

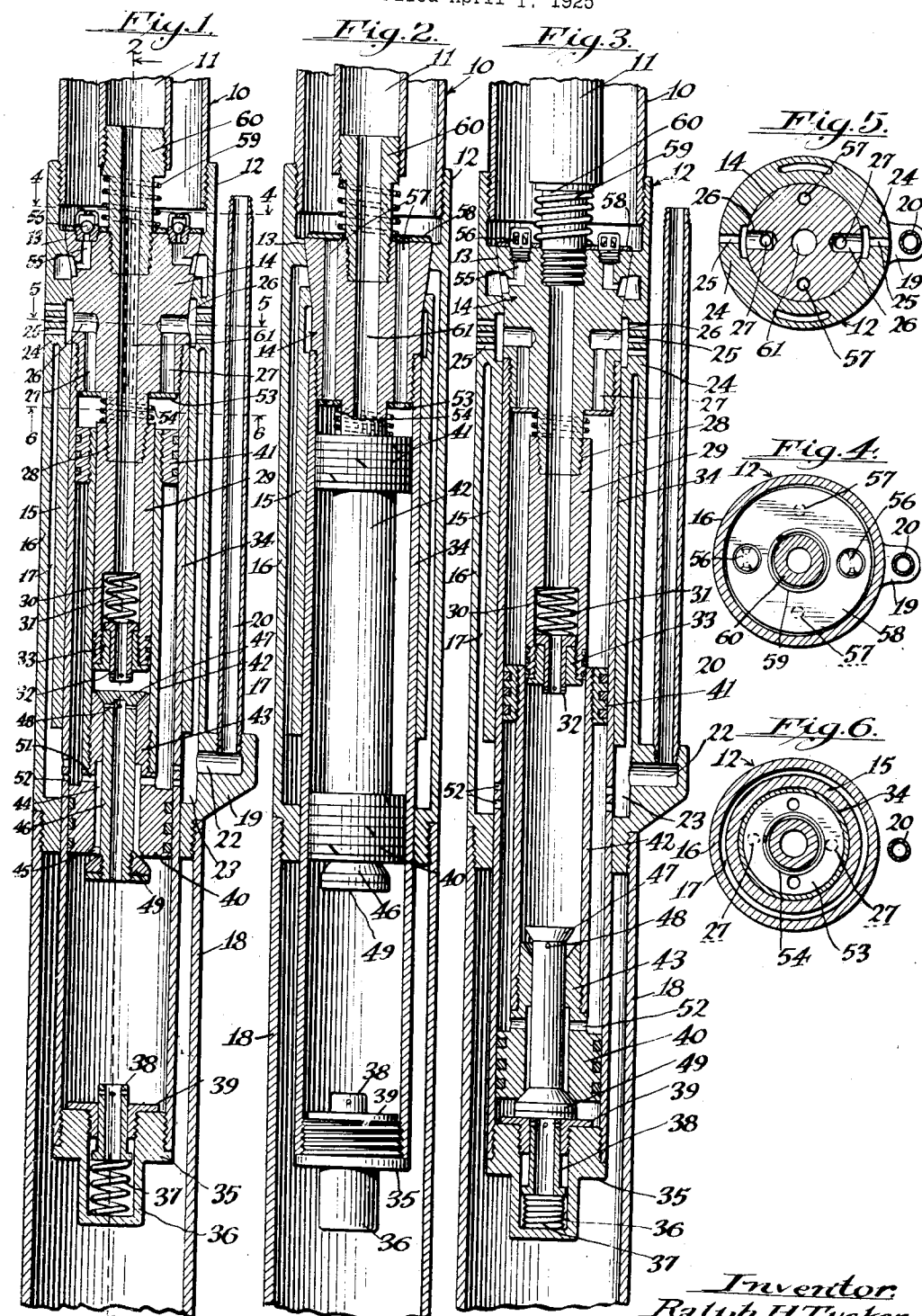
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AIR LIFT PUMP

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UNITED STATES PATENT OFFICE.

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AIR-LIFT PUMP.

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This invention relates to improvements in air lift pumps, and is especially an improvement over the pumps disclosed in my co-pending applications Serial No. 718,794 filed June 9, 1924, and Serial No. 741,242 filed October 2, 1924.

The primary object of this invention is to provide an improved air lift pump which has means for discharging the exhaust air into the oil string above the pump and to provide means for establishing communication between the exhaust passages and the interior of the well hole which is above the fluid level, so that as gas pressure is developed in the well hole above the fluid level, the gas may enter the exhaust passages of the pump and pass into the oil string so as to facilitate lifting the fluid therein as in an air lift.

A further object of this invention is to provide an improved air lift pump.

With the foregoing and other objects in view which will be made manifest in the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

Figure 1 is a vertical section through the pump, the plunger or piston being shown at the top of its stroke;

Fig. 2 is a vertical section taken substantially on the line 2—2 of Fig. 1;

Fig. 3 is a view similar to Fig. 1, the piston being shown at the bottom of its stroke;

Fig. 4 is a horizontal section taken substantially on the line 4—4 of Fig. 1;

Fig. 5 is a horizontal section taken on the line 5—5 of Fig. 1; and

Fig. 6 is a horizontal section taken on the line 6—6 of Fig. 1.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, the oil string which is suspended within a well hole is designated at 10, and the air pipe for supplying compressed air to the pump is indicated at 11. Upon the lower end of the oil string 10 there is threaded an exhaust shoe 12, which adjacent its upper end is provided with a tapered seat 13 for seating a closure or head 14. Within the exhaust shoe 12 there is disposed a sleeve 15 which is held in spaced relation to an outer sleeve 16 of the shoe so as to form air passages 17.

Adjacent the bottom of the exhaust shoe 12 it is reduced to permit securing a pipe 18, which may constitute an anchor or gas trap or the like. A lateral projection 19 is formed upon the exhaust shoe adjacent its bottom and a tube 20 is threaded thereon, which tube extends upwardly within the well to a point above the fluid level. A cavity 22 is formed in the projection 19 and communicates with the tube 20 and with an annular chamber 23 which is formed within the shoe below the inner sleeve 15. The exhaust shoe has portions 24 between the inner and outer sleeves 15 and 16 blocked off, and aperture 25 are formed therein forming inlet passages for the oil to the pump. The head or closure 14 has bores 26 and 27 which communicate with each other, with the bores 26 disposed opposite the apertures 25. The lower end of the head 14 is of a reduced diameter and is threaded as at 28. A nipple 29 is threaded onto the lower end of the head 14 and has a chamber 30 formed therein, within which is disposed a coil spring 31. A buffer member 32 has portions disposed within the chamber 30 against the coil spring 31 and is held therein as by a gland 33.

The barrel 34 for the pump, which is disposed about the nipple 29, is threaded onto the lower end of the head 14. The lower end of the barrel is closed as by a plug 35 having a depression 36 in which is disposed a coil spring 37. A buffer 38 has portions disposed within the depression 36 against the coil spring and is maintained therein by a gland 39. Within the barrel 34 there are arranged two piston heads 40 and 41 which are connected by a hollow stem 42 which is slidable about the nipple 29. The upper piston head 41 is threaded onto the stem 42 whereas the lower end of the stem 42 is threaded onto the nipple 43 formed upon the lower piston head. The lower piston head has an aperture 44 extending longitudinally therethrough, which is enlarged adjacent its bottom, as indicated at 45.

A valve member 46 is enlarged adjacent its upper end, as at 47, and has apertures 48 formed therein. The lower end of the valve member 46 carries a head 49 adapted to seat upon the lower piston head 40. It will be understood that the valve member 46 is capable of reciprocating back and forth within the lower piston head 40 upon

engagement with the buffers 32 and 38. Apertures 51 are formed in the lower piston head 40 and communicate with the enlarged chamber 45. Apertures 52 are formed in the barrel 34 opposite the apertures 51 and communicate with the chamber 23.

An annular plate 53 is disposed about the reduced lower end of the head 14 and is slidable thereon. This plate is urged upwardly as by a coil spring 54 to serve as a check valve, permitting liquid to enter the barrel of the pump through the bores 27 and prevent discharge therethrough. Passages 55 are formed in the head 14 and communicate with the air passages 17 in the exhaust shoe. These passages are controlled as by ball check valves 56. Bores 57 are formed in the head 14 at opposite sides thereof between the bores 27. These bores constitute discharge passages from the barrel upwardly through the head. The plate 53 has apertures formed therein which register with the bores 57. Upon the top of the head 14 there is disposed a plate 58 which has apertures formed therein registering with the discharge bores 57. The plate 58 also has apertures, permitting the plate to pass down over the ball check valve cages which house the ball check valves 56. This plate is urged downwardly as by a coil spring 59 which is disposed about a coupling 60 connecting the air pipe 11 to the head. A bore 61, which is formed in the head, establishes communication between the air pipe 11 and the nipple 29.

The operation of the pump is as follows: Compressed air or gas is forced downwardly through the air pipe 11. It passes downwardly through the coupling 60 and through the bore 61 in the head 14, and enters the chamber 30 in the nipple 29. The compressed air can pass through the buffer 32 into the interior of the hollow stem 42. At the beginning of the down stroke of the plunger, the valve member 46 is in closed position so that the upper closed end of the valve member 46 closes the aperture 44 formed in the lower piston head 40. The air pressure, which is developed within the hollow stem 42, therefore forces the piston downwardly, it being understood that both the upper and lower piston heads 41 and 40 and the hollow stem 42 move downwardly together. When the lower end of the valve member 46 engages the buffer 38, the valve member 46 will be caused to be lifted, so that the head 49 will close the enlarged chamber 45, and the apertures 48 will establish communication between the interior of the hollow stem 42 and the interior of the barrel 34, which is disposed below the lower piston head 40. Air from the air pipe 11 is then caused to be admitted through the lower piston head 40 to its under side, so as to force the piston upon its

upward stroke. It will be understood that upon the downward movement of the piston, the well fluid or oil will be caused to enter the barrel through the apertures 35 and the entrance bores 26 and 27 past the plate 53 which serves as a check valve. When the air from the air pipe 11 is caused to be admitted to the under side of the piston, so as to force the piston upwardly, the plate 53 closes. The oil or well fluid, which is disposed within the barrel 34 above the upper piston head 41, is forced upwardly through the discharge passages 57 past the plate 58 serving as a check valve. During the upward movement of the piston, the valve member 46 is frictionally held in its uppermost position, namely, that in which the apertures 48 permit air to pass through the valve member 46. When the valve member 46 engages the upper buffer 32, causing it to be forced downwardly, the aperture 44 is again closed. At the same time the head 49 is removed from the lower piston head 40, permitting the air which is within the barrel 34 below the lower piston head 40 to exhaust through the enlarged bore or aperture 45 through the apertures 51 and through the apertures 52 into the annular chamber 23. From the annular chamber 23 the exhaust air has two possible routes or passages, one of these is to pass upwardly through the apertures 17 through the passages 55 past the ball check valves 56 and into the oil string 10. The other possible route is to enter the cavity 22 and pass upwardly through the tube 20. The passage, which the exhaust air takes, depends entirely upon the pressures developed.

If the formation is such that but a small quantity of gas is developed in the well above the fluid level, a very small gas pressure will be developed in the well above the fluid, and consequently the exhaust air will pass upwardly through the tube 20 into the interior of the well above the fluid, thus gaining the efficiency of a lower exhaust pressure, which was the purpose of the construction disclosed in my co-pending application Serial No. 741,242. This exhaust air is caused to take such a path because of the weight of the fluid within the oil string 10 bearing upon the ball check valves 56. The exhaust of the exhaust air into the well above the fluid builds up a pressure above the well fluid so that eventually this pressure, which is developed, is greater than the pressure developed upon the ball check valves 56 at the bottom of the oil string 10; and when such a condition of affairs is established, the exhaust air will be forced upwardly past the ball check valves 56 and into the oil string. Where the formation is such that a considerable amount of gas pressure is developed above the well fluid or oil, this pressure frequently is sufficiently

great to lift the column of liquid in the oil string 10. Consequently, the gas because of its pressure can be forced downwardly through the tube 20 into the chamber 23 and can pass upwardly through the air passages 17 beneath the ball check valves 56 and escape into the oil string 10, so that the gas, which flows, in this manner serves as an air lift for lifting the oil in the oil string. In such cases the exhaust air from the pump also passes upwardly through the air passages 17 and cooperates with the gas in lifting the oil in the oil string. The direction or route which the exhaust air takes upon being discharged from the pump will therefore depend entirely upon the condition of pressures developed at the various locations in the well.

From an inspection of Figs. 1 and 3, it will be readily understood that the apertures or exhaust ports 52 in the barrel are never covered by the piston heads 40 and 41. The exhaust air passes from below the lower piston head 40 into the annular chamber defined between the barrel 34 and the hollow stem 42, and it may discharge through the exhaust apertures 52 continually regardless of the positions of the piston or plunger of the pump.

From the above it will be appreciated that an improved pump is provided which is of the reciprocating piston type and which is mounted upon the lower end of an oil string, which has conducting means for conducting the exhaust air from the pump into the oil string, and that a tube is provided which communicates with the conducting means, which tube also communicates with the interior of the well above the liquid level therein. In the improved form of pump construction, it will be noted that the present type of pump employs a construction similar to that disclosed in my co-pending applications, but that the hollow stem 42, which heretofore was slidable within an air cylinder, is now slidable upon a nipple or conducting device, so that the interior of the hollow stem constitutes the air cylinder for forcing the piston downwardly.

It will be understood that various changes in the detail of construction may be made without departing from the spirit or scope of the invention as defined by the appended claims.

I claim:

1. An air lift pump comprising a compressed air operated pumping mechanism secured to an oil string, exhaust conducting means for conducting the exhaust air from the pump to the oil string, and means connecting the exhaust conducting means with the interior of the well above the fluid level as and for the purpose described.

2. An air lift pump comprising an oil string, an air pipe disposed within the oil

string, a barrel connected with the oil string, a piston having an opening therethrough and being reciprocable in said barrel, conducting means providing a connection between the air pipe and the piston, means for alternately opening and closing said conducting means whereby the piston may be forced downwardly by the air when the conducting means is closed and may then be forced upwardly by the air when the conducting means is open, means including check valves for admitting oil to the barrel, means including check valves for discharging the oil from the barrel into the oil string, exhaust conducting means for conducting the exhaust air from below the piston to the oil string, and means establishing communication between the exhaust conducting means and the interior of the well above the liquid level.

3. An air lift pump comprising an oil string, a barrel mounted upon the oil string, a head closing the upper end of the barrel, an air pipe disposed within the oil string, means including a nipple for establishing communication between the air pipe and the interior of the barrel, a stem disposed about said nipple and slidable thereon, a piston head mounted upon said stem having an aperture communicating with the interior of said stem, means for opening and closing said aperture causing reciprocation of said piston, a second piston head mounted upon the upper end of said stem, means including check valves for admitting fluid to said barrel above the second piston head, means including check valves permitting the fluid to be forced through said head from the barrel into the oil string, and exhaust conducting means for conducting exhaust air from said barrel.

4. An air lift pump comprising an oil string, a barrel mounted upon the oil string, a head closing the upper end of the barrel, an air pipe disposed within the oil string, means including a nipple for establishing communication between the air pipe and the interior of the barrel, a stem disposed about said nipple and slidable thereon, a piston head mounted upon said stem having an aperture communicating with the interior of said stem, means for opening and closing said aperture causing reciprocation of said piston, a second piston head mounted upon the upper end of said stem, means including check valves for admitting fluid to said barrel above the second piston head, means including check valves permitting the fluid to be forced through said head from the barrel into the oil string, and exhaust conducting means for conducting exhaust air from said barrel into the oil string.

5. An air lift pump comprising an oil string, a barrel mounted upon the oil string, a head closing the upper end of the barrel,

an air pipe disposed within the oil string, means including a nipple for establishing communication between the air pipe and the interior of the barrel, a stem disposed about said nipple and slidable thereon, a piston head mounted upon said stem having an aperture communicating with the interior of said stem, means for opening and closing said aperture causing reciprocation of said piston, a second piston head mounted upon the upper end of said stem, means including check valves for admitting fluid to said barrel above the second piston head, means including check valves permitting the fluid to be forced through said head from the barrel into the oil string, and exhaust conducting means for conducting exhaust air from said barrel into the open well above the well fluid.

6. An air lift pump comprising an oil string, a barrel mounted upon the oil string, a head closing the upper end of the barrel, an air pipe disposed within the oil string, means including a nipple for establishing communication between the air pipe and the interior of the barrel, a stem disposed about said nipple and slidable thereon, a piston head mounted upon said stem having an aperture communicating with the interior of said stem, means for opening and closing said aperture causing reciprocation of said piston, a second piston head mounted upon the upper end of said stem, means including check valves for admitting fluid to said barrel above the second piston head, means including check valves permitting the fluid

to be forced through said head from the barrel into the oil string, an exhaust shoe disposed about said barrel, and means including check valves for conducting exhaust air from the barrel through the exhaust shoe and discharging it into the oil string.

7. An air lift pump comprising an oil string, a barrel mounted upon the oil string, a head closing the upper end of the barrel, an air pipe disposed within the oil string, means including a nipple for establishing communication between the air pipe and the interior of the barrel, a stem disposed about said nipple and slidable thereon, a piston head mounted upon said stem having an aperture communicating with the interior of said stem, means for opening and closing said aperture causing reciprocation of said piston, a second piston head mounted upon the upper end of said stem, means including check valves for admitting fluid to said barrel above the second piston head, means including check valves permitting the fluid to be forced through said head from the barrel into the oil string, an exhaust shoe disposed about said barrel, means including check valves for conducting exhaust air from the barrel through the exhaust shoe and discharging it into the oil string, and a tube extending upwardly within the well above the well fluid and communicating with said exhaust shoe.

In testimony whereof I have signed my name to this specification.

RALPH H. TUCKER.