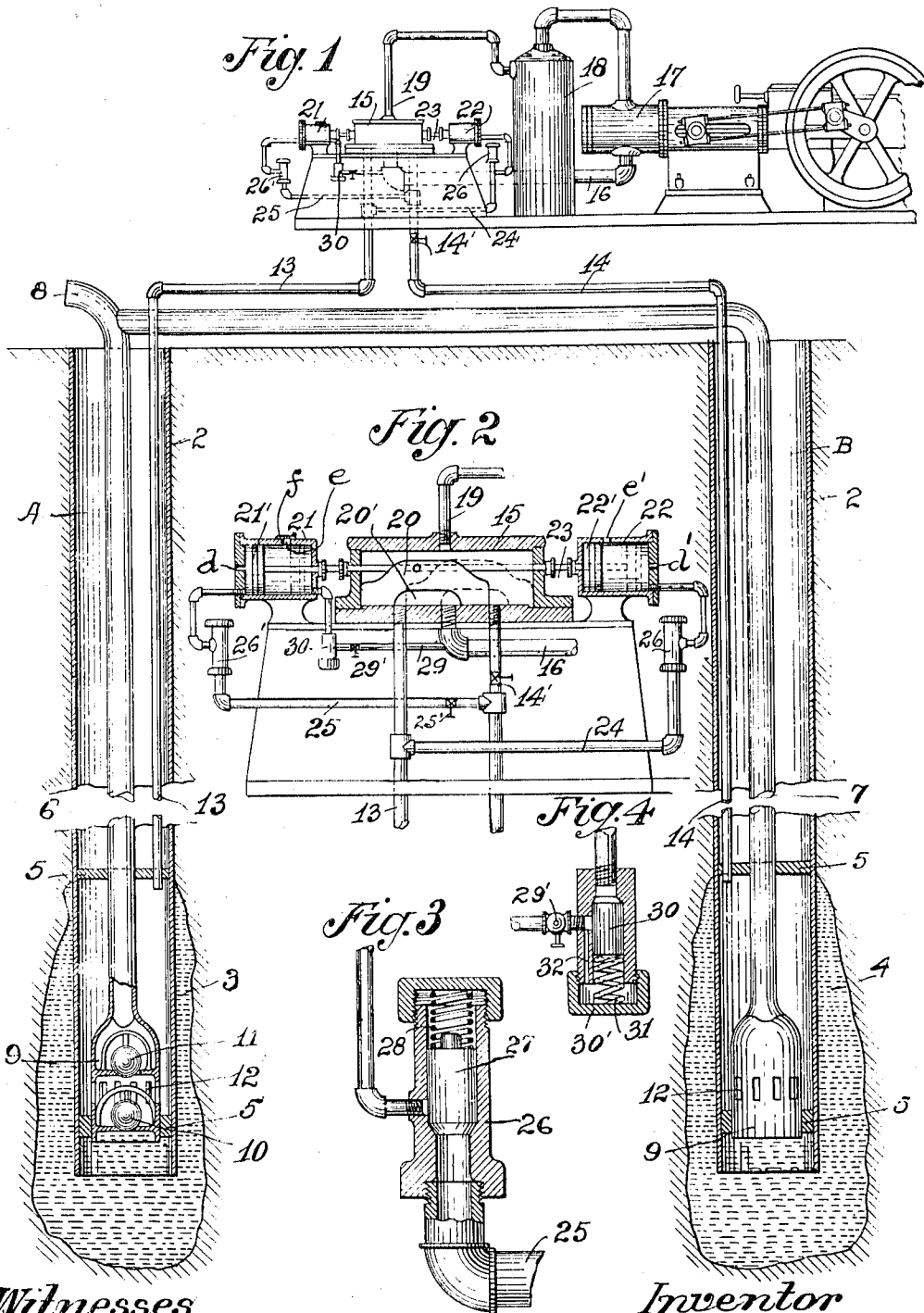


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PUMPING APPARATUS.
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984,329.

Patented Feb. 14, 1911.



Witnesses

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PUMPING APPARATUS.

984,329.

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To all whom it may concern:

Be it known that I, FREDERICK C. WEBER, a citizen of the United States, residing at New York, in the county of Queens and State of New York, have invented certain new and useful Improvements in Pumping Apparatus, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention is a modification of the apparatus disclosed in my application for Letters Patent Serial No. 473,516, filed January 21, 1909, and relates to air-lift pumping apparatus which includes essentially a depressed chamber from which the liquid is expelled by air under pressure acting on its surface, and the primary object is to provide improved means for operating automatically the air-controlling valve.

One object is to provide for operating the valve and shutting off the compressed air by pressure emanating from or having fixed relation to the pressure in the fluid-chamber, whereby when said pressure reaches a predetermined height the air is shut off automatically, and the same movement of the valve places the chamber in communication with the compressor-intake, thereby returning the previously active compressed air to the receiver without waste of pressure such as would occur if the receiver were replenished from the atmosphere. For this automatic operation, the valve is so adjusted as to be thrown before the fluid level has been depressed to the plane of its outlet and hence no air can escape. Like or different means may be employed for accomplishing the opposite movement of the valve. Thus, the apparatus may be double and have oppositely acting parts of like construction which operate alternately in pumping from different fluid sources. Or the other movement may be accomplished alone by suction emanating from the compressor-intake, or this suction force may operate in conjunction with and augment the air-pressure force derived from the fluid-chamber. When employing different means for accomplishing the two movements, the latter may be entirely automatic when pumping either from a single chamber or fluid-source, or from a plurality of sources which may be at the same level or different levels.

A further object is to utilize the well-casing in the formation of chambers from

which the fluid is forced upward in the pumping operation.

In the accompanying drawings, Figure 1 illustrates my improved apparatus applied to two wells. Fig. 2 is a sectional view of the air-controlling valve-mechanism, and Figs. 3 and 4 are similar views of the spring held check-valves.

The two wells A and B may be water, oil, salt or other wells, or drainage outlets for mines. In each well is a casing 2, and these casings are utilized in the formation of fluid-inlet chambers or tanks 3 and 4 by the use of packer-disks or partitions 5 which form the chamber-ends. Extending to the surface from the lower portion of chamber 3 is flow-pipe 6, and a similar pipe 7 extends from chamber 4, the two pipes being here shown united to form the single discharge 8. At the lower end of each of pipes 6 and 7 is a foot-piece 9, each provided with seats—one above the other—for the upwardly opening check-valves 10 and 11, the casing of the foot-piece being slotted at 12 between the valves for the passage of fluid.

Extending downward through well A to the upper portion of chamber 3 is air-pipe 13, and a similar pipe 14 extends through well B of chamber 4. These pipes 13 and 14 are connected to and open through the bottom of valve-casing 15, being on opposite sides of the intake or suction 16 of compressor 17, the latter discharging into receiver 18 from which leads pipe 19 to the top of casing 15.

Within casing 15 is the slide-valve 20 ported on its under side at 20' so as to connect suction 16 with either of pipes 13 or 14. Air-pressure on the top of the valve holds it constantly to its seat on the valve-casing bottom. At opposite ends of casing 15 are cylinders 21 and 22 having their pistons 21' and 22', respectively, connected by stem 23 with valve 20.

A pipe 24 connects air pipe 13 with the outer end of cylinder 22, and a similar pipe 25 connects air-pipe 14 with the outer end of cylinder 21. Interposed in pipes 24 and 25 respectively are the check-valves 26 and 26', in each of which the valve-proper opens toward the cylinder and is held normally seated by the coiled-spring 28. When the air-pressure within pipe 24 or 25 is sufficient to overcome the tension of the spring, the valve is forced upward and air is ad-

mitted to the outer end of the cylinder. I have also shown a pipe 29 connecting suction or compressor-intake 16 with the inner end of cylinder 21, with check-valve 30 interposed therein. This valve closes toward the cylinder and is so held normally by spring 31 acting on its lower end. The lower portion of valve-casing 30' communicates with pipe 29 through port 32, and when the suction through pipe 29 becomes sufficiently strong to counteract spring 31, the valve is lowered, thus opening a passage to cylinder 21 and exhausting the same, the suction operating to move piston 21' toward the inner end of the cylinder. Pipe 29 may be closed by valve 29'; pipe 25 by valve 25'; and pipe 14 by valve 14'.

With valve 20 in the position indicated in Fig. 2, and with valves 14', 25', and 29' open, air discharging from the compressor-receiver into valve-casing 15 passes through pipe 14 to chamber 4 of well B, thereby forcing the liquid therein upward past valve 11 and through flow-pipe 7, the pressure holding valve 10 seated. While chamber 4 is being thus emptied, valve-port 20' has air-pipe 13 in register with the compressor-intake 16, whereby air is withdrawn from chamber 3 of well A and a flow of liquid is induced therein through valve 10. The air under pressure is thus returned to the receiver and not wasted, the receiver being thereby replenished more quickly and with less power than if the supply were drawn from the atmosphere.

In operation, before the fluid level in chamber 4 is lowered sufficiently to admit the liquid-forcing air into flow-pipe 7, the slide-valve 20 is moved automatically and reverses the operation by placing pipe 14 in communication with the compressor-intake and at the same time opening communication between the fluid-filled chamber 3 and valve-casing 15, at which time air under pressure from receiver 18 may pass to said chamber through pipe 13, thereby forcing the fluid from said chamber upwardly through flow-pipe 6. This movement of the valve from its position indicated in Fig. 2 is accomplished by air under pressure operating through pipe 25 to open check-valve 27, thereby gaining admission to the outer end of cylinder 21 and forcing piston 21' inward. The operation in this regard is as follows: When port or pipe 14 is first uncovered, as in Fig. 2, by the movement of valve 20 to the left, the air in pipe 14 and in the upper portion of chamber 4 is at atmospheric pressure or less and immediately begins to rise, its pressure increasing and the pressure in receiver 18 decreasing, until the pressures have equalized or nearly so. Meanwhile of course the increasing pressure in chamber 4 is expelling the fluid upwardly through pipe 7 and lowering its

level. The arrangement is preferably such that the pressure in receiver 18 on the one hand, and in chamber 4 on the other, equalize or nearly so before the fluid level in chamber 4 reaches the outlet 12. Valve 27 is so adjusted as to open under the pressure of air in pipe 25 just before the fluid level reaches discharge 12, and upon the opening of this valve, air under pressure is admitted behind piston 21' and forces it inward and throws the slide-valve, thereby reversing the operation. During this operation, the air in chamber 3 of well A is of course being withdrawn owing to the communication between pipe 13 and compressor-intake 16, during which time liquid is flowing into chamber 3 through valve 10. It will thus be seen that the shifting of the main valve 20 is governed directly by the level of the fluid in intake chambers 3 and 4. Taking the construction at the left hand of Fig. 1 for example, during the fluid lifting or ejecting operation the column of fluid in discharge pipe 6 is of course higher and heavier than the column in chamber 3, the columns being hence necessarily out of balance. Now air under pressure admitted into the upper portion of chamber 3 and acting on the top surface of the fluid therein not only balances the heavier column in tube 6, but exceeds the pressure necessary to make an exact balance, hence the outflow or discharge of the fluid from tube 6.

The adjustment of the apparatus is such that the air pressure which accumulates in chamber 3 is not determined primarily by the source from which the air comes, but rather by the weight of the heavier or unbalanced column of fluid being lifted. This being the case, at each and every discharge at a given height, the air in the upper portion of chamber 3 will always be under a certain pressure when the level of the fluid in that chamber is at a certain point. And of course this pressure will increase with the increasing divergence between the pressures of the two columns—that in tube 6 and that in chamber 3. By this means air pressure within chamber 3 at any given level of the fluid therein may be ascertained, and it will be known that in the successive operations an ascertained pressure will exist whenever the fluid has reached such level. It is owing to this unvarying correspondence between the air pressure and the water level at any given point in chamber 3 that I am enabled to utilize the air pressure when this point is reached to reverse the mechanism, such reverse resulting in shutting off the air from chamber 3 and placing that chamber in communication with air-exhausting means, whereupon the chamber again fills with fluid.

The spring-held controlling valve (26) 130

is located in an air passage extending directly from chamber 3 to the reversing device upon which the air acts, said passage being direct and there being no other interruption therein than the said controlling valve. Hence it is that when the predetermined level in chamber 3 has been reached (which level has an ascertained correspondence to the then existing air pressure, as we have already seen) the valve located within the said directed air passage is caused to open under ascertained air pressure and forthwith the valve-reversing means is operated. The action is direct and absolutely certain owing to this correspondence between a given level of the fluid, the air pressure, and the controlling valve, there being no restricted or graduated passage, expansion chamber, or device other than the controlling valve to interrupt the passage of air or to interfere with its action upon the main valve-throwing mechanism.

With valve 29' open, the operation of throwing valve 20 from left to right is not accomplished entirely by the air passing through pipe 25, as when the suction in pipe 29 overcomes the pressure of spring 31, valve 30 opens, whereupon the inner end of cylinder 21 is exhausted and the suction on the inner end of piston 21' tends to draw it inward, thus augmenting the piston-moving force derived from pipe 25.

With chambers 3 and 4 at equal depths, or with the height of the lift the same from each, piston 21' may be actuated by the two forces, *i. e.*, air pressure at its outer end and suction at its inner end, while air-pressure alone moves piston 22'. However, the two forces for the one piston are preferably used when the lifts from chambers 3 and 4 are of unequal height, as when chamber 3 is deeper and its lift greater than chamber 4. Before moving the valve the pressure in cylinder 22 will have to overcome resistance due to vacuum in the inner end of cylinder 21, and this additional pressure will permit of greater lift in chamber 3. Unequal lifts may also be secured by varying the tension of valve-springs 28.

The outer ends of cylinders 21 and 22 may be provided with relatively small vents *d*, *d'*, respectively, to prevent air cushions which might otherwise react on the plungers during the latter portions of their outward strokes. The said cylinders, inwardly from their outer ends, may also be formed with vents *e*, *e'*, respectively, and as long as these vents are uncovered by the inward travel of the pistons, as shown in solid lines at the right hand side of Fig. 2, and in dotted lines at the left hand side, the air escapes and the plungers move no farther. Vents *e* and *e'* relieve the inner ends of the cylinders when said ends are approached by the pistons, the

slight cushioning resulting after the vents have been covered by the pistons preventing shock as the pistons approach the limit of their movement. Vents *d* and *d'* are of less area than vents *e*, *e'*, so that the escape of air will not retard the movement of the pistons due to air entering through valves 26, 26'. Vent *e* may be closed by the outwardly closing check valve *f* to prevent air from entering the inner end of cylinder 21 when the suction valve 30 is operating.

Various adaptations and modifications of the invention will be apparent to those skilled in the art. Thus, valve 14' may be closed, shutting off well B. When thus used, upon the emptying of chamber 3 valve 20 is moved to the left by air under pressure passing valve 26 and operating on piston 22', and valve 20 is moved in the opposite direction solely by the suction in cylinder 21 operating on piston 21', this occurring when the suction in pipe 29 is sufficiently strong to open valve 30. Or valve 14' may be open and valve 25' closed, whereupon both wells will be pumped, valve 20 being moved in one direction by air under pressure; in the other direction by suction.

While pipes 13 and 14 are here shown extending to two wells, each having a single fluid-chamber, it will be understood that the fluid-chambers comprise the essential feature regardless of their location, and hence said chambers may be arranged in two wells as here shown, or otherwise as conditions and the work to be performed may require. Thus viewed, the invention contemplates the forcing of liquid from a plurality of fluid-chambers regardless of their location, and without regard to whether their lifts are of equal or unequal height.

I claim:—

1. Pumping apparatus comprising a chamber adapted to receive and discharge a liquid, means for alternately withdrawing air from the chamber and for supplying air thereto under pressure, a valve controlling the withdrawal and admission of air, and valve-throwing means—actuated in one direction by air pressure from the said chamber and in the other direction by suction resulting from the withdrawal of air from the chamber—for throwing the valve in reverse directions.

2. Pumping apparatus comprising a chamber adapted to receive and discharge a liquid, means for alternately withdrawing air from the chamber and for supplying air thereto under pressure, a valve movable in reverse directions for controlling the admission and withdrawal of air, means connected to the chamber and actuated by air pressure for moving said valve in one direction, and means connected to said chamber and operated by suction for moving the valve in the reverse direction.

3. In apparatus of the character described, an air reversing valve, means actuated by air alone which has passed the valve for moving it in one direction, and means actuated in part by air which has passed the valve and in part by force derived elsewhere for moving the valve in the reverse direction.

4. Pumping apparatus comprising a chamber adapted to receive and discharge a liquid, a compressor, a valve for placing the compressor-inlet and discharge alternately in communication with said chamber, a cylinder having its piston connected to the valve, a connection between the cylinder and the compressor-intake, and a spring-held valve in said connection opening toward the compressor.

5. Pumping apparatus comprising fluid-chambers, two air pipes connected to different chambers, means for withdrawing air from the chambers and for supplying air thereto under pressure, a valve adapted in one position to admit of the withdrawal of air from one chamber, the valve in another position being adapted to reverse said connections or communications, two cylinders having their pistons connected to the valve, connections between said air-pipes and the cylinders, spring-held valves normally closing said connections and adapted to open toward the cylinders, a connection between one of the cylinders and the compressor-intake, and a spring-held valve normally closing the last mentioned connection and opening toward the compressor.

6. Pumping apparatus comprising fluid-chambers, means for withdrawing air from the chambers and for supplying air thereto under pressure, a valve adapted in one position to admit of the withdrawal of air from one chamber and simultaneously admit air under pressure to the other chamber, the valve in another position reversing said connections or communications, means actuated by air pressure from one of the chambers for moving the valve to one of said positions, and means actuated by suction resulting from withdrawal of air from one of the chambers for moving the valve to the other of said positions.

7. Pumping apparatus comprising fluid-chambers, two air pipes connected to different fluid-chambers, a compressor, an air controlling valve adapted in one position to place the compressor-inlet in communication with one of said pipes and with the compressor-discharge simultaneously in communication with the other pipe, the valve in another position being adapted to reverse said communication, two cylinders having their pistons connected to the valve, an air passage connecting one of said air-pipes and one of the cylinders, a valve normally closing said passage and adapted to open when the air in said pipe has reached a predetermined pressure for moving the controlling valve in one direction, and means forming a partial vacuum in the other cylinder for causing the piston therein to move the controlling valve in the reverse direction.

8. Pumping apparatus comprising fluid-chambers, a valve case, two air-pipes extending from the valve-case to different chambers, a compressor having its inlet and discharge communicating with said valve-case, a valve movable in the case and adapted in one position to place the compressor-inlet in communication with one of said pipes with the compressor-outlet in communication simultaneously with the other air-pipe, the valve in another position being adapted to reverse said communications, two cylinders having their pistons connected to the valve, an air passage connecting one of said pipes and one of the cylinders and another air passage connecting the other cylinder with the compressor inlet, and valves normally closing said passages, the valve in the passage leading from the said pipe adapted to open under predetermined air pressure, and the valve in the passage leading to the compressor inlet adapted to open under predetermined suction pull from the compressor.

In testimony whereof I affix my signature in presence of two witnesses.

FREDERICK C. WEBER.

Witnesses:

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