(No Model.) 2 Sheets—Sheet 1.

J. PATTEN.

WATER ELEVATOR.

No. 265,629. Patented Oct. 10, 1882.

Fig. 1.

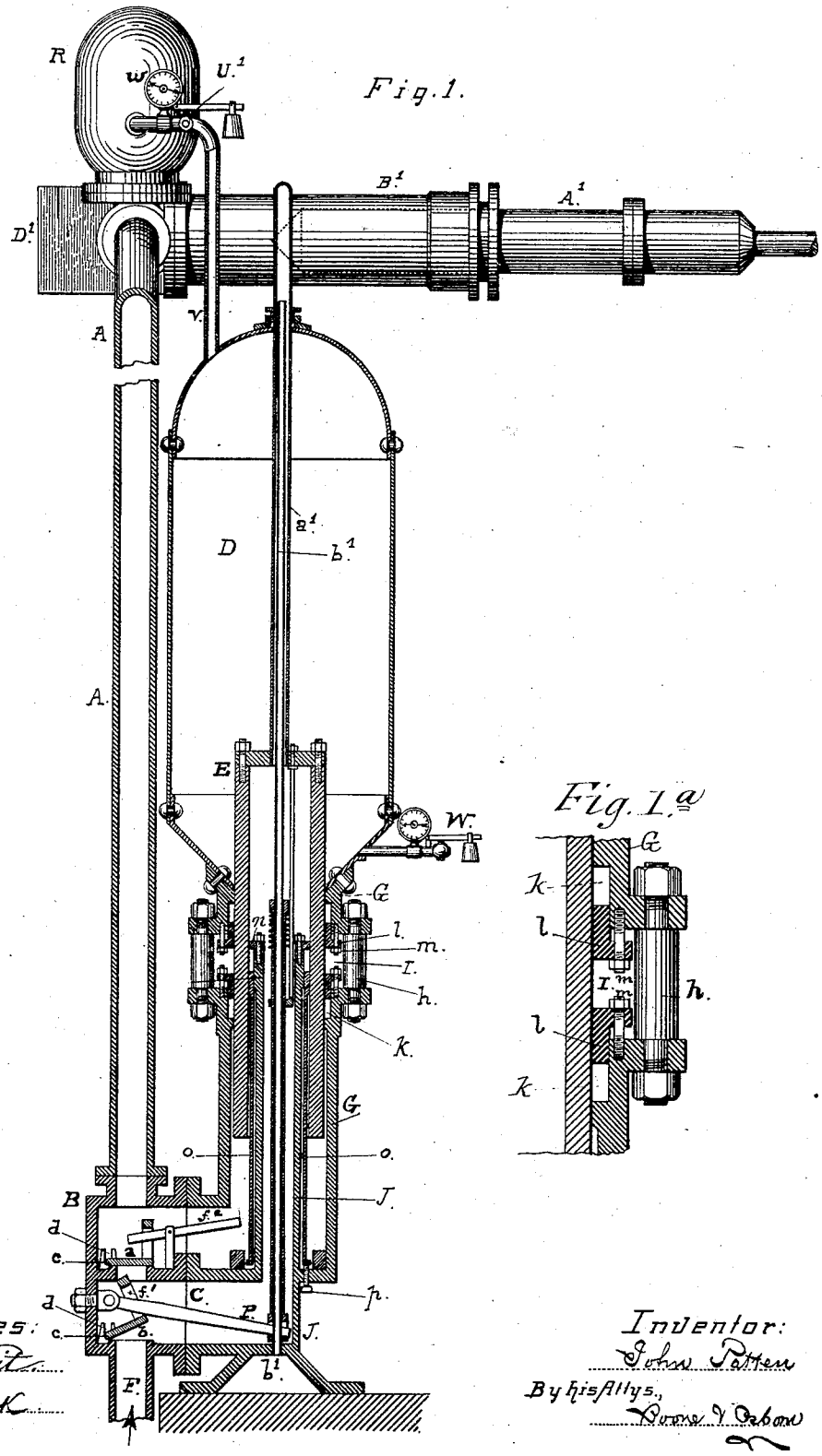

Fig. 1a

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 2.

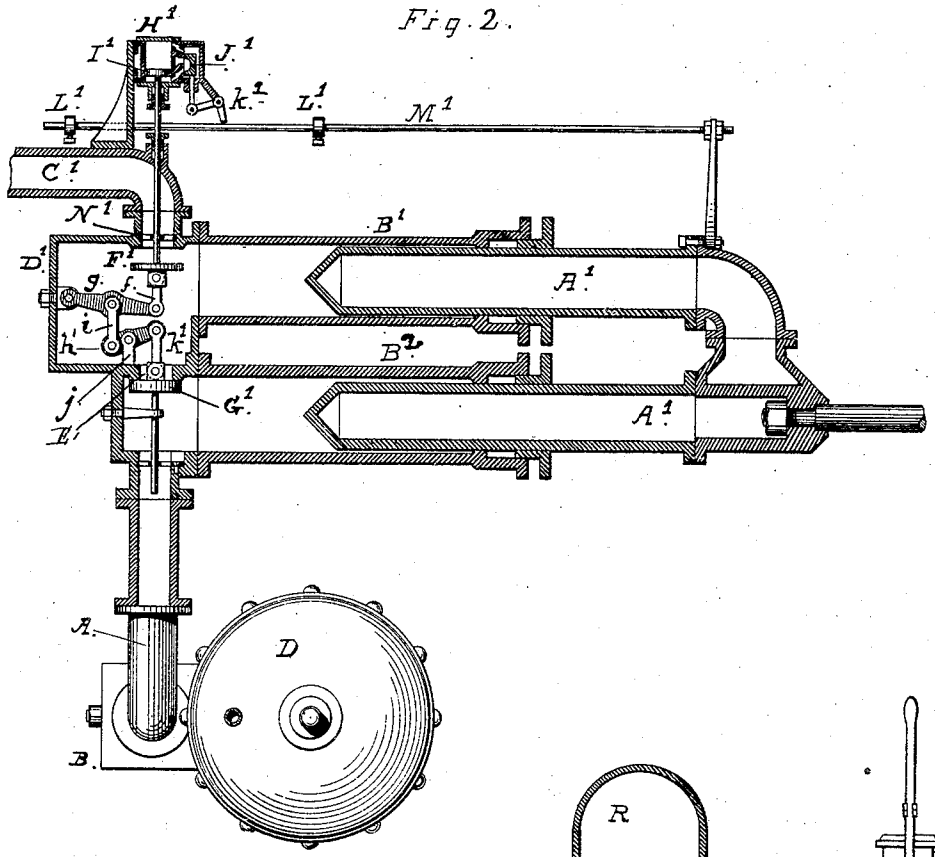
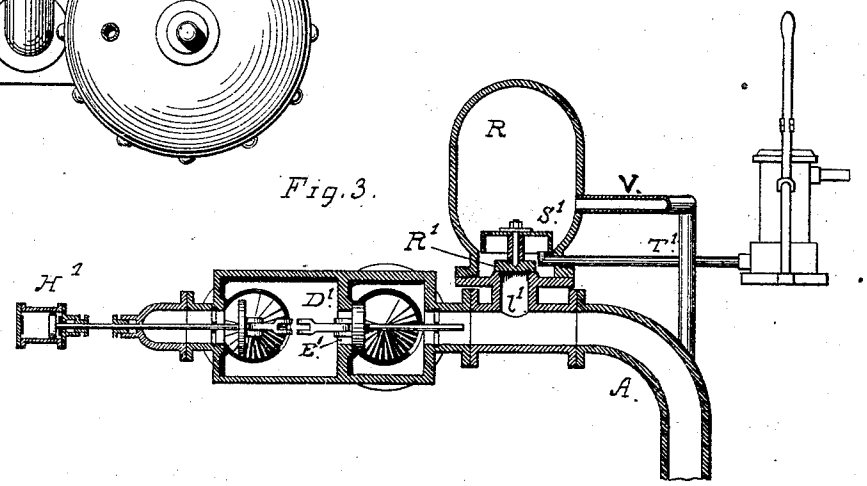


Fig. 3.



Witnesses:
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UNITED STATES PATENT OFFICE

JOHN PATTEN, OF SAN FRANCISCO, CALIFORNIA.

WATER-ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 265,629, dated October 10, 1882.

Application filed August 17, 1881. (No model.)

To all whom it may concern:

Be it known that I, JOHN PATTEN, of the city and county of San Francisco, in the State of California, have invented an Improved Method and Apparatus for Raising Water from a Lower to a Higher Level; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings.

My invention relates to an improved method and apparatus for raising water and discharging it at a higher level, being supplemental to an invention for raising water through a siphon-pipe of unlimited height and discharging it at a lower level for which I have recently made application for Letters Patent. In my unlimited siphon-pump the inverted-U-shaped column of water was counterbalanced between two air-chambers, the pressures in which were unequal, and the water was raised by the action and reaction of the column of water in the pipe against a piston in each of the air-chambers alternately. In my present invention I employ a single straight pipe and connect its lower end with a reaction-pump similar to the one used at the suction end of my unlimited siphon, while its upper end is connected with a steam-operated pump, all as hereinafter described.

It has been found a difficult matter to elevate water when the power is situated more than thirty-three and one-third feet above the body of water to be raised. I use a body of air above and cause it to force water back or down a tube against a body of air securely housed at the lower end, admitting additional water as the air is compressed. Then I relieve the pressure from above and allow the expansion of the just-described compressed air below to drive the column back. It will be found that it reaches a level considerably above the original height. In this way I employ the pump and attendant mechanism hereinafter described.

Referring to the accompanying drawings, Figure 1 shows the two pumps when set up and connected together for operation. The lower or reaction pump is seen in vertical section, while the steam-pump, which works in a horizontal position, is seen in elevation. Fig. 1ª is an enlarged detail view of the means of uniting the air-chamber and the chamber below. Fig. 2 is a plan of Fig. 1, with the steam-pump shown in horizontal section. In this view the air-chamber is removed. Fig. 3 is a vertical section taken across the left-hand end of the steam-pump, Fig. 1, through the air-chamber and the conducting-pipe that leads upward from the reaction-pump chamber.

Let A represent the vertical pipe through which the water is to be raised. The lower end of this pipe connects with the upper chamber, B, of my hydropneumatic pump, as described in my former application for a patent. This pump, as before described in the former application herein referred to, consists of two chambers, B C, one above the other and both connected with an air-chamber, D, by independent passages. A piston, E, is interposed between the air-chamber and the two passages which connect it with the two water-chambers in such a way that the water-pressure in the upper chamber is only exerted against a portion of the piston area to force it upward into the air-chamber when the passage between the two water chambers is closed, thus drawing water by suction into the lower chamber, C, through the suction-pipe F; but on the reactionary or down stroke of the piston the pressure of the compressed air, being exerted upon the water in both chambers, closes the suction-valve and opens the valved passage between the two chambers, so that the water is forced up the pipe A from both water-chambers.

An improvement which I have made in this pump relates to a novel arrangement for packing the piston, by which arrangement I am able to tighten the packing while the machine is in operation. The main point where the packing requires to be tight is around the inverted-cup-shaped piston E, which moves between the water and air pressures. To provide for keeping these joints tight, I make the neck or short upright cylinder G, which connects the air-chamber with the upper water-chamber, in two parts, as shown, and these two parts I connect and tie together by means of strong spacing-bolts *h*, so as to provide a break or space, I, between the two parts. The rim of the cup-shaped piston E then passes down across this break in the cylinder into the annular space between the outside neck or cyl-

inder, G, and the inner tube, J, which connects with the lower water-chamber. On the inner face of each part of the short cylinder G, I make a groove or space, *k*, in which I insert fibrous packing material. I then insert a ring follower or gland, *l*, which can be forced upon the packing by screws *m*, so as to compress it against the piston, the break or space I between the two parts of the cylinder G permitting the ready turning of the nuts or screws to compress the packing while the machine is in operation.

To pack the joint between the interior of the cup-shaped piston and the inner tube, J, I secure or form an outward flange, *n*, on the upper end of the tube, and I insert the fibrous packing underneath this flange. I then employ a long tube-follower, O, which surrounds the tube J and extends to its lower end inside of the lower chamber, and this tube or follower I press upward by bolts or screws *p*, which pass through the shell of the chamber, so that they can be turned from the outside to condense the packing against the flange *n* and tighten the joint. I found upon investigation that this provision was necessary in the practical use of the pump in deep mines, and while I am aware that this method of packing joints is not new, the method of its application has required considerable study and ingenuity. I therefore consider this an important feature of my invention.

Another improvement which I have added refers to the clapper-valves which open and close the water-passages in the water-chambers. The valve *a*, which closes the passage between the two chambers, is directly above the valve *b* at the upper end of the suction-pipe F. Each valve I provide with a short shaft, *c*, at one edge, and this shaft rests in a saddle or seat, *d*, which is formed in the pump-case on one side of the opening. The lower valve has a rectangular arm, *f'*, projecting upward from its free end. This arm is slotted, and the lever P, which is raised and lowered by the movement of the piston E, passes through the slot. This allows the valve to open freely when the piston moves up, and it will remain open until the lever has been carried by the downward movement of the piston down to the lower end of the slot, so that this valve is only closed positively during the latter end of the downward stroke of the piston. The object of this arrangement is to relieve the pressure in the lower chamber to a certain extent, as it is impossible to force all the water up the pipe A that is drawn into the lower chamber by the upward stroke of the piston. I therefore leave the lower valve open during a portion of the downstroke, so that a portion of the water can pass back down the suction-pipe. When the valve is closed, however, on the downstroke, the pressure in the lower chamber forces the upper valve open, and the water in both chambers is forced up the pipe A.

a' is a pipe, which connects with the top of the piston E, and extends up through the top of the chamber; and *b'* is a smaller pipe, which passes from an air-pump up through the central tube, J, and extends up into the pipe *a'*, so that the action of the pump will exhaust the air from below the piston.

The upper end of pipe A, I connect with a steam-driven pump, which can be made in various ways, its object being to impart a downward pressure upon the column of water in the pipe A, in alternation with the downward movement of the piston in the lower pump, so that the steam-pressure, acting through the column of water and upper chamber of the lower pump, forces the piston E upward, so as to raise water through the suction-pipe F into the lower chamber, and at the same time compress the air in the air-chamber D above the piston, so that the reaction of the compressed air, when the steam-pressure is removed, will drive the water in both water-chambers up the pipe A, as before stated.

In one form of my upper pump (shown at Fig. 2) I employ a double piston or twin plungers, A' A', moving in two separate barrels, B' B², the opposite ends of which are connected with the water chambers and passages hereinafter described. These pistons or plungers can be driven by any suitable engine or motor, and they may be placed either horizontal or vertical. One of these plungers acts upon the column of water in the pipe A, while the other is a forcing-piston for driving a portion of water up to a higher level through an upraised pipe, C'. This latter plunger and its barrel can be made lighter than the former, because the pressure required to raise the water from the upper pump through the pipe C' is not so great as that required in the lower pipe, A. I will therefore call the piston which presses upon the column of water in the pipe A the "major" piston, and the one that forces the water up the pipe C' the "minor" piston. The upper end of the pipe A connects with the barrel of the major piston at the end toward which the piston moves on its downstroke, and this barrel is connected with a chamber, D', in the barrel of the minor piston by a port or passage, E'. The upraise-pipe C' is then connected with the chamber D', so that the pipe A, port E', and pipe C' are all in the same line. The port or passage E' and the opening in the end of the pipe C', I arrange to be closed alternately by valves F G' by the movement of the piston.

H' is a small cylinder, which in the present instance is mounted on the pipe C' in line with the opening in the end of the pipe C' and the passages A E'. In this cylinder a piston, I', is moved by steam in the ordinary way. The slide-valve J', which admits steam to drive the piston I', is moved by a bell-crank lever, *k*², and two tappets, L', on a rod, M', that is attached to and moved by and with the main piston. The piston-rod of the piston I' passes through a stuffing-box in the elbow of the pipe C', and through a guide, N', which extends

across the pipe near its open end, and its end is attached to the valve F′, so that when the piston I′ is moved the valve is carried to and from its seat, so as to close or open the end of pipe C′. The valve F′ is connected by a link, *f*, with one end of a rocking lever, *g*, the opposite end of which is pivoted to a lug on the side of the chamber D′. The middle of this rocking lever is connected with one end of another lever, *h*′, by a link, *i*. The lever *h*′ is pivoted at its middle to another lug, *j*, which projects at right angles to the lever *g*, and the opposite end of the lever *h*′ has a link, *k*′, connected with it, which passes through the port or passage E′, and has its opposite end attached to the valve G′, that closes the passage. By this arrangement of levers and links the two valves F′ G′ are moved in alternation by the movement of the piston I′.

R is an air-chamber, which is connected with the upper end of the pipe A, near the pump. The passage *l*′, (see Fig. 3,) which connects the pipe A with the chamber, is closed by a float-valve, R′, which has secured above it an inverted pan, S′.

T′ is an air-pipe, through which a continuous stream of air is introduced into the chamber under the pan by an air-pump.

U′ is a safety-valve, and V is an air-pipe, to which the pressure-gage W and safety-valve U′ are attached. (See Fig. 1.) This pipe extends from the escape of the safety-valve to the lower chamber, thereby connecting the two air-chambers together. The object of interposing a safety-valve between them is to retain a greater pressure in the upper chamber, as hereinafter explained.

Preparatory to starting the pump into operation I introduce a small quantity of water into each of the air-chambers and place a thin layer of oil on top of the water to separate it from the compressed air. I then force air into the upper air-chamber, R, until the pressure is greater than the pressure which is to be maintained in the lower chamber. The air then escapes through the safety-valve U′ and passes into the lower chamber, and as soon as the proper working-pressure is reached in both chambers the air will commence to escape through the safety-valve into the outer air. I then fill the remaining portion of the machine with water, after which it is ready for operation. To commence with, let everything be in the position represented in the drawings, Figs. 1 and 2. Then, as the two pistons A′ A′ are forced into the barrels B′ B², the water is forced out of the inner barrel, B′, through the pipe C′, and, on account of the valve G′ being closed, the water in the major barrel B² will be forced into the pipe A. As the pressure in the air-chamber R is greater than the pressure in the lower chamber, D, the pressure of the water, as it is forced out of the major barrel B², will not be great enough to raise the float-valve, and consequently the water is forced down the pipe A. The valve *a* being closed, the force of the water is exerted against the annular piston E and pushes it up into the air-chamber D, and in so doing the water is drawn through the suction-pipe F into the machine. Before the plungers A′ A′ reach the end of the stroke one of the catches L′ L′, which are connected with them, strikes the bell-crank lever *k*², and reverses the steam-valve; but the pressure of the steam is not great enough to open the valve G′ until it is relieved of pressure. When the plungers A′ A′ reach the end of the stroke it is obvious that the water will be traveling down the pipe A with a certain velocity, and cannot be stopped instantaneously. It will consequently continue to move down the pipe A until its force is expended in elevating the piston E. Consequently as soon as the major plunger ceases to follow the water the valve G′ will be relieved of its pressure, and the small steam-piston I′ will instantly close the valve F′ and open the valve G′. As the valve F′ prevents the ingress of any water, there will be a partial vacuum created in the barrels B′ B² for an instant. As soon as the force of the water in the pipe A is expended it comes to a state of rest, and then the piston E commences to descend. While it is in its highest position it holds the lever P up, which prevents the suction-valve *b* from closing. Consequently during the first few inches of its descent the full force of the air in the chamber D is expended on the annular piston, which is one-half of its area, thereby producing a double pressure, which is the force for starting the water in the pipe A with the required velocity equal to the force of gravity. By the time the piston descends far enough to allow the valve *b* to close the water in the pipe A will have the required velocity. The valve *a* is then forced open and the water from both chambers is forced through pipe A into the barrels B′ B² and follows the plungers A′ A′ on their return-stroke. Before the plungers A′ A′ reach the end of their stroke the catch L′ strikes the bell-crank lever *k*², which causes the valve G′ to close and F′ to open. Then, when the plungers reach the end of their stroke, the sudden stoppage of the plunger creates a high pressure, which opens the float-valve, and the water rushes in the chamber R until its force is expended. While the machine is making the return-stroke the float holds the valve open until the air forces the water back into the pipe A. By the time the water in the pipe A comes to a state of rest the twin plungers will be making another stroke, and consequently a high pressure is produced in the pipe A, which forces the water down to the lower machine. While the piston E is in its lower position it strikes the lever *f*•, which prevents the valve *a* from closing. Consequently while the piston E is being elevated the first few inches and the water in the pipe A is attaining the required velocity the whole of the area of the piston is exposed to pressure; but as soon as the water has attained the required

velocity the valve *a* closes. Then only one of the compartments is exposed to pressure while the other is drawing water through the suction-pipe F.

During the working of the machine a small air-pump (not shown) keeps up the supply of air in the air-chambers to the required pressure, thus compensating the loss by leakage, evaporation, &c.

By this invention the steam-pressure is used to force the column of water against the piston in the lower pump and condense the air in the air-chamber, and at the same time raise the water to a still higher level, while the reaction of the compressed air drives the water up the pipe into the upper pump, the entire operation being accomplished by the use of a single pipe to connect the two pumps.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The herein-described method of raising water to a greater height than thirty-three and one-third feet above the level of the body of water, consisting of driving a column of water from an upper level against a body of air below and admitting additional water as said air is compressed, then relieving the pressure above and allowing the expansion of the compressed air below to force the water upward, as set forth.

2. A hydropneumatic pump consisting of the air-chamber D, connected with the water-chambers B C by the piston E, the chamber C being connected with the suction-pipe F by ingress-valve *b*, and with pipe A by egress-valve *a*, and the chamber B being connected with the pipe A through an open port, the pipe A being connected with the power above, substantially as described.

3. In a pumping system for transmitting power through the pipe through which the water is raised, the means for producing movement of the water-column, consisting of the plungers A′ A′, moving in the cylinders B′ B², and means for connecting the cylinder B′ with the discharge-pipe C′ while the plunger is advancing, and for connecting it with the pipe A while retreating, the cylinder B² being connected through an open port with the pipe A all the time, whereby, by the movement backward and forward of the plunger, the water is made to reciprocate in the pipe, traveling farther while ascending than descending, and at each stroke discharging water, substantially as described.

4. The valves F′ G′, connected with rocking levers *g h′* and links *f i k*, operated by an auxiliary engine, H′, the valve of which is operated by the main plungers, substantially as described.

5. In a hydropneumatic pump, the valves *a b*, provided with slotted arms projecting above the free side of the valves, in combination with levers *f*² P, for preventing a too sudden closing of said valves, substantially as set forth.

6. The improvement in packing the plunger or piston of hydropneumatic pumps, consisting in dividing the cylinder G into two parts and fastening them together by the space-bolts *h*, in combination with the packing-groove *k* and follower or gland *l* and screw *m*, substantially as described.

7. The packing between tube J and annular piston E, consisting of the flange *n*, fixed to the top of the tube J, the long tube or follower surrounding the tube J and extending to the bottom of the cylinder, and the screws *p*, substantially as described.

In witness whereof I have hereunto set my hand and seal.

JOHN PATTEN. [L. S.]

Attest:

J. H. BLOOD,

ALBERT J. HIGGINS.