(No Model.) 3 Sheets—Sheet 1.

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PUMP.

No. 568,742. Patented Oct. 6, 1896.

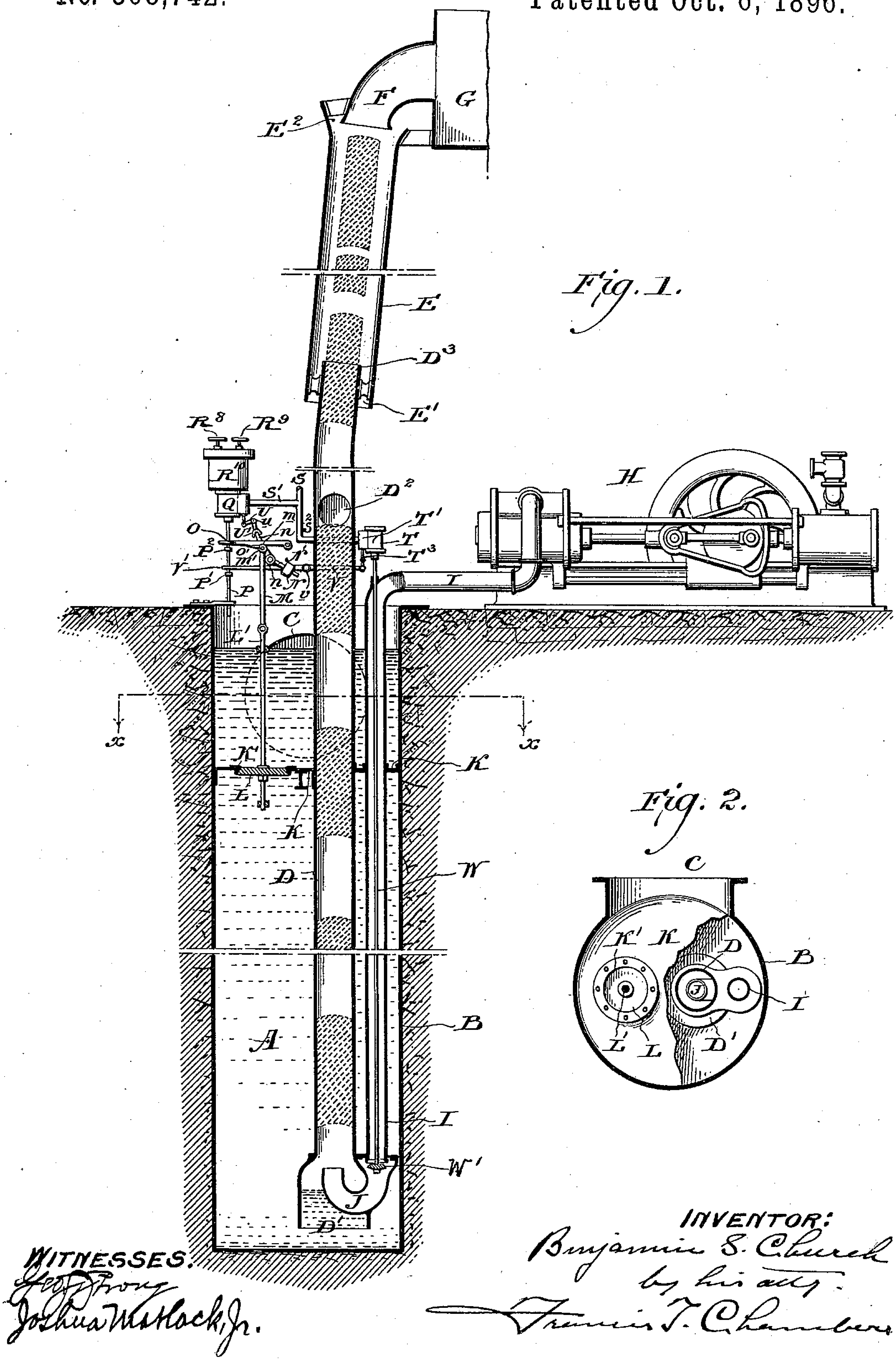

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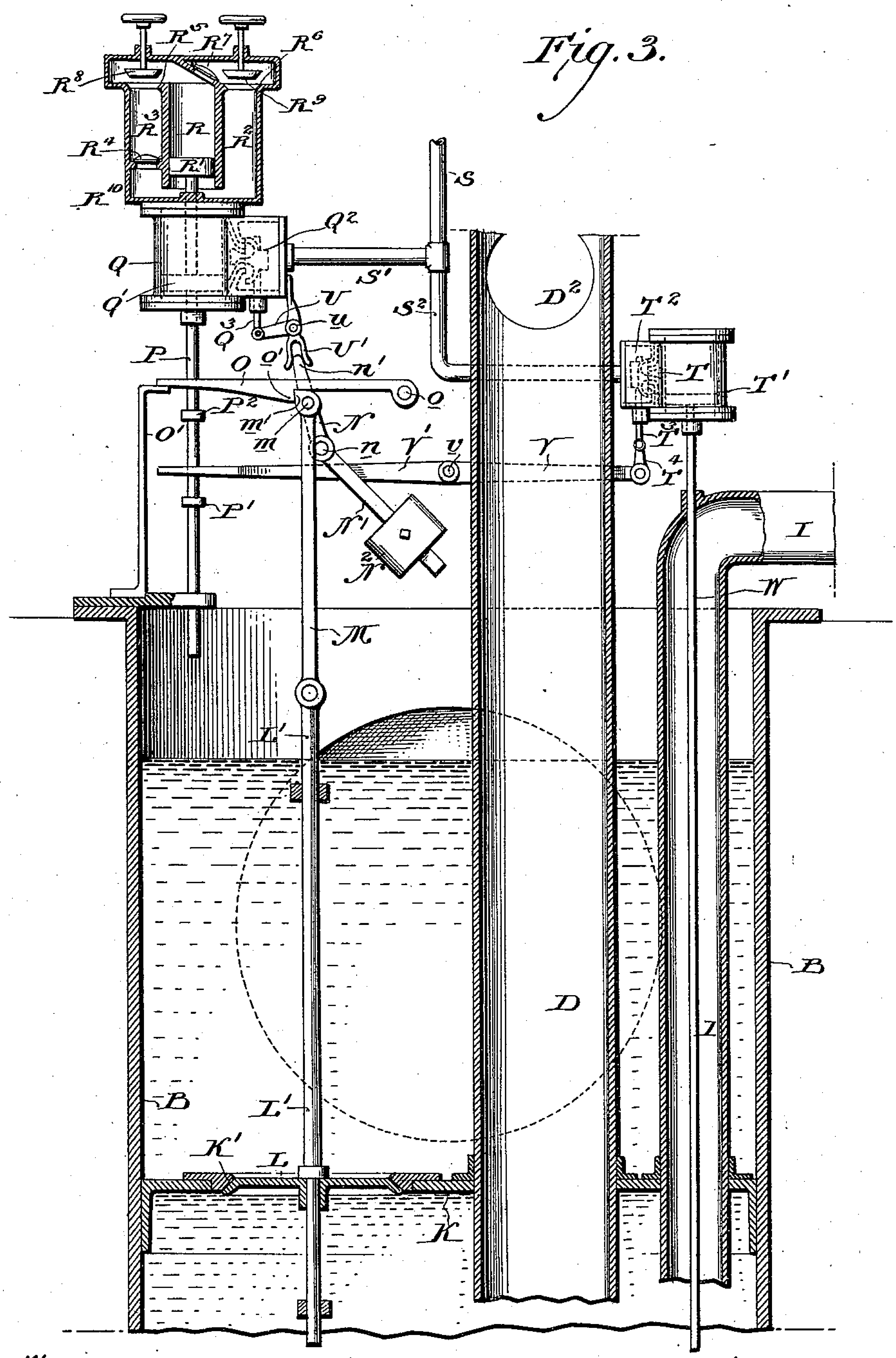
Fig. 3.



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by his atty
Francis T. Chambers

(No Model.) 3 Sheets—Sheet 3.

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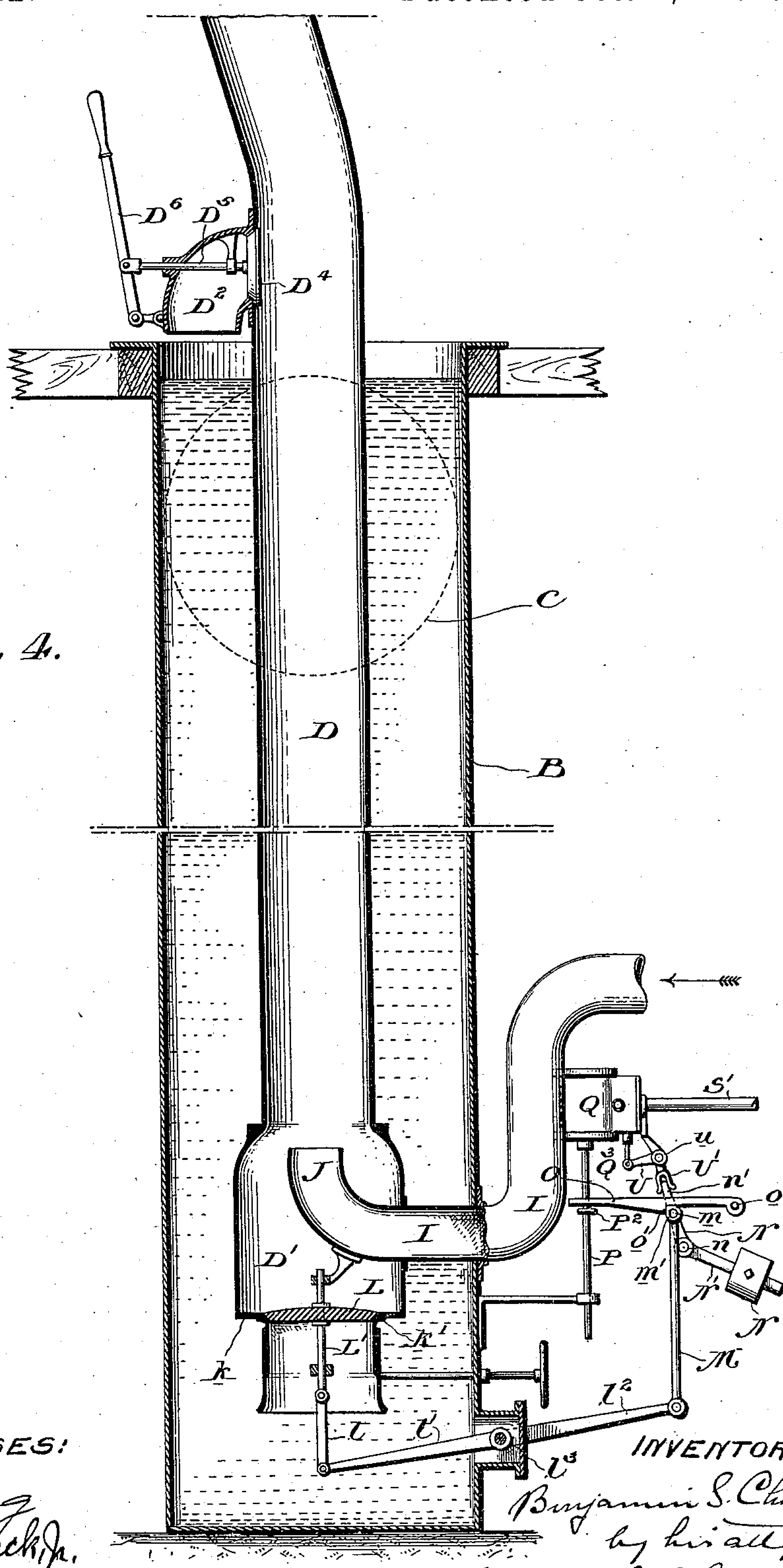

Fig. 4.

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UNITED STATES PATENT OFFICE.

BENJAMIN S. CHURCH, OF NEW YORK, N. Y.

PUMP.

SPECIFICATION forming part of Letters Patent No. 568,742, dated October 6, 1896.

Application filed February 15, 1892. Serial No. 421,535. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN S. CHURCH, of the city and county of New York, State of New York, have invented a certain new and useful Improved Pump, of which the following is a true and exact description, reference being had to the accompanying drawings, forming part of this specification.

My invention relates to pumps of the kind in which the fluid is raised by the injection of compressed air or steam into the lower and submerged end of a pipe, creating in said pipe a column made up of alternate sections of fluid and gas, which is propelled upward by a force corresponding to the excess weight for a given height of the fluid at the base of the pipe and the mixed column within the pipe.

The object of my invention is to increase the capacity and facilitate the control and management of pumps of this description.

The nature of my improvements will be best understood as described in connection with the drawings, in which they are illustrated, and in which—

Figure 1 is a sectional elevation of a pump provided with my improvements. Fig. 2 is a sectional plan view on the line x x of Fig. 1. Fig. 3 is an enlarged sectional view illustrating in detail the valve-actuating mechanism which I prefer to use, and Fig. 4 is a sectional elevation showing the application of my improvements to a tank situated above ground.

A, Fig. 1, is a well provided with a casing B, which may be considered as a sunken tank, and as illustrated in Fig. 4 is a tank situated entirely above ground.

C is a main leading to the top of the tank or well, by which it is kept filled with water or any other fluid.

D is a pipe which is contained in the tank B, into which its lower end D′ opens freely, said lower end being preferably made bell-shaped, as shown. At or about the level of the fluid in the tank or slightly above it, as shown, an opening D^2 is made in the pipe D, which opening is controlled by a valve D^4. (See Fig. 4, where this valve is shown as actuated by a lever D^6, connected with it by a rod D^5.) The function of this valve or opening is to facilitate the starting of the apparatus by allowing the fluid to escape at this point or to serve as a by-pass when for any other reason it is not desired to drive the fluid to a greater height.

D^3 is the top of the pipe D, the height of which above the level of the fluid in the tank will depend upon the height of the liquid column in the tank and the relative proportion of gas and liquid in the pipe.

E is a casing of larger diameter than pipe D, but parallel and concentric with its end and open to the atmosphere at top and bottom, as shown; F, a receiving-conduit, the end of which is also in line with the mouth of pipe D, and which leads into a receiving-tank G.

H is an air pump or compressor; I, a compressed-air pipe leading from the compressor and terminating with a nozzle J, situated in the bottom of pipe D and pointing upward in line with said pipe, as shown.

The arrangement of the well, pipe D, compressor, and compressed-air pipe to the extent already described is familiar; and it has been found that by forcing air through the nozzle J at a slightly greater pressure than that of the fluid column at the same point with a mixed attending column made up of alternate sections of air and fluid will be formed in the pipe D, as illustrated by the shaded and blank spaces in the drawing Fig. 1; and it is also found that the velocity of this column increases rapidly as it moves upward, for the obvious reason that the air-sections will expand as the pressure above them diminishes, so that the velocity of each water-section is constantly increasing and at the top of the pipe is equal to the velocity of the entering fluid at the bottom of the pipe plus the velocity due to the expansion of the air from the maximum point of compression to or nearly to atmospheric pressure. In order to take advantage of this accelerated velocity, I place the receiving-tank G at some distance above the top of pipe D, provided with a receiving-nozzle F, the end of which is in line with the end of pipe D. By this arrangement the water-sections are shot across the intervening space between the end D^3 of pipe D and the mouth of nozzle F, the air-sections, expanded already to nearly atmospheric pressure, escaping to the side, so that a practically continuous supply of water enters tank G through nozzle F. Preferably the casing E, open at both ends, extends between the nozzle F and the mouth D^3 of pipe D. This casing prevents the formation of cross-currents, the air passing through it parallel to the water-sections and acting to hold them together, so to speak.

Passing now to the main feature of my invention, I will first state that I have taken advantage of the naturally intermittent alternating flow of fluid and gas and have ascertained that by artificially regulating the relative admission of air and fluid to the pipe D the mixed column in said pipe may be driven to almost any desired height or delivered at a lower point at almost any desired pressure. Roughly speaking, for instance, and assuming that without regulation the column in pipe D will be raised to a height equal to the depth of the tank B, by doubling the proportionate quantity of air supplied to the pipe I am enabled to raise the column to a height above the tank twice as great as its depth, and so on.

Reference being now again had to the drawings, L is a valve by which the flow of water into pipe D can be regulated at will. This valve, in case of a sunken tank, as shown in Fig. 1, is most conveniently arranged to operate in an opening K′, situated in a partition or diaphragm K, extending across the casing B. By closing this valve the water or other fluid above the diaphragm is cut off from the fluid below and the pressure of fluid at the mouth of pipe D correspondingly diminished.

Where the tank is supported above ground, as shown in Fig. 4, the valve L can be conveniently situated at the mouth of the bell-like bottom D′ of pipe D, the seat k' being there provided for it in an annular rim k. For obvious reasons it is best that the valve L should open in the direction of the flow of fluid.

The valve L is to be actuated at proper intervals by means of automatic valve-actuating mechanism, and is preferably so counterweighted or balanced that when the liquid column is not descending it will seat itself. Then by providing an automatic catch which will hold it to its seat it is only necessary, in addition, to provide an intermittently-acting catch-lifting device, which, at regular intervals, will lift the catch, permitting the valve to open under the pressure of a descending liquid column. The flow of liquid into the pipe D being of an intermittent character, as described already, the counterweighted valve will always seat itself at the proper time; that is to say, at the time when the ascending column of water is broken by the pressure of the air.

Referring again to the drawings, (see Figs. 1 and 3,) M is a connecting-rod secured to the top of the valve-rod L′ and pivoted to an arm N of a lever N N′, which is pivoted at n and provided with a counterweight N^2 on its arm N′. This counterweighted lever will perform the function of drawing the valve L to its seat whenever the fluid in the casing B is at rest.

m' is a shoulder which, when the valve is seated, is engaged by a shoulder o' of a catch-lever O, pivoted at o.

P is a trip-rod having a stop P^2, so placed that when the rod is raised it will engage the catch-lever O, which normally rests upon a stop O′, and raising to a sufficient height to disengage the shoulder o' from the shoulder m'. As shown, the rod P is a continuation of the piston-rod passing through a cylinder Q and attached to a piston Q′. Air or steam passing through conduits S S′ enters the valve-box of the cylinder Q and is directed to one side or the other of the piston Q′ by a valve Q^2, the valve-stem Q^3 of which is secured to the arm U of bell-crank lever U U′, pivoted at u, the end U′ of which is forked and engaged by a projection n' of the lever-arm N. The effect of this arrangement, as will be readily seen, is to admit steam to the bottom of cylinder Q as soon as the valve L has seated itself. This causes the piston Q′ and rod P to move upward until the lug P^2 disengages the catch-lever O, this disengagement being timed to occur when the water in the casing B is free and ready to move downward and enter the pipe D. Consequently the valve L at once opens, pulling down the arm N of lever N N′ and reversing the position of the valve Q^2, which admits the air or steam to the top of cylinder Q and causes the rod P to move down again.

In working the pump, as I propose to do, with artificially timed and proportioned sections of air and fluid in the pipe D it is advisable not only to control the flow of fluid, but also the flow of air. Indeed, while the results I aim at can be secured to a greater or less extent by regulating either the flow of water or the flow of air, the best results can only be had when both are regulated; and I therefore provide a valve w', (see Fig. 1,) by which the air-conduit I can be opened and closed at will. This valve is connected to the end of a rod W, the upper end of which is secured to a piston T′, working in a cylinder T, which communicates, through a valve-box and the pipes S S^2, with a boiler or receiver of steam or air, a valve T^2 governing the admission of the actuating fluid to the top or bottom of the cylinder.

The valve-stem T^3 of valve T^2 is connected by link T^4 with the arm V of a lever V V′, pivoted at v, and the arm V′ of which extends within the path of stops on the rod P, being so placed that the stop P′ will act upon it at substantially the same time that the catch-lever O is lifted out of engagement by the stop P^2. This motion of lever V V′ draws the valve T^2 down, admitting steam or air to the bottom of cylinder T and forcing valve w' to its seat, where it remains until the rod P, moving downward, comes in contact with the lever V V′, shifting the position of valve T^2 and causing the valve to be pushed down away from its seat. The inrush of air in the pipe D has at once the effect of checking the flow of water into the said pipe, and as soon as the water comes to rest the valve L moves up to its seat, locking itself there by the devices already described, and at the same time shifting the valve Q^2 and causing the rod P to move upward.

In order to properly regulate and time the up-and-down strokes of the piston Q′ and rod P and through it to regulate the admission of air and fluid, I provide the regulating device R^{10}, which consists of a cylinder R, in which works a piston R′, this piston being connected with the rod P, as shown, being fastened directly to a continuation of it. The cylinder R opens at top and bottom in the by-passes R^2 and R^3 and upwardly-opening valves R^4 and R^7, arranged in these by-passes, as shown, so that when the piston R′ moves downward the fluid with which the apparatus is filled must pass upward through valve R^4 in by-pass R^3, while when the piston R′ moves upward the fluid must pass downward through by-pass R^2. In each by-pass there are situated also adjustable regulating-valves R^8 and R^9, which, as shown, can be moved to or from seats R^5 and R^6 at will. By adjusting these valves the resistance to the up-and-down motions of the piston R′ can be regulated and varied at will, and this resistance regulates the speed with which the rod P moves up and down. Hence by this simple device I am enabled to regulate and adjust the time of air and fluid admission to the pipe D in any desired proportion.

In Fig. 4 I have shown the tank B as placed above ground and having the compressed-air pipe I passing through its side near the bottom instead of extending down from the top of the tank. The valve L is also placed in the bottom of pipe D, extending across its bell-shaped mouth D′, in which position it opens upward and is controlled by devices similar to those already described, with which it is connected through links *l*, lever *l′ l²*, pivoted at *l³*, and secured to the end of a rod M.

It is obvious, of course, that my improved device can be used in connection with any natural reservoir of water as well as with a well or deep tank; that is to say, the pipe D may be immersed in a lake or river and provided with valve-actuating mechanism and will operate in the same way as I have described above.

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

1. A pump having the combination of a conduit D with its lower end open for the admission of fluid, a water-reservoir connected with the lower end of conduit D an air-compressor, a compressed-air pipe I having a nozzle J opening into the bottom of conduit D; a conduit F situated above and in line with the upper end of conduit D, the space between conduit D and conduit F being open to the atmosphere and a receptacle G.

2. A pump having the combination of a conduit D with its lower end open for the admission of fluid, a water-reservoir connected with the lower end of the conduit D, an air-compressor, a compressed-air pipe I having a nozzle J opening into the bottom of conduit D; a ventilated conduit E leading upward from the top of conduit D, and a conduit F situated at the top of conduit E and leading to a reservoir G.

3. A pump having the combination of a well or tank as B, a conduit D opening at the bottom of said tank; an air compressor and pipe I leading therefrom into the bottom of conduit D; a diaphragm K situated in tank B or its equivalent as described and having a valve-seated opening K′, a valve L operating in opening K′, and automatic valve-actuating mechanism for opening and closing said valve to regulate the supply of water to conduit D.

4. A pump having the combination of a well or tank as B, a conduit D opening at the bottom thereof; an air compressor and pipe I leading therefrom into the bottom of conduit D; a diaphragm K situated in tank B or its equivalent as described and having a valve-seating opening K′, a valve L operating in opening K′, a valve *w′* arranged in air-pipe I, and automatic valve-actuating mechanism arranged to actuate valves L and *w′* regulating the supply of water and air to conduit D.

5. In a pump constructed substantially as described, the combination with a valve L governing the flow of water and opening in the direction of flow, of a counterweight adjusted to close said valve when the flow of water ceases or diminishes; a catch arranged to hold the valve seated, and an automatic catch-lifting device arranged to lift the catch and permit the valve to open at regular intervals.

6. In a pump constructed substantially as described, the combination with a valve L governing the flow of water and opening in the direction of flow; of a counterweight adjusted to close said valve when the flow of water ceases or diminishes; a catch arranged to hold the valve seated; a valve *w′* regulating the flow of compressed air in the pump; valve-actuating mechanism arranged to open and close said valve, and an automatic device arranged to lift the catch of valve L at regular intervals and to open and close valve *w′* substantially as and for the purpose specified.

7. In a pump constructed substantially as described, the combination with the water and air valve connections of the cylinder Q, the piston Q′ moving thereon, the piston-rod P connected to piston Q′ and arranged to actuate the valves as described; the valve Q^2 controlling the admission of fluid to cylinder

Q and actuated by the movements of the water-valve; the cylinder R, the piston R′ working in said cylinder and connected with rod P; the by-passes R^2 and R^3 connecting with cylinder R at both ends, the valves R^4 and R^7 situated in by-passes R^3 and R^2 and the adjustable valves R^8 and R^9 also situated in said by-passes, all substantially as and for the purpose specified.

BENJ. S. CHURCH.

Witnesses:

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JOSHUA MATLACK, Jr.