Jan. 3, 1933. C. D. RUBEL 1,893,151

PNEUMATIC DISPLACEMENT PUMP

Original Filed June 11, 1927 4 Sheets-Sheet 1

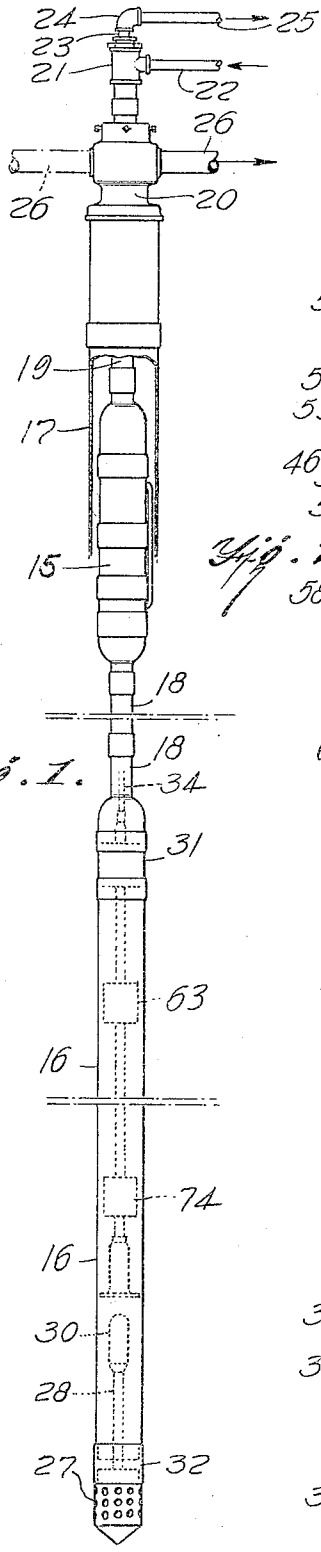


Fig. 1.

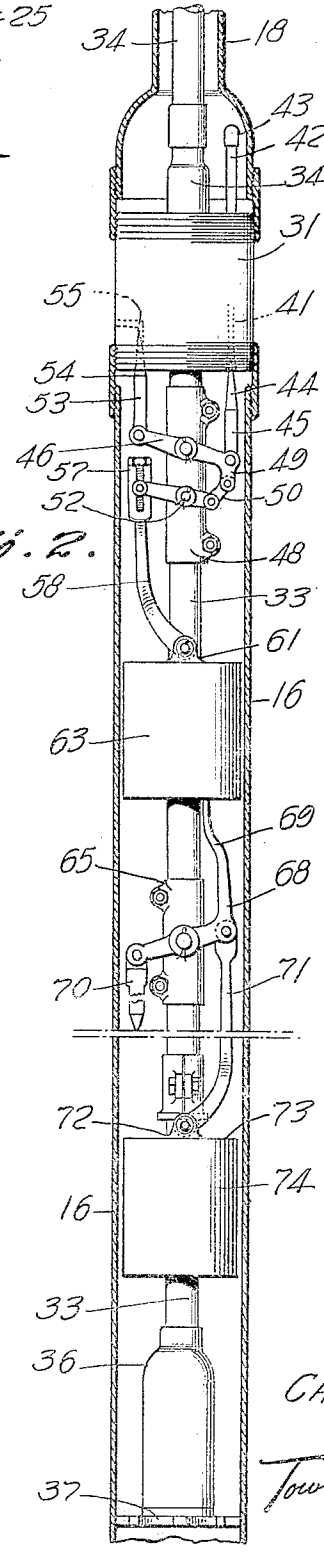


Fig. 2.

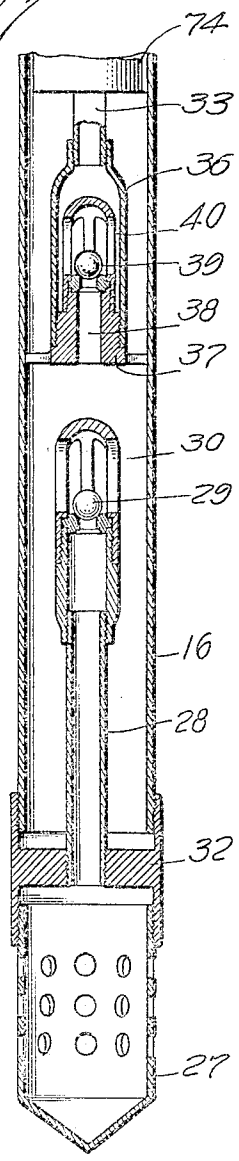


Fig. 3.

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PNEUMATIC DISPLACEMENT PUMP

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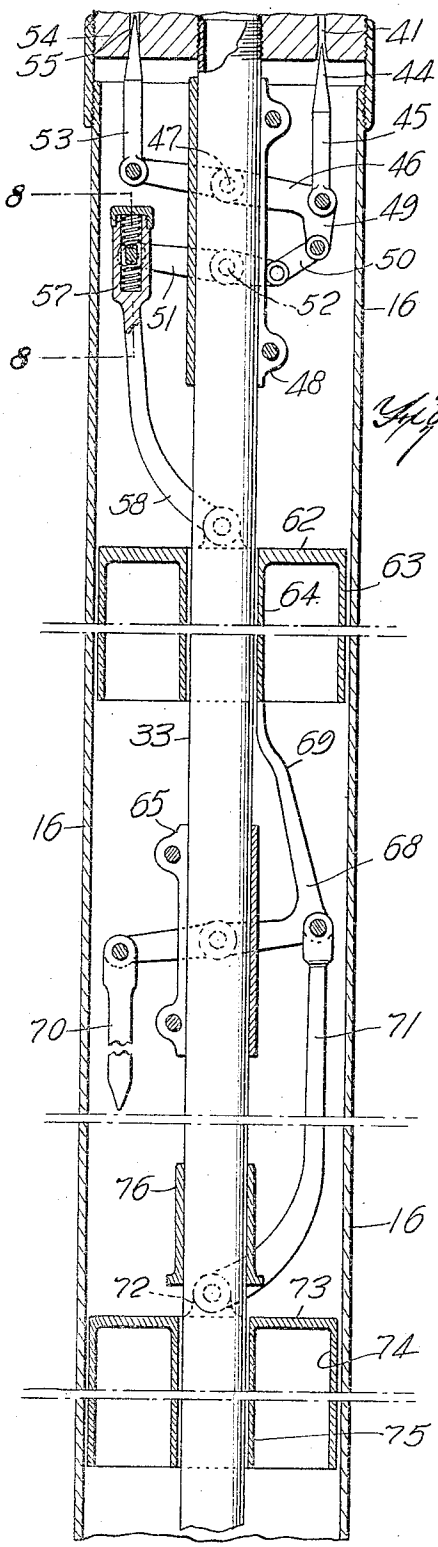


Fig. 4.

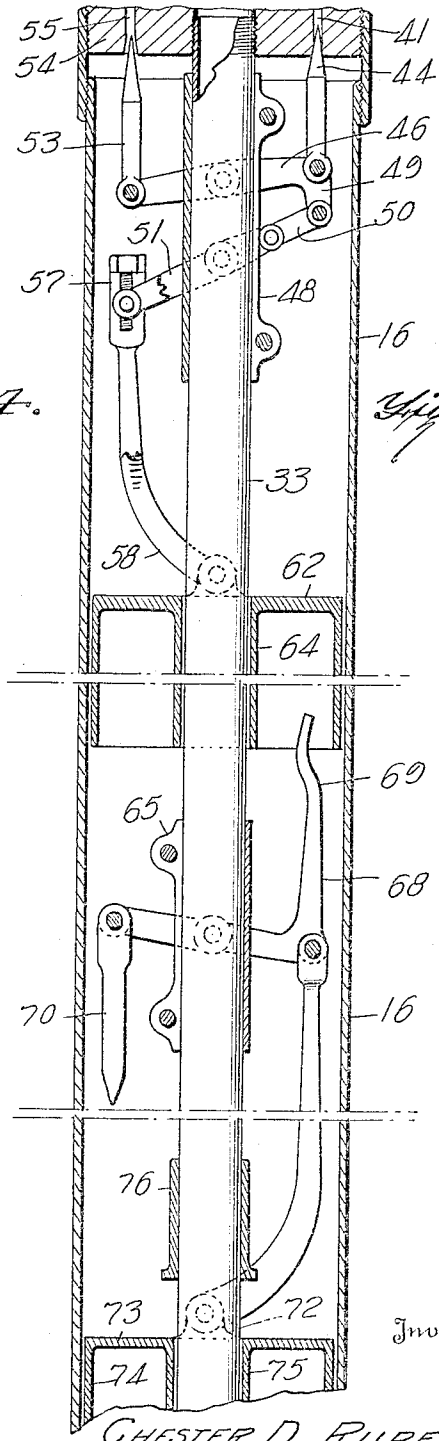


Fig. 5.

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PNEUMATIC DISPLACEMENT PUMP

Original Filed June 11, 1927 4 Sheets-Sheet 3

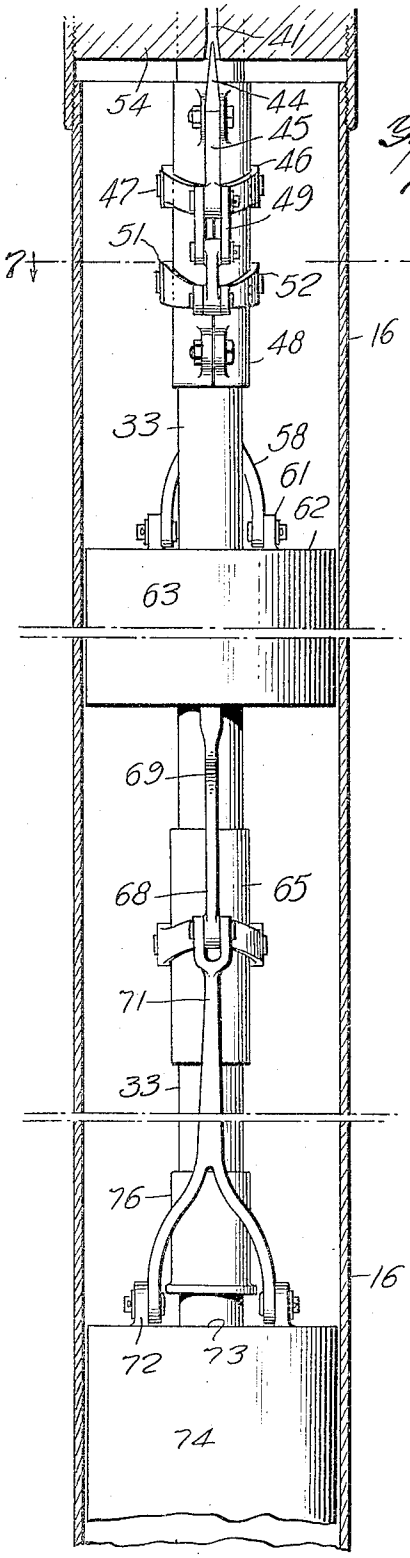


Fig. 6.

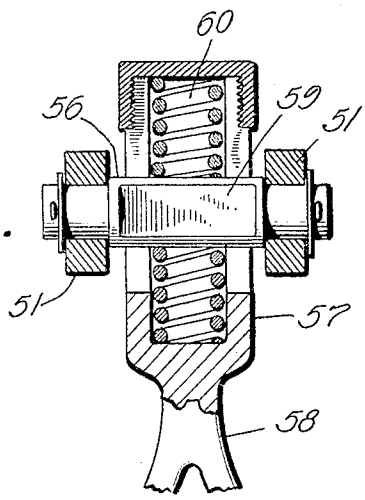
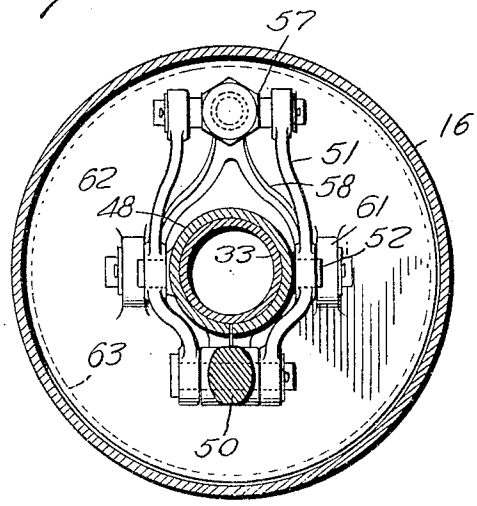


Fig. 8.

Fig. 7.



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PNEUMATIC DISPLACEMENT PUMP

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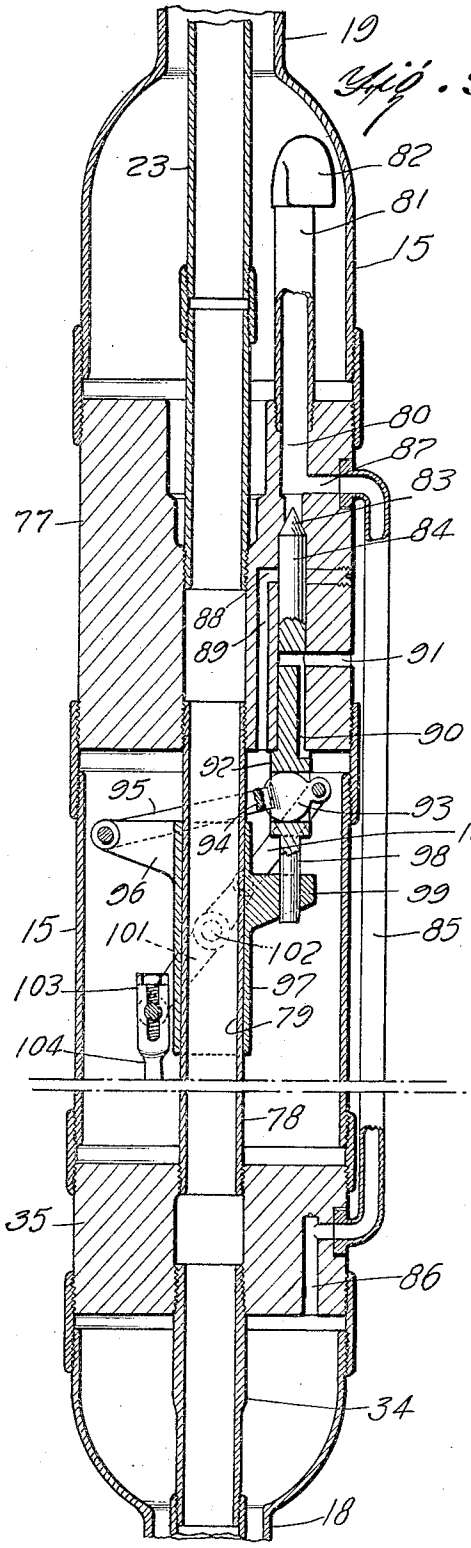


Fig. 9.

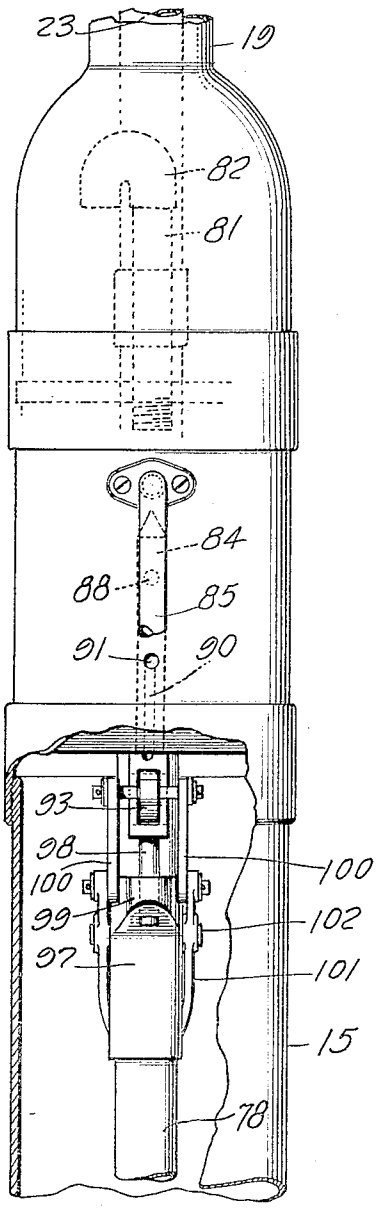


Fig. 10.

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UNITED STATES PATENT OFFICE

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PNEUMATIC DISPLACEMENT PUMP

Application filed June 11, 1927, Serial No. 198,182. Renewed June 18, 1931.

This invention relates generally to pumps of the pneumatic displacement type, and in particular to lift pumps for oil wells. This specification and the accompanying drawings describe and illustrate a practical, physical embodiment of the principles of my invention, and while the use in the disclosure is limited to oil wells, I desire it to be understood that the invention is intended for and is capable of use in any pumping system, or arrangement for elevating liquids.

The primary object of the invention is to provide an improved pneumatic displacement pump of the kind which operates automatically under the control of the liquid within the well; more particularly, to provide an improved valve mechanism or valve operating mechanism for pumps of the kind indicated.

The invention is illustrated in the accompanying drawings.

In the drawings, Figure 1 is a vertical elevation of a pump system constructed in accordance with the principles of my invention, as applied in an oil well casing.

Figure 2 is a detail elevation, partly in section, of the float and valve mechanism of the lowermost pump unit or bottom trap.

Figure 3 is a vertical sectional view of the lowermost portion of the bottom trap.

Figure 4 is an enlarged vertical detail section of the float and valve mechanism shown in Figure 2, with the pressure inlet valve in open position and pressure exhaust valve closed.

Figure 5 is a section similar to Figure 4, with the inlet valve closed and the exhaust valve opened.

Figure 6 is a section taken from the right of Figure 4, with the float and valve details in elevation.

Figure 7 is a horizontal section on the line 7—7 of Figure 6.

Figure 8 is a detailed sectional illustration of the arm and lever connection shown at the upper left of Figures 4 and 5.

Figure 9 is a vertical section through the valve mechanism of an upper or intermediate pump unit or trap.

Figure 10 is an elevation, partly in section, from the right of Figure 9.

A preferred assembly for deep wells is shown in Figure 1. In detail, the pump comprises one or more pump units or traps represented by the upper barrel or pump casing 15 and a lower barrel or pump casing 16, which, when in the forms illustrated, are preferably spaced several hundred feet apart within the well casing 17, being serially connected by a reduced pipe line 18. The external diameter of the pump unit barrels is appreciably less than the internal diameter or bore of the well casing 17, to provide an effective clearance therebetween. The upper pump unit 15 connects at its top with a reduced air inlet pipe 19 which extends up through the casing head 20 to a T joint 21, having connection thereat with a pipe line 22 leading from a suitable source of pneumatic pressure, not shown, such as an air or gas compressor. Extending down through the top of the T joint 21 is an oil discharge pipe 23 having an elbow connection 24 with the oil discharge line 25 from the well. The oil pipe 23, as will be hereinafter explained, is of a smaller diameter than the air line 19, through which it passes, and is continuous, through proper section joints, to the bottom of the upper pump unit 15. It will of course be understood that the usual packing is provided at the casing head to prevent any leakage of oil, air or gas at that point. Casing head gas and exhaust air are permitted to pass through the exhaust conduits 26 leading from the casing head 20.

The lower end of the bottom pump unit barrel 16 has secured thereto a conventional sand strainer plug 27 above which is disposed, internally of the barrel, the oil inlet conduit 28 provided with the usual ball check valve 29 operating in the cage 30. It will be understood of course that my invention is not limited to the joint use of a plurality of pumping units of which 15 and 16 are representative; one unit only may be used, as will be apparent.

The bottom pump unit, within the barrel 16 will now be described in detail. As shown in Figure 2, the top of the barrel 16 is con-

nected to the intermediate pipe line 18. Adjacent its upper end the barrel 16 is closed by a head plug 31 of solid formation, and at its lower end it is closed by a bottom plug 32, above the sand plug 27, and which carries the inlet conduit 28. Extending centrally down through the barrel 16 is an oil discharge pipe 33 which connects at its upper end through the head plug 31 with an intermediate oil discharge pipe section 34, which section extends upwardly through the pipe line 18 to a connection with the bottom plug 35 of the upper pump unit barrel 15, as shown in Figure 9. The lower end of the oil pipe 33 has attached thereto a bell nipple 36 into the lower open end of which is threaded a spider 37 having an oil inlet bore 38 controlled by the ball check valve 39 operating in its cage 40 carried by the spider plug within the nipple 36. From this construction it will be apparent that under proper operation of the pump, oil entering the barrel through the sand strainer and valve 29, may be forced through the inlet 38 and up through the oil pipe 33 to the upper pump unit in the barrel 15.

The head plug 31 is provided at one side of the oil line with a vertical air passage formed therethrough, as at 41. Threaded into the upper end of the passage 41 is an upstanding air pipe 42 provided at its upper end with a reverse elbow 43 in open communication with the interior of the pipe line 18. The purpose of the elbow 43 is to preclude the possibility of scale and dirt from dropping into and clogging the air pipe 42, while at the same time permitting free passage of air through the pipe and passage 41. The lower end of the passage 41 communicates with the interior of the barrel 16 below the plug 31, and in this illustrative embodiment, is formed as a seat for a needle valve 44 on a stem 45, the lower end of which is pivotally connected to and between the adjacent long arm ends of a pair of bell crank levers 46 pivoted intermediate their ends on lateral trunnions 47 carried by a split sleeve casting 48 rigidly clamped on the oil pipe 33.

The short arm sections 49 of the bell crank levers 46 have pivotal connection with a link 50 depending therefrom and in turn pivotally connected to the adjacent end of a pair of rocking levers 51 pivoted intermediate their ends on lateral trunnions 52 carried by the split sleeve 48 in vertically spaced relation below the trunnions 47, whereby the long arms of the bell crank levers 46 and the rocking levers 51 are disposed in parallel vertically spaced relation. On the opposite side of the oil pipe 33, the bell crank levers 46 are pivotally connected at their ends to the stem 53 of a needle valve 54 having a seat in an air exhaust passage 55 formed through the plug 31 and opening laterally from the plug into the space between the barrel 16 and the well casing 17.

Beneath the valve stem 53, the ends of the rocking levers 51 are pivotally secured over the ends of a pin 56 mounted for vertical movement in a slotted guide 57 formed integral with the upper end of a forked arm 58. Movement of the pin 56, which has flat side portions 59 for sliding engagement with the edges of the slot in the guide, is resisted in opposite directions by tension elements 60 which may be small coil springs housed within the guide 57. The forked arm 58 is curved inwardly and the lower end of each fork is pivotally connected to a lug 61 on opposite sides of the oil pipe 33 and formed integral with and on the flat top 62 of a float 63 of cylindrical formation having a lower open end and a central sleeve 64 through which the oil pipe 33 passes and by which the float is slidably disposed on the oil pipe for vertical movement thereon.

At an appreciable distance below the bottom of the float 63, the oil pipe 33 has clamped thereon in rigidly secured relation a second split sleeve casting 65 provided with lateral trunnions 66 on which are pivoted the forked short arms 67 of a bell crank lever 68 having a single upstanding long arm 69 and constituting a latch to hold the float 63 in or near its uppermost position. The upper end of the arm 69 is curved inwardly toward the oil pipe 33 and is adapted in one position of the lever 68, to seat under and engage the lower end of the sleeve 64 at the bottom of the float 63, as seen in Figure 4. The free ends of the short arms 67 have pivotally connected thereto a depending counterweight 70, the function of which is normally to depress the ends of the arms 67 so as to maintain the arm 69 engaged against the pipe 33 or the sleeve 64 of float 63 upwardly inside of the float.

Directly beneath the arm 69, the bell crank lever 68 is pivotally connected to the upper end of a float arm 71 generally similar in construction to the arm 58 of the upper float 63, which arm 71 is pivotally connected at its lower end to lugs 72 formed integrally on the flat top 73 of a lower float 74 similar in construction to the float 63, and provided with a sleeve 75 surrounding the oil pipe 33. A stop sleeve 76 is rigidly secured on the oil pipe above the top of the float 74 to limit the upward travel of the float on the oil pipe. The external diameter of each float is less than the internal diameter of the barrel 16 so that a sufficient clearance is provided between the floats and the barrel for oil to pass freely upward or pass the floats in the operation of the pump.

The upper pump unit contained in the upper barrel 15 is in general principle similar to the lower unit, with however, certain structural differences. In the upper unit as shown in Figures 9 and 10, the upper portion of the barrel 15 is closed by the solid head plug 77

while its lower end is closed by the solid bottom plug 35 through which communication is established between the oil pipe section 34 and the oil inlet pipe 78 of the upper unit. Although not shown in Figures 9 and 10 wherein the parts have been omitted for economy of space and to avoid repetition of detail already illustrated, it is to be understood that the inlet pipe 78 is provided above the plug 35 with a ball check valve and cage similar to the valve 29 and cage 30 shown in Figure 3, and also that the oil discharge pipe 79 depending from the head plug 77 has on its lower end a bell nipple, spider and ball check valve assembly identical in structure to the bell nipple 36, spider 37, ball valve 39 and cage 40 shown in Figure 3. The head plug 77 is formed as shown with a central bore through which communication is established between the oil discharge pipe section 79 and the upper oil discharge pipe 23 leading to the top of the well.

At one side of the oil discharge line the plug 77 is formed with a vertical air passage bore 80 into the upper end of which is threaded a short air pipe 81 having a reverse elbow 82 on its upper end in open communication with the interior of the barrel 15 below the pipe 19. In the lower portion of the bore 80 a needle valve 83 having a cylindrical plug or body 84 is arranged for vertical sliding movement to control the passage of the pressure medium to the interior of the barrel 15 below the plug 77. The entire upper pump unit is provided with a by-pass 85 for the pressure medium, which consists of an air pipe disposed externally of the barrel 15 in the clearance provided between the barrel and the well casing. This by-pass pipe extends from the head plug 77 downwardly the entire length of the pump unit, having at its lower end communication with an air passage formed through the bottom plug 35, designated as 86, which air passage enters laterally of the plug and opens at the bottom thereof. At its upper end the by-pass communicates with a lateral bore 87 extending through the plug 77 into communication with the bore 80 at a point above the seat of the needle valve 83. By this construction a means is provided whereby with the valve 83 closed against its seat, air pressure may be by-passed around the upper pump unit to the lower unit.

In the closed position of the valve 83 the body 84 also closes a lateral bore 88 formed through the plug 77 and communicating with a vertical bore 89 opening through the plug to the interior of the barrel 15, whereby no air is permitted to reach the interior of the barrel. In open position of the valve the point 83 is lowered below the bore 88 thus establishing communication between the pressure supply bore 80 and the interior of the barrel through the bore 89. The interior of the barrel is exhausted through a groove 90 provided in the valve plug 84 when, in closed position of the valve relative to pressure inlet, the head of the groove registers with a lateral bore 91 extending through the plug 77 to the exterior thereof, whereby the barrel may be exhausted into the well casing.

The lower end of the valve plug 84 is formed below the head plug 77 with a yoke 92 within which is seated a ball 93 formed integrally on the end portion of a forked lever 94 having arms 95 at opposite sides of the oil pipe 79, which arms are pivoted at their ends to a lateral lug 96 formed on the sleeve 97 clamped on the oil pipe below the head plug 77. The lower portion of the yoke 92 is formed with a stem 98 slidable vertically in the bore of a guide lug 99 with which the sleeve 97 is provided. Beyond the ball 93 the free end of the forked lever 94 is pivotally connected with a depending link 100 which is in turn pivotally connected to the adjacent end of a rocking lever 101 pivoted intermediate its ends on lateral trunnions 102 carried by the sleeve 97 substantially midway between its ends. The opposite end of the rocking lever 101 is in pivotal connection with a slotted guide 103 at the upper end of a float arm 104, which connection and float arm is identical in structure to that of the float arm 58 as shown in Figures 4 and 5. It is to be understood that within the barrel 15, the float arm 104 is connected to a two float assembly which is identical in every detail with the two floats 63 and 74 as shown in Figures 4 and 5, the only difference between the upper and lower pump units being in the valve structure and the by-pass arrangement of the upper unit.

In operation the action of the pump is entirely automatic. A constant pneumatic pressure, such as compressed air or gas, is supplied through the air inlet pipe 22 and pipe 19 to the upper portion of the upper unit barrel 15 above the plug 77. At the start of the cycle in either of barrels 16 or 15 the parts will be in the positions as shown in Figures 5 and 9. Assuming that the lower pump unit barrel is being filled, the action is as follows. Pressure within the chamber formed by the interior of the lower barrel 16 having been exhausted, oil will flow through the sand plug 27 and inlet conduit 28 past the ball valve 29 to the interior of the lower barrel chamber, rising under its own pressure of flow upwardly to the lower float 74. It may again be noted here that as the oil rises, the floats 63 and 74 are in the position shown in Figure 5. As the oil continues to rise it will enter the open bottom of the float 74, trapping air therein and rendering the float buoyant whereby it will rise with the column of oil within the chamber of the barrel. As the oil and float 74 continue to rise, the flat top 73 of the float will

engage against the stop sleeve 76, or the upper end of lever arm 69 will strike the sleeve 64, and further upward travel of the float will be arrested. However, due to the clearance between the walls of the floats and the barrel, the oil will continue to rise in the chamber above the arrested float and up into the open bottom of the upper float 63, trapping air therein and lifting this float to the position as shown in Figure 4. In the lifting action of the float 63 its sleeve 64 clears the upper end of the trigger arm 69 on the bell crank lever 68, and the top of the arm 69 will fall against the oil discharge pipe 33 and under the bottom end of the float sleeve 64, as shown in Figure 4, whereby the float 63 will be locked in raised position until the trigger 69 is released from under the sleeve 64.

The air or gas pressure in the passage or inlet port 41 tends to thrust the valve 44 to its passage-open position, but during the time in which the oil is rising in the barrel 16 and until the float 63 rises, the inlet valve 44 is held closed against its seat in the air passage 41 by valve latch mechanism here constituted by link 50 and lever 51 and the dead center alignment of the link 50 with the lever 51, and the exhaust valve 54 is open permitting the rising column of oil to force air within the barrel out into the well casing through the exhaust port 55. When the float 63 is lifted on the rising oil level, the arm 58 will be moved upwardly elevating the attached end of the levers 51 which rock on the trunnions 52 depressing the link connection 50 and breaking the dead center lock. This action also rocks the bell crank levers 46 on their pivots 47 to force the exhaust valve 54 upwardly into closed position against its seat, and at the same time the inlet valve 44 is lowered into open position. As in the upward movement of the float 63 the trigger arm 69 engages under the sleeve 64, the float will be locked in raised position and the exhaust valve will thus be held closed against its seat, the resilient connection of the guide 57 of the arm 58 with the levers 51 permitting the necessary play to insure proper seating of the exhaust valve.

When the inlet valve 44 opens the air pressure supplied through pipe 22, pipe 19, upper pump unit pipe 81, around the upper unit through the by-pass 85, passage 86, and air line 18, will enter the barrel 16 above the head plug 31 and the air under pressure will enter the chamber of the barrel below the head plug 31 through elbow 43, pipe 42 and air passage 41. The pressure of this air within the chamber of the barrel 16 acting against the top of the oil column therein, will force the oil down in the barrel closing the ball check valve 29, so that under continuation of applied pressure the oil will be forced through the valve 39 and bell nipple 36 up into the oil discharge pipe 33. The oil is forced upwardly in the discharge pipe 33 until its level in the barrel 16 has been driven below the top of the lower float 74, whereupon the float will drop down and exert a pull on the arm 71 to depress the bell crank lever 68, releasing the trigger arm 69 from under the upper float sleeves 64, whereupon the float 63 also drops, and through the medium of its arm 58 rocks the levers 51 to snap the inlet valve 44 into closed position as shown in Figure 5. This closing action of the valve 44 also opens the exhaust valve 54, and the accumulated air in the barrel chamber is exhausted into the well casing as previously described.

On the cessation of pressure on the column of oil being forced up in the oil discharge pipe 33, the check valve 39 will close holding the oil in the discharge pipe. Under the natural flow of the oil through the sand plug 27, the chamber of the barrel 16 will again be filled with oil as above described until the floats have risen to close the exhaust valve and open the inlet valve 44, upon which the cycle of operations just described is repeated and more oil is forced up in the discharge pipe 33. This elevating action of the lower pump unit continues automatically and the oil in the discharge pipe rises until it flows out of the discharge pipe 34, in the present instance flowing through the oil inlet check valve previously referred to as being at the bottom of the upper pump unit barrel 15, above its bottom plug 35.

As the chamber of the upper unit barrel 15 is equipped with a float assembly identical with the float assembly of the lower pump unit, it will be apparent that the rising oil level in the upper unit barrel will through the medium of the floats, elevate the arm 104, as seen in Figure 9, rocking the lever 101 on its pivots 102 to depress the link 100 and draw down the ball 93 and arm 95. Through the connection of the ball 93 with the yoke 92, the valve stem 84 will be lowered in the bore 80 until its head 83 has cleared the port 88, whereupon the head of the exhaust passage 90 in the valve 84 will have moved down out of registry with the exhaust port 91. In this position of the parts the compressed air or other medium will enter the chamber of the barrel 15 below the plug 77 through the inlet passage 89 acting on the oil column therein to force oil up into the oil discharge pipe 79 and through its communicating section 23 to its delivery through the discharge line 25 at the top of the well, after the unit has operated the required number of times to elevate the oil to the top of the well.

As in the case of the lower pump unit, when the oil level in the barrel 15 drops below the top of the lower float, the upper float will drop drawing down the arm 104 and moving the parts into the position shown in

Figure 9, in which the inlet valve head 83 is forced upwardly into closed position against its seat in the air passage 80, and the exhaust port 91 is opened so that oil entering the barrel from the lower pump unit by way of the oil pipes 34 and 78, will exhaust the air into the well casing. As soon as the oil level rises to elevate the floats, the cycle of operations is repeated and the unit again functions to lift the oil further in the discharge line.

In the case of wells which approximate about three hundred feet in depth, the pump may be operated using only the lower unit and eliminating the upper unit from the assembly. At a depth of three hundred feet the pump with a single unit, can be operated with a pneumatic pressure of approximately 135 pounds. In the case of a deeper well, it may be operated with a single unit but the pressure must be increased. In deep wells a plurality of pump units may be employed, and it will be apparent that the greater number of units employed of the kind illustrated, the less pressure is required for operation. Where a plurality of units like those illustrated are made use of, all units above the lowermost are of the by-pass construction as shown in Figures 9 and 10, because it is desirable that all the lifting power come from a common source of pressure supply.

Pumps constructed in accordance with my invention may be operated by utilizing the Bradenhead gas pressure at the casing head as the pneumatic pressure medium, thus making the entire apparatus a self contained automatic pump wherein the operating power is supplied by the well itself. The pump action is entirely automatic and the reduced pressures on the working parts, both of the power medium and oil column, eliminates the heavy wear on the parts, increasing the life of the pump immeasurably far beyond pumps heretofore employed in this art.

While in the disclosed embodiment of my invention I have illustrated and described certain details, I desire it to be understood that the invention is not limited thereto, but that any desired changes and modifications may be made in construction within the scope of the invention as claimed.

I claim:—

1. The combination with an oil well casing, of a pump comprising successively arranged serially connected barrels disposed in the casing for vertical movement therein, an oil discharge pipe line leading from and through said barrels to the top of the well, a pneumatic pressure supply pipe leading from the top of the well to said barrels and surrounding said oil discharge pipe, a check valved oil inlet in the bottom of each barrel, a pressure inlet and exhaust valve control means in each barrel, and liquid level controlled means in each barrel for operating said inlet and exhaust valve control means, the overall width of the assembly being less than the internal diameter of the well casing.

2. A pneumatic pressure liquid elevator comprising a chamber adapted to be filled with liquid under natural flow from the bottom, a vertical discharge pipe for the liquid leading from said chamber, a plurality of floats slidably disposed in vertical spaced relation on said discharge pipe, means for supplying and exhausting a pneumatic pressure medium from the top of said chamber, valved control means for said last named means and operatively connected with the uppermost of said floats, said operative connection acting to limit the downward movement of said uppermost float, a latch pivoted on said discharge pipe intermediate said floats, and means on a lower float for operating said latch to lock said uppermost float in raised position until the liquid level in said chamber falls below said lower float.

3. In a pneumatic pump, a pump chamber, a liquid discharge pipe, a float slidable vertically thereover, a sleeve rigidly secured to said pipe above said float, valve means for alternately supplying and discharging a pneumatic pressure medium above said float, a compound lever mechanism supported on said sleeve for operating said valve means, and a lever actuating arm having pivotal connection at its opposite ends to said float and an element of said compound lever.

4. In a pneumatic displacement pump, the combination of means providing a chamber having an inlet port for fluid under pressure and an exhaust port, valve mechanism for opening and closing the passageways through said ports alternately, means providing a discharge passage for the fluid to be pumped, leading from the bottom portion of said chamber, fluid-responsive mechanism actuable by the rise and fall of fluid to be pumped within said chamber and connected to said valve mechanism to control both the opening and the closing of both the passageway through said inlet port and the passageway through said exhaust port, said fluid-responsive mechanism being free to act in one direction by movement of the fluid to be pumped within said chamber, means for temporarily holding said fluid-responsive mechanism against actuation in the opposite direction, and means to actuate said means which temporarily holds the fluid-responsive mechanism against actuation.

5. In a pneumatic displacement pump, the combination of means providing a chamber having an inlet port for fluid under pressure and an exhaust port, valve mechanism for opening and closing the passageways through said ports alternately, means providing a discharge passage for the fluid to be pumped, leading from the bottom portion of said chamber, fluid-responsive mechanism,

accessible to fluid to be pumped, actuable by the rise and fall of fluid to be pumped within said chamber and connected to said valve mechanism to control both the opening and the closing of both the passageway through said inlet port and the passageway through said exhaust port, said fluid-responsive mechanism being free to act in one direction by the movement of the fluid to be pumped within said chamber, means for temporarily holding said fluid-responsive mechanism against actuation in the opposite direction, and means accessible to fluid to be pumped, to actuate said means which temporarily holds the fluid-responsive mechanism against actuation.

6. In a pneumatic displacement pump, the combination of means providing a chamber having an inlet port for fluid under pressure and an exhaust port, valve mechanism for opening and closing the passageways through said ports, alternately, means providing a discharge passage for the fluid to be pumped, leading from the bottom portion of said chamber, a member in the chamber, liftable by fluid therein to be pumped, connected to said valve mechanism for actuating the same to open and close both said passageways as said member rises and falls, a latch mechanism for temporarily holding said member in one of its positions, said member being free to move to said one of its positions and a second member in the chamber, liftable by the fluid therein to be pumped, to actuate said latch mechanism.

7. In a pneumatic displacement pump, the combination of means providing a chamber having an inlet port for fluid under pressure and an exhaust port, valve mechanism for opening and closing the passageways through said ports, alternately, means providing a discharge passage for the fluid to be pumped, leading from the bottom portion of said chamber, a member in the chamber, liftable by fluid therein to be pumped, connected to said valve mechanism for actuating the same to open and close both said passageways as said member rises and falls, a latch mechanism for temporarily holding said member in one of its positions, said member being free to move to said one of its positions and means to actuate said latch mechanism.

8. In a pneumatic displacement pump, the combination of means providing a chamber having an inlet port for fluid under pressure and an exhaust port, valve mechanism for opening and closing the passageways through said ports, alternately, means providing a discharge passage for the fluid to be pumped, leading from the bottom portion of said chamber, a member in the chamber, liftable by fluid therein to be pumped, connected to said valve mechanism for actuating the same to open and close both said passageways as said member rises and falls, latch mechanism to hold said member in an upper position, said member being free to move to said upper position, and a second member in the chamber, at a lower level than the first mentioned member also liftable by the fluid in the chamber to be pumped, to release said latch mechanism to permit the first mentioned member to move downwardly.

9. In a pneumatic displacement pump the combination of means providing a chamber having an inlet port for fluid under pressure and an exhaust port, valve mechanism including valve means for opening and closing the passageways through said ports alternately and valve latch mechanism to hold at least one of said valve means in one of its positions, at least said one of said valve means being of such type that the load thereon tends to thrust the same toward its opposite position, means providing a discharge passage for the fluid to be pumped, leading from the bottom portion of said chamber, fluid-responsive mechanism, accessible to the fluid to be pumped and actuable by the rise and fall of said fluid, to cause the actuation of said one valve means to the first-mentioned of its positions, means for temporarily holding said fluid-responsive mechanism against movement in the direction to cause the actuation of said one valve means to its said first-mentioned position, said fluid-responsive mechanism being free to act in the opposite direction by movement of the fluid to be pumped, and means to actuate said means which temporarily holds the fluid-responsive mechanism against movement.

10. In a pneumatic displacement pump, the combination of means providing a chamber having an inlet port for fluid under pressure and an exhaust port, valve mechanism including valve means for opening and closing the passageways through said ports alternately and valve latch mechanism to hold one of said valve means in its passageway-closed position, at least said one of said valve means being of such type that the load thereon tends to thrust the same toward its passageway-open position, means providing a discharge passage for the fluid to be pumped, leading from the bottom portion of said chamber, fluid-responsive mechanism, accessible to the fluid to be pumped and actuable by the rise and fall of the fluid to be pumped within said chamber, to produce the movement of said one of the valve means to its passageway-closed position, means for holding said fluid-responsive mechanism against movement temporarily in the direction to cause movement of said one of the valve means to its passageway-closed position, said fluid-responsive mechanism being free to act in the opposite direction by movement of the fluid to be pumped, and means to actuate said means which temporarily holds the

fluid-responsive mechanism against movement.

11. In a pneumatic displacement pump, the combination of means providing a chamber having an inlet port for fluid under pressure and an exhaust port, valve mechanism including valve means for opening and closing the passageways through said ports alternately and valve latch mechanism to hold the valve means for said inlet port in passageway-closed position, said valve means for the inlet port being of such type that the fluid pressure at the inlet port tends to thrust the said valve means toward passageway-open position, means providing a discharge passage for the fluid to be pumped, leading from the bottom portion of said chamber, fluid-responsive mechanism, accessible to the fluid to be pumped and actuable by the rise and fall of the fluid to be pumped within the chamber, to produce the movement of said valve means for the inlet port to its passageway closed position, means for holding said fluid-responsive mechanism against movement temporarily in the direction to cause movement of said valve means for the inlet port toward its passageway-closed position, said fluid-responsive mechanism being free to act in the opposite direction by movement of the fluid to be pumped, and means to actuate said means which temporarily holds the fluid-responsive mechanism against movement.

12. The subject matter of claim 11, characterized by the fact that said fluid-responsive mechanism is a float, said means for temporarily holding said float against movement so holds said float against downward movement, and said means to actuate said temporary holding means is a float below the first mentioned float.

13. In a pneumatic displacement pump, the combination of means providing a chamber having an inlet port for fluid under pressure and an exhaust port, valve mechanism for opening and closing the passageways through said ports alternately, means providing a discharge passage for the fluid to be pumped, leading from the bottom portion of said chamber, latch mechanism to hold the valve of at least one of said ports in one of its positions, and a float in the chamber, liftable by the liquid in said chamber to be pumped, to both release said latch mechanism and actuate said valve.

14. In a pneumatic displacement pump, the combination of means providing a chamber having an inlet port for fluid under pressure and an exhaust port, valve mechanism for opening and closing the passageways through said ports alternately, means providing a discharge passage for the fluid to be pumped, leading from the bottom portion of said chamber, latch mechanism to hold the valve of at least one of said ports in one of its positions, a float in the chamber, liftable by the liquid in said chamber to be pumped, to both release said latch mechanism and actuate said valve, latch mechanism to engage and hold said float in one of its positions, and means to release the last mentioned latch.

15. The subject matter of claim 14, characterized by the fact that the last mentioned means is a float within said chamber.

16. The subject matter of claim 14, characterized by the fact that the last mentioned latch mechanism holds said float in an upper position, and the last mentioned means is a float in said chamber at a lower level than the first mentioned float.

17. The subject matter of claim 13, characterized by the fact that said valve is the valve opening and closing the passageway through said inlet port.

18. In a pneumatic displacement pump the combination of means providing a chamber having an inlet port for fluid under pressure and an exhaust port, valve mechanism including valve means for opening and closing the passageways through said ports alternately and valve latch mechanism to hold at least one of said valve means in one of its positions, means providing a discharge passage for the fluid to be pumped, leading from the bottom portion of said chamber, a float, accessible to the fluid to be pumped and actuable by the rise and fall of said fluid, to cause the actuation of said one valve means to the said one of its positions when the float moves in one direction and to release said latch mechanism when the float moves in the opposite direction, a float latch for temporarily holding said float against movement in the direction to cause the actuation of said one valve means to its said one of its positions, said float being free to act in the opposite direction by movement of the fluid to be pumped, and means to actuate said float latch which temporarily holds the float against movement.

19. In a pneumatic displacement pump, the combination of means providing a chamber having an inlet port for fluid under pressure and an exhaust port, valve mechanism including valve means for opening and closing the passageways through said ports alternately and valve latch mechanism to hold the valve means for said inlet port in passageway-closed position, means providing a discharge passage for the fluid to be pumped, leading from the bottom portion of said chamber, a float, within the chamber and actuable by the rise and fall of the fluid to be pumped within the chamber, to produce, by the downward movement of the float, the movement of said valve means for the inlet port to its passageway-closed position, and, by its upward movement, to operate said latch mechanism to release the valve means for the inlet port, a float latch for holding said float against downward movement tem-

porarily, said float being free to act in the upward direction by movement of the fluid to be pumped, and means to actuate said float latch which temporarily holds the float against movement.

In testimony whereof I affix my signature.

CHESTER D. RUBEL.