June 24, 1924.

1,499,315

H. B. HALVORSEN

AIR LIFT

Filed Dec. 4, 1918

Fig. 1.

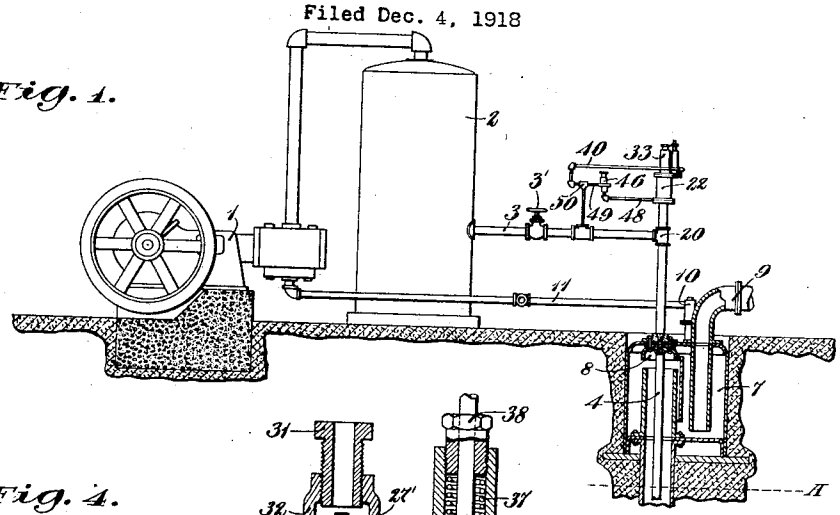
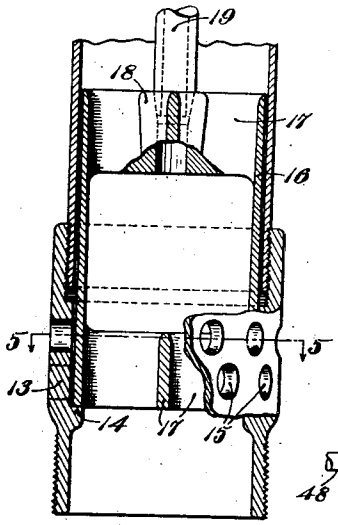


Fig. 4.



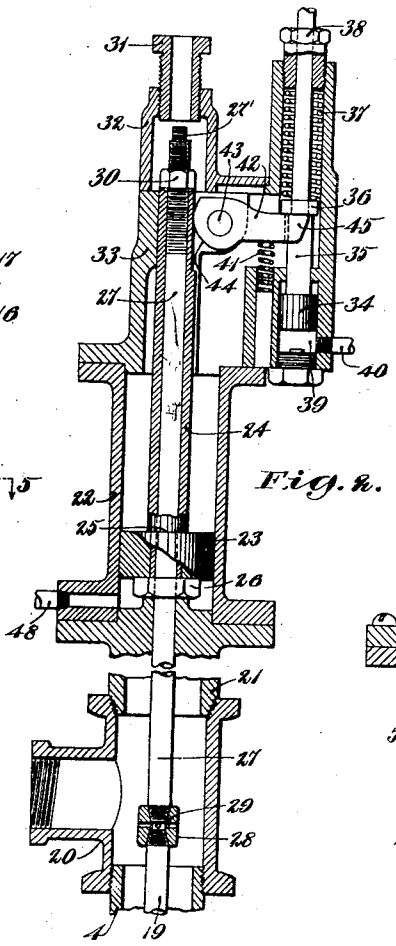


Fig. 2.

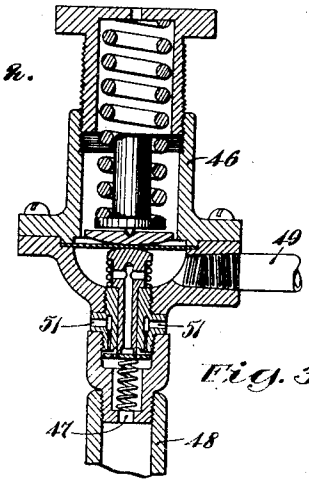


Fig. 3.

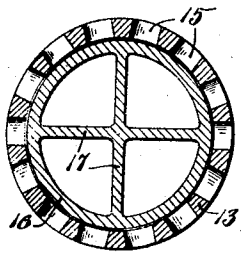


Fig. 5.

Inventor:
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by
Atty.

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UNITED STATES PATENT OFFICE.

HALBERT B. HALVORSEN, OF CHICAGO, ILLINOIS, ASSIGNOR TO SULLIVAN MACHINERY COMPANY, A CORPORATION OF MASSACHUSETTS.

AIR LIFT.

Application filed December 4, 1918. Serial No. 265,226.

To all whom it may concern:

Be it known that I, HALBERT B. HALVORSEN, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Air-Lifts, of which the following is a full, clear, and exact specification.

This invention relates to pneumatically operated wells wherein a pressure fluid is mixed with the liquid to be pumped to decrease the weight of the liquid column, and wherein the pressure of and the expansive force of the pressure fluid acts on the liquid column to force the liquid out of the well. Pneumatic pumps operate most economically and efficiently at a certain depth below the liquid surface, the depth depending principally upon the type of pump used, the fluid to be pumped, and the height to which the liquid is to be pumped. Practice has shown that when a pump is installed at a given depth below the normal liquid surface the pumping action will lower the liquid level below normal, rendering the pump less efficient and less economical, and it has been found necessary, in order to obtain the best results from a pump, to place it far enough below the normal liquid level to insure a proper static pressure on the pump when the latter is in action. When the pump stops, the liquid flows into the well from the surrounding strata, bringing the level of the liquid above the normal pumping level to the normal liquid level, and creating an excess head of liquid whose static pressure is greater than that which the pump can sustain. My invention has for its principal object to provide means for blowing off or otherwise removing this excess head and to provide an improved automatically acting means for controlling the removal of this excess. These and other objects and advantages of my invention will, however, hereinafter more fully appear.

In the drawings,—

Fig. 1 shows a side elevation, partially in section, of an air lift system having my improvement.

Fig. 2 is a longitudinal sectional view of the starting valve actuating mechanism.

Fig. 3 is a sectional view of a Judson pilot valve.

Fig. 4 is a longitudinal sectional view of the starting valve, some of the parts being shown in elevation.

Fig. 5 is a horizontal sectional view taken on the line 5—5, Fig. 4.

In this illustrative construction, I have shown my invention applied to an air lift system including a compressor 1, a receiver 2 connected therewith, and a supply pipe 3 and controlling valve 3′ connecting the receiver with a down pipe 4 leading to an air lift pump 5 disposed in the well and adapted to direct the air or other fluid stored under pressure in the receiver into the well to cause the liquid to be pumped to be carried up through a pipe 6 into a booster 7. In this booster the fluid entering through the pipe 6 comes in contact with an umbrella top 8 which reverses the direction of the flow and separates the air from the liquid. The air arising to the top of the booster acts on the fluid which falls to the bottom to force it out through a discharge pipe 9. The accumulating air in the top of the booster is drawn off through a relief valve 10 and pipe 11 to the intake of the compressor, the relief valve functioning to control the air pressure which causes the liquid discharge.

The upper horizontal dashed line A in Fig. 1 denotes the normal liquid level, while the lower dashed line B denotes the normal pumping level. When the pump is not in operation the liquid rises from the normal pumping level B to the normal liquid level A, creating an excess head A B which must be removed in order to bring the pumping head within the capacity of the pump 5 and compressor 1.

By my improvement I provide for this purpose a blow-off valve 12 placed in the down pipe 4 at a point somewhat below the level B, this valve constituting a secondary or auxiliary pump to be used for discharging the excess head when the pump 5 is to be started, it being understood that the latter pump has sufficient capacity to operate the well to force the liquid therefrom after the pumping has been started.

As shown, this valve 12 consists of a valve casing or member 13 interposed in the supply line 4 and having a valve rest 14 and staggered discharge ports 15, the latter be-

ing preferably placed in the circumference of the valve casing in such a manner that any fluid discharged therethrough mixes with the liquid in the pipe 6 to lighten the excess head and blow it off. Reciprocating within the supply pipe, and normally supported on the valve rest 14, is a hollow valve plunger 16 which may close the ports 15 to stop all discharge therethrough but is preferably spaced from the inner wall of the valve casing 13 to permit a slight leakage so that the compressed air may act on the liquid column being forced upward from the pump 5 to further lighten this column and act as an auxiliary pump or accelerator. The hollow valve plunger 16 is reenforced internally by two cross bridges or webs 17 which do not materially affect the downward flow of the compressed air or other fluid, the upper bridge carrying a centrally threaded hollow boss 18 to which is attached a hollow valve control rod or pipe 19 extending upward through the down pipe 4 and terminating preferably within a T coupling 20 near the surface.

This T coupling connects the down pipe 4 and supply pipe 3 and carries a vertically disposed union 21 whose upper end serves as a head for a cylinder 22. In the form of my improvemenet herein shown, a piston 23 is reciprocatively mounted in the cylinder 22 on a hollow sleeve 24, being held thereon against a shoulder 25 by a nut 26 threaded onto the lower end of the sleeve. Cooperating with this sleeve I have also provided a rod 27 passing centrally through the sleeve and connected to the valve control pipe 19 by a hollow coupling 28, the latter being provided with a number of openings 29 to permit a portion of the air supply entering the T 20 to flow downward through the pipe 19 to a point adjacent the blow off valve 12. Threaded onto the other end of the rod 27 into contact with the upper end of the sleeve 24, is a nut 30 which transmits the movement of the piston and sleeve to the rod 27 whereby the degree of movement of the piston may be made to govern the degree of opening of the valve ports. The upper end of the rod 27 is flatted, as shown at 27′, to permit the use of a wrench to hold the rod while the nut 30 is being adjusted.

Cooperating with my improved mechanism just described, I have also provided means whereby, if desired, the range of movement of the piston 23 may be regulated to correspond with variable conditions, these means being herein shown to include a threaded sleeve or stop 31 adjustable from the ground level and extending downward into a cap or cover 32 of a box 33 which contains a locking mechanism to be hereinafter described. Obviously, by adjusting this member 31, the range of movement of the piston, and therefore the amount of opening of the valve 12, may be regulated as desired.

Cooperating with this improved valve actuating mechanism I have also provided means whereby the valve is held open until the excess head has been blown off and is thereafter permitted to close so that the pressure fluid is fed almost entirely to the pump 5. This means, as shown, comprises a box 33, through which the sleeve 24 extends, and in which is mounted a piston 34, a piston rod 35, and a collar 36 held against a shoulder on the piston rod by a spring 37 abutting against the collar and an adjustable stop or plug 38; the piston, piston rod and collar being moved upward by terminal pressure introduced to the lower end of a cylinder 39 by a pipe 40, and being moved downward by the pressure of the spring 37. Mounted within the casing and adapted to be operated in one direction by the coiled spring 37 and in the other direction by a lighter coiled spring 41, is a cam lever 42 pivoted on a pin 43 and having on one end a knurled cam face 44 adapted to be engaged with the sleeve 24 to hold the latter in adjusted positions. The opposite end of this lever is provided with a yoke 45 which straddles the piston rod 35 and is held against the collar 36 by the light spring 41 which always tends to so rotate the cam lever as to engage the cam surface with the sleeve 24. By this construction it will be noted that when the fluid pressure in the small cylinder 39 overbalances the spring 37 the piston is moved upward and the cam is turned to engaging position. However, should the sleeve be moved upward when the cam lever has been rotated to engaging position, the light spring will give so that the sleeve is not locked against such a movement. When the pressure of the fluid in the cylinder 39 falls to a point where the large spring 37 overbalances the small spring 41 and the fluid pressure in the cylinder 39, the cam lever will be moved to disengage the sleeve 24 and the latter will fall due to its weight and that of the parts attached thereto.

As is evident from the foregoing, the actuation of the valve lifting mechanism and of the locking mechanism depends on the fluid pressures supplied respectively to cylinders 39 and 22. For this purpose there is provided a Judson valve 46, of usual construction, and since the details thereof form no part of the present invention an extended description is not thought necessary, the outlet 47 of the valve being connected with the pipe 48 leading to the cylinder 22, the inlet 49 being connected to a T coupling 50, the latter also having a connection with the supply pipe 3 and the pipe 40 connected to the cylinder 39.

The pilot valve is adjusted to operate at receiver pressure, and this pressure will be supplied at the valve inlet when there is an

excess head of water which prevents an outflow of fluid pressure from the supply line. However, when the excess head is being blown off, the pressure in the supply line and down pipe will fall to some extent but not to what is termed the operating pressure, which is lower than the receiver pressure, and the pilot valve will close. By this construction receiver pressure is automatically supplied to the lower side of the piston 23 to open the valve 13 to blow off the excess head, but because the pilot valve will be closed and the pressure fluid in the cylinder 22 exhausted through the exhaust ports 51 in this valve as soon as the air pressure in the supply line has decreased, additional means are required for holding the valve 13 open until practically the entire excess head has been blown off. In the form of the invention herein shown, this means is the locking cam, which has been added to retain the valve control rod 19 in an elevated position for an appreciable length of time. The spring 37 is so regulated that it will be overbalanced by receiver pressure but will itself overbalance normal operating pressure in the supply line to move the cam to a releasing position. By this pressure regulation of the pilot valve and cam releasing mechanism it is apparent that after the piston has been raised and locked in an elevated position by the action of the fluid under receiver pressure, the cam locking means will engage the sleeve 24 to hold the valve 12 open until the pressure has dropped to operating pressure, so that while the pilot valve controls the flow to permit the elevating of the valve plunger only at the maximum pressure maintained, the locking mechanism will retain the valve plunger off its rests until the operating pressure has been reached.

If it is found desirable to increase the interval of time between the raising of the rod and the releasing of the same, a small tank may be substituted for the T coupling 50 or may be placed in the pipe line 40, it being evident that it will take a longer period of time for the pressure in this tank and the pipe 40 to fall from the higher to the lower pressure than when the pipe 40 alone is used. This tank or auxiliary reservoir is also desirable where, owing to local conditions, several starting or blow-off operations will follow one another at short intervals before the regular working conditions are established. In such cases the auxiliary air reservoir will have a steadying effect and prevent pulsations of the well.

In connection with the use of my improvement, it will be noted that the slight leakage through the valve 13 prevents any accumulation of sediment in the valve, which sediment may be carried upward with the liquid column, that the leakage also assists the pump 5 to raise the water column by further lightening the column, and that the clearance provided between the plunger and casing prevents any sticking of the valve. It is also to be noted that the amount of movement of the valve plunger 16 and the time element between the raising and releasing of the valve control rod may be regulated from a point above ground. Attention is also directed to the fact that due to the use of a hollow valve plunger there is little or no interruption of the flow of fluid through the down pipe 4, and that through the use of a pipe 19 for operating the valve plunger, practically the entire area of the down pipe is rendered available for normal pressure fluid supply purposes. As will be evident to those skilled in the art, my improvement is applicable to pneumatically operated wells having either a continuous or intermittent flow.

While I have in this application specifically described one main embodiment which my invention may assume in practice, it is to be understood that the same is not limited thereto but may be modified in various other forms without departing from the spirit of the invention.

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

1. In a valve controlling mechanism, a valve member, a valve rod operatively connected thereto, power means cooperating with said rod for moving the valve member through movement of the valve rod, and means operating directly on the valve rod for holding the valve member in adjusted position.

2. In a valve controlling mechanism, a valve member, a valve rod operatively connected thereto, power means cooperating with said rod for moving the valve member through movement of the valve rod, and means operating directly on the valve rod and permitting free movement of the latter on movement thereof by said first mentioned means for holding the valve member in adjusted position.

3. In a valve controlling mechanism, a valve member, a valve rod operatively connected thereto, power means cooperating with said rod for moving the valve member through movement of the valve rod, and means for gripping said valve rod to hold the member immovable in adjusted position.

4. In a valve controlling mechanism, a valve member, a valve rod operatively connected thereto, means cooperating with said rod for moving the valve member through movement of the valve rod, and a member having a cam surface directly engaging said rod for holding the valve member in adjusted position.

5. In a valve controlling mechanism, a valve member, a valve rod operatively connected thereto, means cooperating with said

rod for moving the valve member through movement of the valve rod, means engaging said valve rod for holding the valve member after movement thereof by said first mentioned means, and means for causing said second mentioned means to become operative upon movement of said rod by said first mentioned means.

6. In a valve controlling mechanism, a valve member, a valve rod operatively connected thereto, means cooperating with said rod for moving the valve member through movement of the valve rod, means engageable with the valve rod to hold the valve member after movement thereof by said first mentioned means, and means simultaneously operative to make said first and second mentioned means operative.

7. In a valve controlling mechanism, a valve member, a valve rod operatively connected thereto, means cooperating with said rod for moving the valve member through movement of the valve rod, means engageable with the valve rod to hold the valve member after movement thereof by said first mentioned means, means for rendering said second mentioned means automatically operative, means operative on movement in one direction to render said second mentioned means inoperative, means normally moving said fourth mentioned means in said direction, and means for overcoming said fifth mentioned means to permit operation of said second mentioned means.

8. In a valve controlling mechanism, a valve member, a valve rod operatively connected thereto, means for moving said rod and so moving said valve, means for engaging and holding said rod after movement, and fluid pressure controlled means for rendering the last mentioned means operative.

9. In a valve controlling mechanism, a valve member, a valve rod operatively connected thereto, means for moving said rod and so moving said valve, means for engaging and holding said rod after movement, fluid pressure controlled means for rendering the last mentioned means operative, and means for varying the responsiveness of said fluid pressure controlled means to fluid pressure.

10. In a valve controlling mechanism, a valve member, a valve rod, a member having a cam surface for engaging said rod, means for rendering said member operative to hold said rod after movement thereof to open said valve member, and fluid pressure controlled means for controlling said first mentioned means.

11. In a valve controlling mechanism, a valve member, a valve rod, fluid pressure means for actuating said rod to move the valve in one direction, and a fluid pressure controlled means for holding said valve member after movement by said first mentioned means.

12. In a valve controlling mechanism, a valve member, a valve rod, fluid pressure means for actuating said rod to move the valve in one direction, fluid pressure controlled means for holding said valve member after movement by said first mentioned means, and means for actuating said last mentioned means operative to render said valve rod immovable.

13. In a valve controlling mechanism, a valve member, a valve rod, fluid pressure means for actuating said rod to move the valve in one direction, fluid pressure controlled means for holding said valve member after movement by said first mentioned means, means for varying the fluid pressure control, and means for actuating said last mentioned means operative to render said valve rod immovable.

14. In a valve control means, a valve rod, a pivoted cam adapted to contact therewith, a piston rod, a collar on said rod adapted to contact with said cam, and a spring abutting against the collar.

15. In a valve control means, a valve rod, a piston, a piston rod, a collar thereon, a spring adapted to move the piston in one direction, means for overbalancing the spring pressure to move the piston in the opposite direction, and a cam operated in one direction by the piston rod and adapted to hold the valve rod in adjusted position.

16. In a valve control means, a valve rod, a lever having a cam surface adapted to contact with the valve rod, a relatively strong spring to move the cam lever to a releasing position, a lighter spring to move the cam lever to an engaging position, and pressure operated means for overbalancing said first named spring.

17. In an air lift system, air lift mechanism, means for moving a part thereof to render the mechanism effective at different depths, and means for substantially rigidly holding said part in adjusted position during pressure variations.

18. In an air lift system, air lift mechanism, fluid pressure means for moving a part thereof to render the mechanism effective at different depths, and means for substantially rigidly holding said part in adjusted position during pressure variations.

19. In an air lift system, air lift mechanism, fluid pressure means for moving a part thereof to render the mechanism effective at different depths, fluid pressure controlled means for substantially rigidly holding said part in adjusted position during pressure variations, and means for transmitting variations in pressure in said air lift system to said last mentioned means.

20. In an air lift system, the combination including a pump, a booster, and means for

successively permitting auxiliary pumping action and acceleration of the fluid during continuous normal supply to said system.

21. In an air lift system, the combination including a down pipe, a pipe for conducting the liquid to me pumped, a pump associated with said pipes, and an auxiliary pump also associated with said pipes and operative either with said pump or separately therefrom, one of said latter operations during a certain period thereof being unaffected by the head of the liquid being pumped.

22. In an air lift system, the combination including a down pipe, a pump near the lower end thereof, an accelerator fed thereby, and means for operating and controlling said accelerator for blowing off an excess head including a plurality of pressure fluid actuated elements.

23. In an air lift system, the combination including a down pipe, a pump near the lower end thereof, an accelerator adapted to blow off an excess head, and means for controlling said accelerator to render the latter operative to blow off an excess head or to accelerate the flow produced by the pump, said means including a positively operable member to accomplish said latter function.

24. In an air lift system, the combination including a down pipe, a pump near the lower end thereof, an accelerator adapted to blow off an excess head, and means for actuating said accelerator to render the latter operative over a predetermined period to blow off an excess head or to accelerate the flow produced by the pump, said first mentioned operation being independent during a certain period thereof of the head of the liquid being pumped.

25. In an air lift system, the combination including a down pipe, a pump near the lower end thereof, an accelerator adapted to blow off an excess head, a member movable in said accelerator, means for moving said member, and means controlled by fluid pressure for holding said member in an adjusted position to permit a flow of fluid pressure through said accelerator to blow off said excess head, said last named means being operative upon a change in fluid pressure to render said accelerator inoperative to blow off said head and operative to accelerate the liquid flow produced by the pump.

26. In an air lift system, a fluid supply pipe, a pump at the bottom end thereof, a valve above the bottom thereof, means for opening said valve upon supply of air to said pipe, and automatic means for maintaining said valve in substantially only one open position during pressure variations.

27. In an air lift system, a fluid supply pipe, a pump at the bottom thereof, a valve above the bottom thereof, means for opening said valve upon supply of air to said pipe, automatic means for substantially rigidly holding said valve open during pressure variations, and means for releasing said holding means governed by pressure in said air supply pipe.

28. In an air lift system, the combination including a down pipe, a pipe for conducting the liquid to be pumped, a pump adjacent the bottom of said down pipe, a valve above said pump in said down pipe, said valve being formed to prevent fluid tight closure, and means responsive to the static head in said conducting pipe controlling the position of said valve.

29. In an air lift system, the combination including a down pipe, a pipe conducting the liquid to be pumped, a pump adjacent the lower end of said down pipe, a blow off means arranged above said pump, means for opening said blow off means upon the supply of pressure to said down pipe, automatic means for maintaining said blow off means in substantially only one open position during pressure variations, and means operative upon a predetermined drop in pressure supplied to said down pipe to discontinue the operation of said blow off means.

30. In an air lift system, the combination including a down pipe, a pipe for conducting the liquid to be pumped, a pump adjacent the bottom of said down pipe, a combined accelerator and blow off valve arranged above said pump, means responsive to the pressure in said down pipe to regulate the function performed by said combined valve, and means whereby said latter means is adapted to be held in a position against actuation while the pressure of the actuating fluid varies.

31. In an air lift system, a fluid supply pipe, a pump at the bottom end thereof, a valve above the bottom thereof, means for opening said valve, means governed by the pressure in said pipe for controlling the opening of said valve, automatic means for substantially rigidly holding said valve in open position during pressure variations, and means governed directly by the pressure in said pipe for controlling said automatic means.

32. In an air lift system, a fluid supply pipe, a pump at the bottom end thereof, a valve above the bottom thereof, fluid pressure actuating means for opening said valve, a fluid pressure supply connection between said valve opening means and said fluid supply pipe, and means in said connection controlling the same and responsive to pressure in said fluid supply pipe, said last mentioned means operating to effect opening of said valve only upon building up of a predetermined pressure in said supply pipe.

In testimony whereof I affix my signature.

HALBERT B. HALVORSEN.