to an inwardly flaring lower end 65 of the tubing by welding or the like. The lower end of the cage is in the form of an inverted dome to close the bottom of the flowing apparatus, except for a hole 66 centrally of the dome for a purpose to be described, and slots 67 for passing well fluid to the cage.

The upper end of the valve cage extends within the end 65 of the tubing and terminates in an inwardly bevelled valve seat 68 for a gravity valve 69. The gravity valve includes a head 70 having a tapered face 71 to seat on the bevel 68. The lower face of the valve is provided with a dome-shaped boss 72, and its upper surface with a boss 73; the bosses being centrally bored to receive upper and lower valve stems 74 and 75. The upper stem 74 projects upwardly to a point slightly below the inner tubing 63 and is guidingly supported by a cross plate 76, shown in Fig. 4. The plate 76 extends laterally and centrally across the tubing and is relatively narrow to allow passage of well fluid from the formation upon opening of the valve. The lower valve stem 75 projects through the hole 66 in the bottom of the valve cage and is provided with stop nuts 77 screwed thereon.

As above pointed out, the standing valve is positioned within the casing at the bottom thereof and is submerged in the well fluid. As the formation pressure rises, the well fluid collects within the tubing which forms a collecting chamber, and the gravity valve prevents back flow therefrom into the formation.

Mounted on the tubing directly below the cylindrical body is a packer 78, of any conventional design, for sealing with the casing and forming a bottom for the annular flow space to provide a reservoir 79. The packer thus supports the weight of well fluid contained therein and prevents the pressure medium from acting against flow of well fluid from the formation.

The operation of a flowing apparatus constructed and assembled as described, is as follows:

Well fluid is admitted to the lower end of the tubing through the standing valve and due to formation pressure is forced upwardly therein to a point at which the pressure of the hydrostatic head equals the formation pressure. Assuming that the formation pressure is sufficient for this purpose, well fluid rises in the casing to the packer

78, and through the inner tubing 63 to the ball valve 57 and outlets 48, where it starts to fill the reservoir 79.

Well fluid is also forced up the tubing 6, by formation pressure, to pass through the perforations 46 of the block 45 and continues upwardly to pass the gravity valve 34 and flow through the outlet ports into the reservoir 79.

If the formation pressure has become so depleted that the well fluid will not flow to the top of the well, artificial pressure medium is introduced to the tubing 6 in predetermined quantities and intervals for further lifting the well fluid.

Assuming that the reservoir is filled with well fluid to a point above the outlets 48, the pressure medium is forced down the tubing through the perforations 18 to unseat the valve 22 against tension of its spring 26, which allows seating of the gravity valve. The pressure medium then continues downwardly through the perforations 31 and 46 arriving at the bottom of the well, where it is turned back by the closed end of the tubing. When the pressure medium enters the tubing 6, the liquid therein is expelled through the inner tubing 63 and is followed by the pressure medium which seeks the path of least resistance. The pressure medium then rushes up the inner tubing 63 through the ball valve 57 and outlets 48, aerating the well fluid with which it comes in contact and forcing through the fluid above it to lift the well fluid to the surface.

When the pressure medium is shut off at the top of the well by a suitable time cycle controlled valve (not shown), pressure tends to equalize on the respective sides of the valve, whereupon the spring 26 becomes effective to close the valve 22 and effects unseating of the gravity valve 34, to permit free escape of pressure medium from the vents 41. The reservoir then again fills with well fluid by means of the formation pressure, as above described, to continue the flow cycles.

From the foregoing, it is apparent that I have provided an improved apparatus for flowing wells wherein artificial pressure medium cooperates with the formation pressure to lift oil to the surface of the earth in a safe and practical manner.

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

1. In a well flowing apparatus including the well tubing, means forming a well fluid collecting chamber having a well fluid inlet, an outlet and a vent port, packing means connected with the well tubing below the outlet and vent port to form a reservoir and flow chamber having connection with said collecting chamber through the outlet, valve means for controlling the well fluid inlet, means for admitting a fluid pressure medium to the collecting chamber to effect flow of well fluid into the reservoir and toward the top of the well, a check valve preventing back flow of well fluid from the reservoir to the collecting chamber, a spring loaded valve for controlling flow of pressure medium, and a gravity valve controlling the vent port and adapted to unseat incidental to closure of the spring loaded valve for venting the collecting chamber to the reservoir.

2. Well flowing apparatus of the character described including a casing, a main tubing within the casing, a fluid inlet valve at the bottom of the tubing, packing means sealing off the main tubing and casing to form a reservoir for well fluid, an inner tubing located within and connected to the main tubing above the fluid inlet valve and having a flow connection with the reservoir, a check valve connected with the inner tubing, a vent valve in the main tubing above the check valve, a pressure medium control valve for admitting a supply of pressure medium for effecting flow of well fluid past the check valve and through the reservoir, and a connection between the vent valve and pressure medium control valve for unseating said vent valve upon closure of said control vale.

3. Well flowing apparatus of the character described including a casing, a main tubing within the casing, a fluid inlet valve mechanism at the bottom of the tubing, packing means sealing off the main tubing and casing to form a reservoir for well fluid, an inner tubing within the main tubing and having a flow connection with the reservoir, means for preventing back flow of well fluid through the inner tubing, and means in said main tubing for controlling a supply of pressure medium for effecting flow of well fluid through the inner tubing to the reservoir, including means for venting the tubing below said control means.

4. In a well flowing apparatus, a casing, a tubing within the casing, packing means sealing off the tubing and the casing to form a reservoir for well fluid, means forming a collecting chamber in the lower end of the tubing, means for admitting well fluid into the collecting chamber, flow conducting means connecting the collecting chamber with the reservoir, coupling means inserted in the tubing above the collecting chamber and having an inlet seat and spaced outlet seats, said coupling having a passageway for flow of pressure medium through the inlet seat to the collecting chamber and a vent port between the outlet seats in communication with the collecting chamber through one of said outlet seats, an inlet valve for said inlet seat to control flow of pressure medium from the tubing to the collecting chamber, a spring loading said inlet valve, a gravity valve engaging said outlet seats to normally close flow from the collecting chamber through the vent port and having lost motion connection with said inlet valve whereby said valve is seatable for diverting flow of pressure medium to the collecting chamber when the inlet valve is open and free to unseat for venting the collecting chamber through the vent port when the inlet valve is closed, and check means for preventing back flow of well fluid from the reservoir into the collecting chamber.

5. In a well flowing apparatus, a casing, a tubing within the casing, packing means sealing off the tubing and the casing to form a reservoir for well fluid, means forming a collecting chamber in the lower end of the tubing, means for admitting well fluid into the collecting chamber, flow conducting means connecting the collecting chamber with the reservoir, a coupling member connected in the tubing and having a valve seat, an inlet valve for said seat to control flow of pressure medium from the tubing to the collecting chamber, a spring loading the valve, a second coupling having spaced valve seats and having a vent port between said seats and a port by-passing said seats for passing the pressure medium to the collecting chamber, a gravity valve engaging said last named seats to close flow through the vent port and having lost motion connection with said inlet valve whereby said valve is seatable for diverting flow of pressure medium to the collecting chamber when the inlet valve is open and free to unseat for venting the collecting chamber through the vent port when the inlet

valve is closed, and check means for preventing back flow of well fluid from the reservoir into the collecting chamber.

6. In a well flowing apparatus, a casing, a tubing within the casing, packing means sealing off the tubing and the casing to form a reservoir for well fluid, means forming a collecting chamber in the lower end of the tubing, means for admitting well fluid into the collecting chamber, flow conducting means connecting the collecting chamber with the reservoir, a coupling member connected in the tubing and having a valve seat, an inlet valve for said seat to control flow of pressure medium from the tubing to the collecting chamber, a spring loading the valve, a second coupling having spaced valve seats and having a vent port between said seats and a port bypassing said seats for passing the pressure medium to the collecting chamber, a gravity valve engaging said last named seats to close flow through the vent port, a socket projecting from one of the valves, a stem projecting from the other valve and guidingly retained in the socket whereby the last named valve is seatable upon opening of the spring loaded valve to divert flow of pressure medium to the collecting chamber and movable from said seats for venting the collecting chamber when the inlet valve is closed, and means for preventing back flow of well fluid from the reservoir into the collecting chamber during venting of said collecting chamber.

7. In a well flowing apparatus, a tubing, packing means on the tubing for sealing off the tubing with a well in which the tubing is inserted to form a reservoir for well fluid exteriorly of the tubing, means connected with the tubing and forming a collecting chamber at the lower end of the tubing, means for admitting well fluid into the collecting chamber, flow conducting means connecting the collecting chamber with the reservoir, insert means in the tubing above the collecting chamber and having spaced aligning passageways and a lateral vent port intersecting the lower passageway and communicating with the reservoir, an inlet valve for controlling flow of pressure medium through the upper passageway, a spring normally retaining the inlet valve in seated position, a vent valve operable in said lower passageway to close the passageway above and below the vent port, means interconnecting said valves whereby the vent valve closes the vent port when the inlet valve is opened for diverting flow of pressure medium to the collecting chamber and whereby the vent valve is opened to vent the collecting chamber when the inlet valve is closed, and check means for preventing back flow of well fluid from the reservoir into the collecting chamber.

WILLIAM L. CLARK.