No. 629,866

Patented Aug. 1, 1899.

M. L. MITCHELL.

COMPRESSED AIR WATER ELEVATOR.

(Application filed Apr. 22, 1898.)

(No Model.)

4 Sheets—Sheet 1.

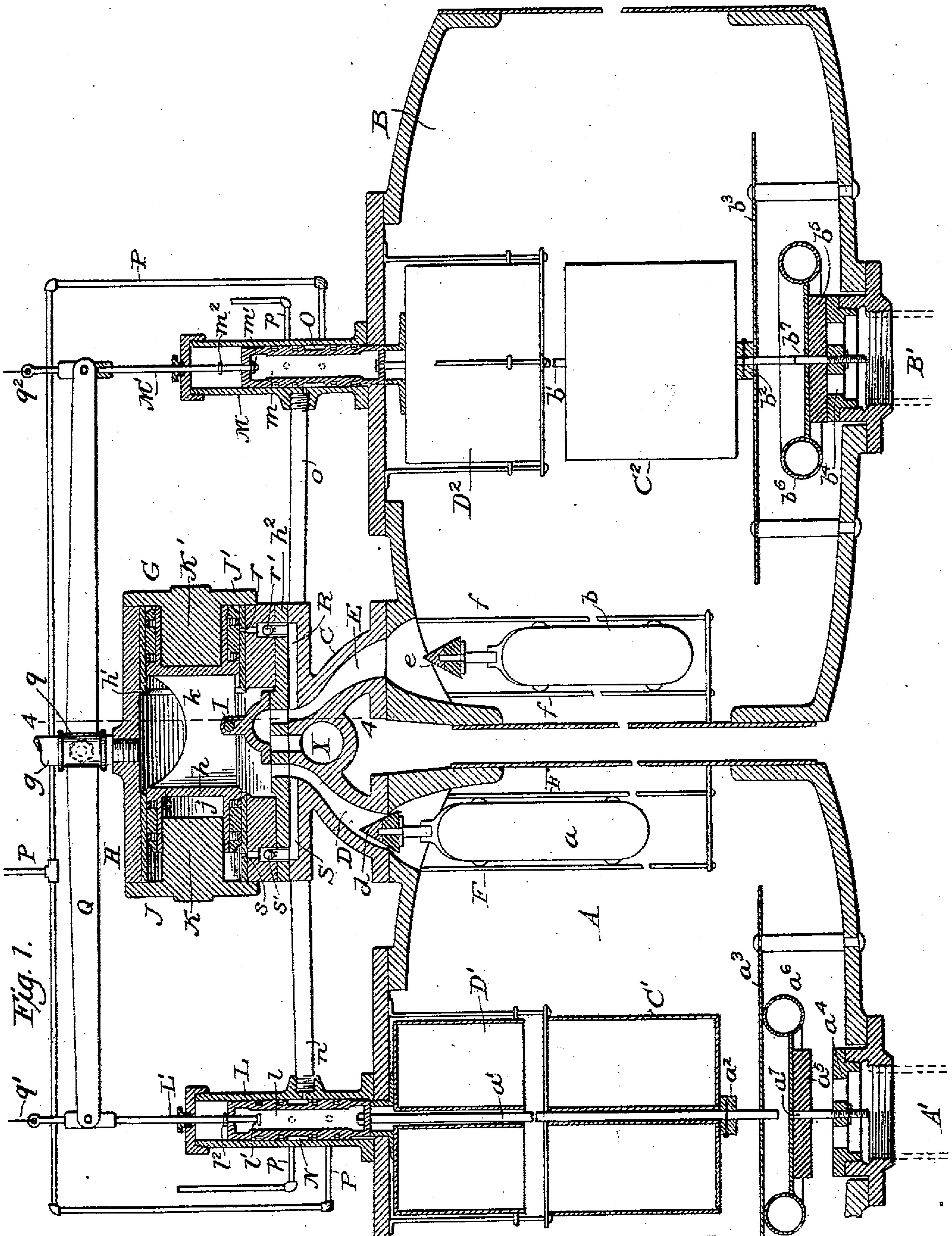

Fig. 1.

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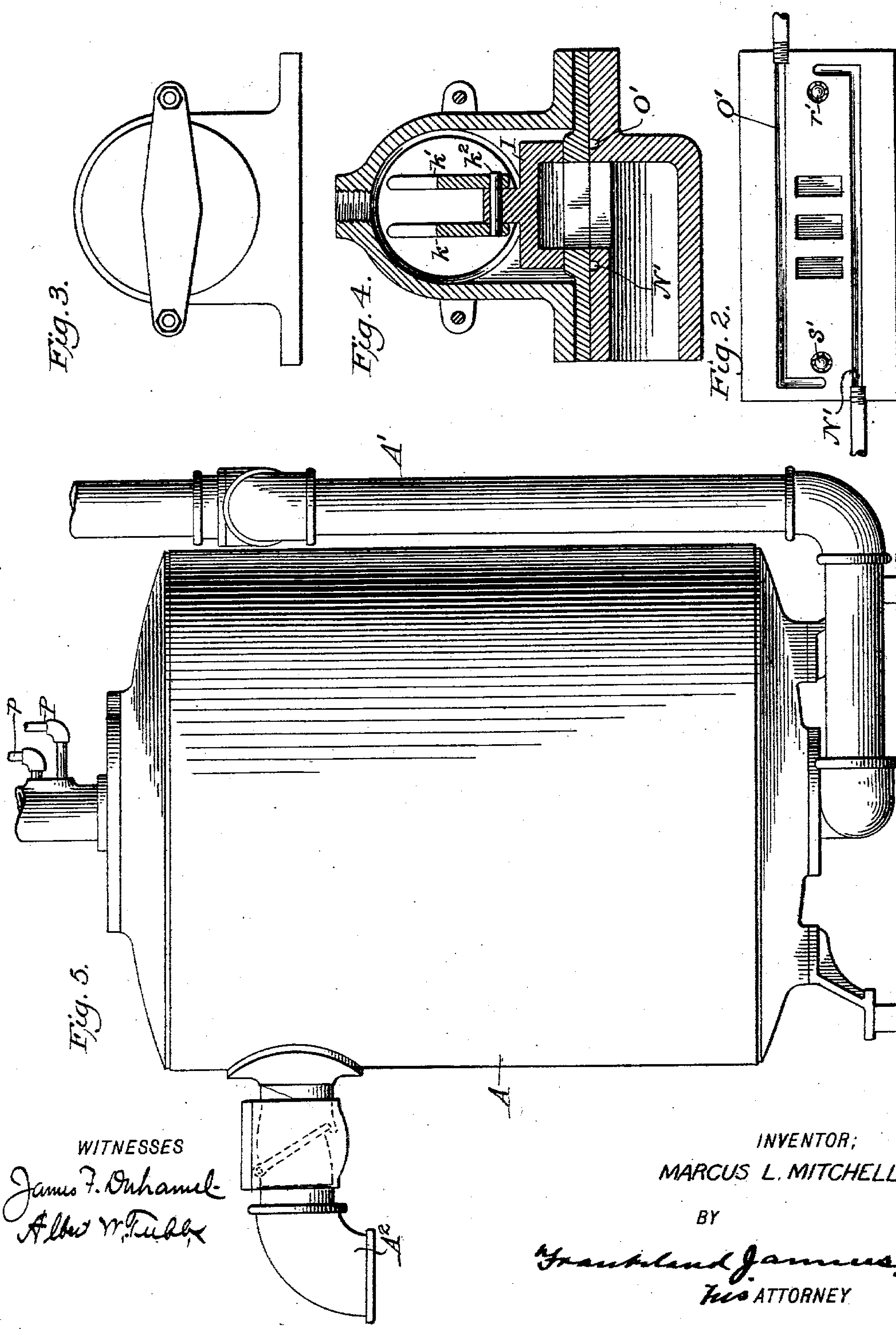

WITNESSES

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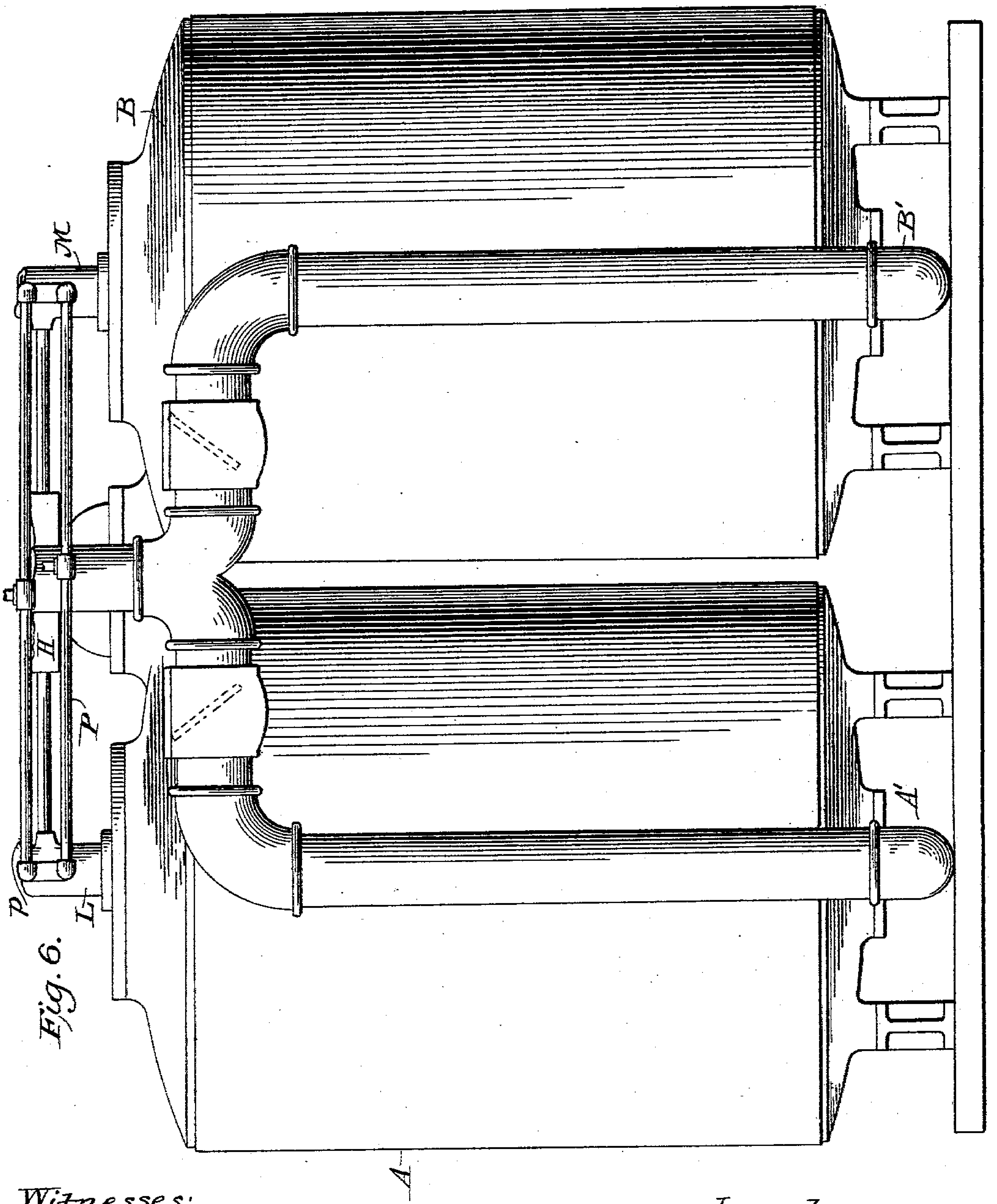

Fig. 6.

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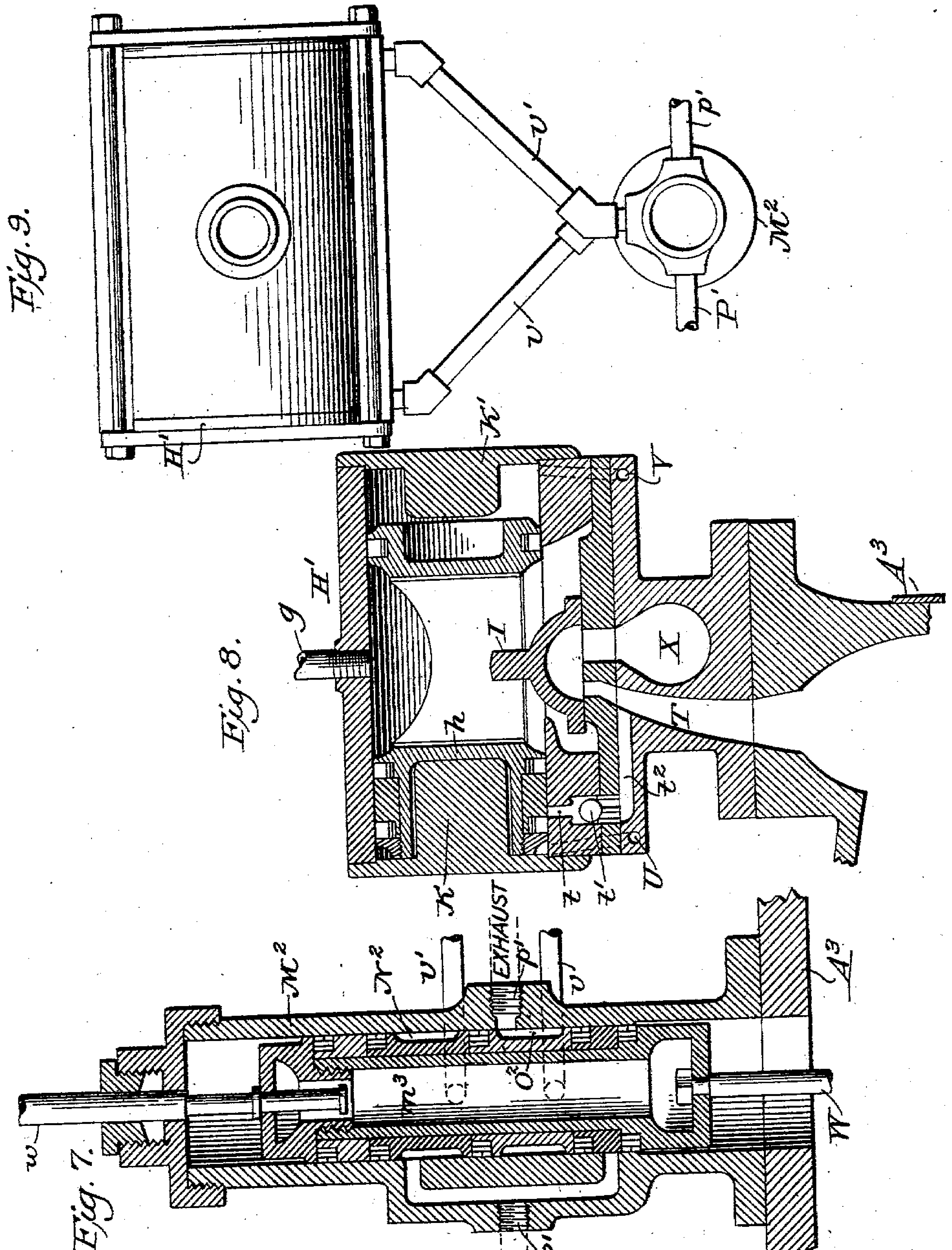

WITNESSES

James F. Duhamel

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UNITED STATES PATENT OFFICE.

MARCUS L. MITCHELL, OF ST. LOUIS, MISSOURI.

COMPRESSED-AIR WATER-ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 629,866, dated August 1, 1899.

Application filed April 22, 1898. Serial No. 678,462. (No model.)

To all whom it may concern:

Be it known that I, MARCUS L. MITCHELL, a citizen of the United States of America, and a resident of the city of St. Louis, in the State of Missouri, have invented certain new and useful Improvements in Compressed-Air Water-Elevators, of which the following is a specification.

My invention relates to improvements in compressed-air water-elevators—that is to say, pumps for raising water or other liquids by means of compressed air, and more particularly to the type known as "displacement-pumps," as will more fully and at large appear from the following description of the construction and mode of operation of the apparatus and be particularly pointed out in the appended claims.

Figure 1 is a vertical sectional elevation showing a general view of the apparatus, a portion of one of the pump-chambers and the delivery-pipe being broken away for convenience of illustration. Fig. 2 is a detailed plan view of the port-plate of the main valve. Fig. 3 is an end view of the main-valve cylinder. Fig. 4 is a transverse sectional elevation on the line 4 4 of Fig. 1. Fig. 5 is an enlarged detail of one of the pump-chambers, showing the inlet and outlet pipes, together with a portion of one of the controlling-valves. Fig. 6 is a view in elevation, showing the two pump-chambers, their delivery-pipes, and portions of the air-controlling valves. Fig. 7 is a vertical sectional elevation of a double-acting controlling-valve. Fig. 8 is a vertical longitudinal sectional elevation of a main valve, slightly modified, for use in connection with a single-acting pump. Fig. 9 is a top plan view of the controlling-valve and main valve shown in Figs. 7 and 8.

As indicated in the drawings, A B are two air-tight vessels, preferably of metal, and which may be in cylindrical or other form. These vessels are immersed in and placed together on a suitable base near the bottom of the well, tank, cistern, or other container of liquids to be raised, and they should be strong enough to withstand the pressure of the gas or fluid by which the liquid contained in the said tank is expelled through the delivery-pipe by displacement. Compressed air being preferably used for this purpose will be hereinafter referred to.

The chambers A B are arranged near together on any suitable base and are connected with a casting C, which contains two principal air-ports D E, extending from the main valve to supply compressed air to said chambers alternately. Said part C also includes a common exhaust X.

Each of the chambers A B is provided with a free float *a b*, which is adapted to move vertically between guide-rods F *f*, and each of which is provided with a conical head *d e*, adapted when the said floats are raised by the filling of their respective chambers to close the openings to the air-passages D E. When empty, the pump-chambers are allowed to fill automatically, as will appear, and their contents are alternately forced out by compressed air, which is controlled by the main valve G and supplied thereto by pipe *g*, extending from any suitable source.

The main valve G comprises a cylinder H, provided with a piston *h* and with a slide-valve I, which is connected to and moved by said piston over a set of three ports D, E, and X, which are arranged as in ordinary steam practice—the exhaust-port in the middle between the two air-ports.

The cylinder H may be made of the usual cast-iron; but I prefer to line it with bronze, as indicated at *h'*. The piston *h* is best of brass.

The port-plate h^2 is preferably in a separate piece, as indicated in Figs. 1 and 2, and this I prefer also to make of bronze, while the slide-valve may be of cast-iron, since under constant exposure to water these materials give good results and work well without lubrication.

The piston of the main valve G is formed with hollow heads *j*, and the cylinder-heads J J' are provided with inward extensions K K', corresponding to the hollows in the ends of the piston in order to diminish the cubic contents of the spaces between the ends of the piston and the ends of the cylinder. The end portions of the said piston *h* are provided with any usual form of packing to secure tight joints with the cylinder. The central portion of the piston *h* between its two cylindrical end parts is in the form of a rib or ribs $k\ k'$, to which the slide-valve I is secured by a suitable bolt k^2 or otherwise.

The air-pipe g is connected with the central portion of the cylinder H, and the motor fluid or compressed air passes freely through the central portion of the cylinder to the air-ports D E.

The movement of the valve-piston h and slide-valve I to alternately supply live air to and exhaust spent air from the pump-chambers A B is effected through two similar controlling-valves, which are preferably placed one on top of each of the pump-chambers A B in corresponding positions with respect to the main valve G. The controlling-valves comprise cylinders L M, one on each pump cylinder or chamber. The valve-cylinders are open below into their respective pump-cylinders and closed on top by an air-tight head, through each of which passes a rod L' M'. A cylindrical valve $l\ m$ is arranged to be moved vertically in each of the cylinders and is formed hollow and with openings into the cylinders, so that it is balanced and not affected by the pressure of the air in its pump-chamber. Each of the pistons $l\ m$ is formed with a central groove or depression N O. The pipe n extends from a suitable point in the cylinder L to the cylinder of the main valve G and through duct or port N' therein to its opposite end, and a corresponding pipe o extends from the cylinder M to the main valve G and through port O' therein to the opposite end of its cylinder, as will be clearly seen in Fig. 2. The pipe P is connected with both of the cylinders L M, connecting with ports therein arranged in similar relation. This pipe supplies compressed air to the said controlling-valves separate from the main air-pipe g, although it may be from the same source at same pressure. A second pipe p is similarly connected to both the cylinders L M and serves as exhaust therefrom. The live-air and exhaust pipes P p and the grooves N O in the pistons $m\ l$ are, as indicated, so arranged that at opposite extremities of their stroke they will lap the air or the exhaust ports in the cylinders L M and the ports communicating with the main-valve-actuating pipes $n\ o$.

The controlling-valve pistons $l\ m$ are operated by a combination of floats and weights within the pump-cylinders and normally are raised and lowered in accordance with the rise and fall of the liquid in the pump-cylinders, thereby controlling the position of the piston h of the main valve G.

The pump-chambers are provided with vertical rods $a'\ b'$, which are secured at their upper ends to the pistons $l\ m$ and at their lower ends pass through guide-openings in cross-pieces $a^3\ b^3$. The lower part of each chamber A B is provided with an exit $a^4\ b^4$, communicating with the delivery-pipes A' B', and each of these exits is provided with a closing-valve $a^5\ b^5$, which valves are normally sustained out of contact with the exit-openings by annular floats $a^6\ b^6$, which when the chambers are not entirely empty float up against the under side of the cross-piece $a^3\ b^3$, keeping the openings $a^4\ b^4$ free. These valves are also guided by short stems $a^7\ b^7$, which are in line with the rods $a'\ b'$.

Open-top buckets C' C^2 are secured near the lower ends of the vertical rods $a'\ b'$, desirably resting upon blocks $a^2\ b^2$, secured to the rods, and as the water lowers in the pump-chambers the water contained in the buckets acting as a weight pulls down the rod a' or b' and with it the controlling-valve attached thereto. Each rod $a'\ b'$ is also provided near its upper end with a float D' D^2, by which the rod, weight, and piston l or m is raised when the desired quantity of water has entered the cylinder.

One of the difficulties attending the use of compressed-air water-elevators is due to the fact that when immersed at the bottom of the well and beyond reach it frequently happens that after a period of disuse the sediment from the water settling around the moving parts makes it impossible to start them up. I have therefore so arranged and constructed my improved apparatus that the controlling-valves may be operated by hand through manual connections extending to the surface. These comprise the rods L' M', which enter packed openings in the heads of the cylinders L M and are loosely connected to the upper ends of the pistons $l\ m$ by collars $l'\ l^2\ m'\ m^2$, so as not to affect the normal operation of the said pistons. The rods L' M' are pivotally connected to the extremities of the rocking lever Q, which may be pivoted upon the projection q, secured to the air-pipe g or other convenient place. Wires $q'\ q^2$ extend from the said rods to a convenient point at the surface where they may be manipulated manually. When stopped, both chambers will fill with water, and should the main valve refuse to start or not be in position to start automatically when the compressed air is turned on through pipe g then the secondary air is thrown against first one and then the other end of the piston h by raising and lowering the pistons $l\ m$ of the controlling-valve through the wires $q'\ q^2$ and rocking lever Q. This by striking the main-valve piston h repeated blows from opposite ends will readily move it into position to resume normal automatic operation.

To secure high efficiency, the motor fluid is supplied to the full chambers in large volume. A very great obstacle to the successful working of this class of apparatus has been due to the sudden and violent application of the ejecting medium, causing great shocks and strains, accompanied by liability of derangement and violent and spasmodic action, all of which I have obviated by gradually applying the pressure to the full pump-chambers before admitting the full volume of the compressed air thereto. I also secure a very material economy in operation by shutting off the supply of compressed air to the chamber which is being discharged before discharge is complete. These desirable results are secured through the valve controlling and operating mechanism, whereby the movement of the piston h of the main valve is begun before the discharging chamber is empty. This piston is operated by a separate air-supply through the pipe P and one or other of the controlling-valves, and the movement of the said piston is arrested by the escape of said air through a by-pass into the pump-chamber that has been filled.

R is a by-pass port extending from the main air-port E to and entering one end of the cylinder H of the main valve G, a short distance from the head J′, through the port r. The port r is always free in the direction from the cylinder to the main port E and thence into the chamber B, but is closed by a preponderance of pressure by means of the valve r', which seats upward, but permits the passage of air downward. In like manner the by-pass S communicates with the chamber A through main port D and with the opposite end of the cylinder H by the port s and is closed upward by the valve s'.

With this construction or its substantial equivalent the mode of operation is as follows: The chamber A is full and ready to discharge, while the chamber B is filling. The check-valve or float b of the said chamber B is at its lowest position, which should be such that it will not be blown up into closed position by the outrush of the exhaust through the ports, which, as shown, are fully open. The valve m has been pulled down by the weight C^2, establishing connection for the live air from the pipe P through the pipe o and duct or port O′ to the opposite end of the cylinder of the main valve G, forcing the piston h over and with it the slide-valve I, opening the port D and establishing communication between the main air-supply from the pipe g through the main valve to the full pump-cylinder A. At the same time the rising of the float D′ in chamber A carries with it the weight C′, which being surrounded by water becomes neutralized and in raising the valve-piston l shuts off the live air from the pipe P and establishes communication between pipe n, duct N′, the opposite end of the main-valve cylinder H, and the exhaust-pipe p, thereby permitting the movement of the main-valve piston h. These are the conditions under full operation. The intermediate steps are that as the water leaves the chamber A and enters the chamber B by an appropriate adjustment of the floats D′ D^2 when the chamber B is nearly filled its float will rise, shutting off the live air which held the piston h of the main valve. Correspondingly the weight in the opposite chamber becoming uncovered will assert itself and pull down the piston l, closing the exhaust on that side and opening the communication to the secondary live-air supply from pipe P, which will then accumulate in a suitable groove around the opposite end of the piston of the main valve, and this, continuing to flow, will start and move it (the piston h) until the ports D and E are closed and the port r is uncovered, when the live air will escape through the by-pass R, around the valve r', into the filling chamber B, into which it will continue so to flow, the piston h remaining stationary while the pressure in chamber B accumulates. When the small stream of air flowing into the filling-chamber B has backed up so as to bring the pressure therein up to that of the main air-supply, the said pressure will also exist at the end of the piston h, controlled by said port r, and the exhaust at the opposite end of the said piston being open the said piston h of the main valve will complete its movement, carrying the slide-valve I to the final position, where it will lap the main port D and the exhaust-port, giving free vent to the spent air in the chamber A, when it will immediately proceed to refill. Similar inlet-pipes are provided, one only, A^2, being shown. These are placed near the upper portions of the pump-chambers A B in order to prevent the admission of debris, and they are provided with suitable check-valves, and with screens also when necessary.

My invention is not limited to a duplex apparatus, as it may be operated in single form without departing from the invention, as indicated in Figs. 7, 8, and 9. As there shown, H′ indicates a main-valve cylinder substantially like the one already described, except that it is provided with only one principal air-port T instead of with two. The slide-valve I is similar in construction and arrangement, as is also the exhaust-port and the main air-supply pipe g. In a single-acting arrangement only a single chamber A^3 is employed, and one double-acting controlling-valve takes the place of the two small valves heretofore described. The chamber A^3 resembles those shown, and hence is only indicated by broken parts.

M^2 is the cylinder of the controlling-valve, which is provided with a double-ported air-inlet extending from the air-supply pipe P′. A single exhaust-port p' is provided, and the valve-piston m^3 is provided with two annular depressions or ways N^2 O^2. Pipes v v' extend from the cylinder M^2 of the valve to opposite ends of the cylinder H′ of the main valve, pipe v being connected with the port V and the pipe v' being connected with the port U. The chamber A^3 is provided with outlet and inlet openings, as in the previous instances, and also with a weight and a float, which are connected with the depending rod W, the construction and operation of these parts being as already described. As the rod W is raised and lowered by the filling and emptying of the pump-chamber A^3 the valve-piston m^3 is raised and lowered, alternately supplying air to and exhausting it from the opposite ends of the cylinder H′. In this instance, however, only a single by-pass port t^2 is needed, this being provided with a check-valve t', preventing back pressure through the small port t. The operation of the apparatus is similar to that already described, except that the delay in the movement of the valve will occur only prior to the beginning of the discharge of the contents of the chamber A^3. In this instance also I provide means in the rod W, extending to the surface, for manually operating the controlling-valve in order that should the main valve be clogged by sediment or otherwise by repeatedly applying the force of the motor fluid from the secondary supply-pipe to alternate ends of the piston of the main valve it may be readily started into normal operation.

The main air-supply pipe g, as well as the secondary pipe P, also supplying compressed air, are each provided with any convenient form of regulating-cock at accessible points, so that the main supply of air may be discontinued and the piston h relieved of the pressure thereof while the motor fluid from the secondary supply is applied to the ends of the piston h in alternation for the purpose of starting it into condition for normal operation, and any separation of the main and secondary air-supply pipes which will permit independent use thereof will answer the purpose. At the same time it need not be understood that the main air-supply to the pipe g is in all cases cut off until the valve h has been stopped, this being discretionary with the person in charge.

While I have described in detail the construction shown, it will be apparent that the same may be altered or modified in many particulars without the exercise of invention in view of the foregoing. I therefore do not limit myself to the precise details or the exact arrangement thereof in practice.

Having described my invention, what I claim is—

1. In a compressed-air water-elevator, two chambers each provided with a valved inlet and a valved delivery, a main valve for controlling the admission of air to and exhaust thereof from said chambers, and means for alternately and independently connecting each end of said main valve with the air supply and exhaust by the rise and fall of the liquid in said chambers, whereby the shifting of the main valve is controlled by the admission and exhaust of air due to the conjoint action of both chambers.

2. In a compressed-air water-elevator, two chambers each provided with a valved inlet and a valved delivery, a main valve for controlling the admission of air to and exhaust thereof from said chambers, two independent primary valves each adapted to control both the supply and exhaust to operate said main valve, a primary valve being in connection with each of said chambers, a float in each of said chambers for moving the primary valve connected therewith in one direction independently of the other primary valve, a weight in each of said chambers for moving the primary valve connected therewith in the other direction independently of the other primary valve, and operating connections between said primary valves and said main valve, whereby said main valve is actuated by the conjoint action of said primary valves.

3. In a compressed-air water-elevator, two chambers each provided with a valved inlet and a valved delivery, a piston for controlling the admission of air to and exhaust thereof from said chambers, a double-acting primary valve for each of said chambers, one communicating with one end of said piston, and the other with the other end thereof, and means for independently operating each of said primary valves by the rise and fall of the liquid in its respective chamber.

4. In a compressed-air water-elevator, a chamber for containing the liquid to be raised and provided with a valved inlet and a valved delivery, an air-supply for supplying compressed air to force out the contents of said chamber, a valve controlling the admission of air from said air-supply to said chamber through a main port, a secondary port for supplying air to said chamber to raise the pressure in the same, and means for opening said latter-named port by the initial movement of said valve before the main port is opened.

5. In a compressed-air water-elevator, a chamber for containing the liquid to be raised and provided with a valved inlet and a valved delivery, an air-supply for supplying compressed air to force out the contents of said chamber, a valve controlling the admission of air from said air-supply to said chamber through a main port, a secondary port for supplying air to said chamber to raise the pressure in the same, means for opening said secondary port by the initial movement of said valve before the main port is opened, and means for retarding the movement of said valve after said secondary part is opened until the pressure in said chamber is raised to substantially the pumping pressure.

6. In a compressed-air water-elevator, a chamber for containing the liquid to be raised and provided with a valved inlet and a valved delivery, a main air-supply for supplying compressed air to force out the contents of said chamber, a valve controlling the admission of air from said main air-supply to said chamber through a main port, a second air-supply, a secondary port for supplying air to said chamber from said second air-supply to raise the pressure, and means for opening said secondary port by the initial movement of said valve.

7. In a compressed-air water-elevator a chamber for containing the liquid to be raised provided with a valved inlet and a valved delivery, a main pipe supplying compressed air for forcing out the contents of the chamber, a main valve for directing the compressed

air to and exhausting it from the chamber, a separate air-supply pipe and a valve for controlling the flow of the compressed air in the secondary supply-pipe to the main valve for actuating the same and a by-pass or release port extending from the cylinder of the main valve to the main air-port, intermediate the movement of said main valve, whereby the valve-moving air will escape into the chamber to be discharged, and delay the movement of the main valve until the pressure in the said chamber becomes equal to that of the main air-supply.

8. In a compressed-air water-elevator a chamber for containing the liquid to be raised provided with a valved inlet and a valved delivery, a main pipe supplying compressed air for forcing out the contents of the chamber, a main valve for directing compressed air to and exhausting it from the chamber, a separate air-supply pipe and a valve for controlling the flow of the compressed air in the secondary supply-pipe to the main valve for actuating the same, and a by-pass or release port extending from the cylinder of the main valve to the main air-port intermediate the movement of said main valve whereby the valve-moving air will escape into the chamber to be discharged and delay the movement of the main valve until the pressure in the said chamber becomes equal to that of the main air-supply, and a check-valve in said by-pass to prevent backflow when the cylinder is exhausted.

9. A combination with a chamber adapted to be immersed in liquid to be raised and having a valved inlet and delivery, of a main source of compressed air, a main valve directing the supply and exhaust thereof to and from the chamber to discharge its contents, a secondary source of compressed air for operating the main valve a controlling-valve for said secondary supply of air and means for actuating the controlling-valve, and a by-pass extending from the main valve to the main air-port for temporarily reducing the pressure in the main-valve cylinder below the valve-moving point, whereby the main valve is delayed in mid-stroke until the pressure of the secondary supply of air in the filling chamber equals that of the main air-supply when the main valve will complete its movement and the chamber be discharged.

10. The combination with a pair of chambers adapted to be immersed in liquid to be raised and having valved inlets and delivery-pipes of a main source of compressed air, a main valve directing the supply and exhaust thereof to and from the chambers to discharge their contents, a secondary source of compressed air for operating the main valve, a controlling-valve connected with each chamber for said secondary supply of air, means operated by the contents of the chambers for actuating the controlling-valves, and a by-pass extending from each end of the main-valve cylinder to a main air-port for temporarily reducing the pressure in the main-valve cylinder below the valve-moving point whereby the main valve is delayed in mid-stroke and the air-supply is cut off from the other chamber until the pressure of the secondary supply of air in the filling chamber equals that of the main air-supply when the main valve will complete its movement and one chamber be discharged and the other exhausted and refilled.

11. The combination with a water-chamber of a compressed-air water-elevator of a main valve comprising a reciprocating piston and valve having an air-port extending into the chamber and a suitable exhaust-port adapted to be connected with the air-port by the valve, a main air-supply connected to said valve, an auxiliary, release or by-pass port extending from the cylinder of the main valve to the air-port of the chambers beyond the main valve, whereby when compressed air is admitted behind the piston to move the same said air will escape when the auxiliary port is uncovered delaying the movement of the piston until the pressure in the chamber equals that of the main air-supply, and a check-valve in said auxiliary port to prevent backflow when that end of the cylinder is exhausted.

12. In a compressed-air water-elevator the combination with a chamber for containing the liquid to be raised having a valved inlet and a valved delivery, of a main air-supply pipe, a main air-port connected with the chamber, an exhaust therefor, and a main valve for opening and closing said ports, of a controlling-valve actuated by the rise and fall of the contents of the chamber and a separate supply of compressed air through the controlling-valve for moving the main valve and means for cutting off and confining the compressed air supplied to the chamber before its contents are fully discharged.

13. In a compressed-air water-elevator, a chamber for containing the liquid to be raised and provided with a valved inlet and a valved discharge, a main air-supply, a main valve controlling said main air-supply, a separate and independently-controllable air-supply for operating said main valve, an auxiliary valve for controlling said air-supply, mechanism for automatically operating said auxiliary valve, and means for manually operating said auxiliary valve while said main air-supply is cut off.

Signed by me at St. Louis, Missouri, this 19th day of April, 1898.

MARCUS L. MITCHELL.

Witnesses:

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