No. 751,626. PATENTED FEB. 9, 1904.

H. L. FROST.

WATER ELEVATING APPARATUS.

APPLICATION FILED OCT. 3, 1901.

NO MODEL. 3 SHEETS—SHEET 1.

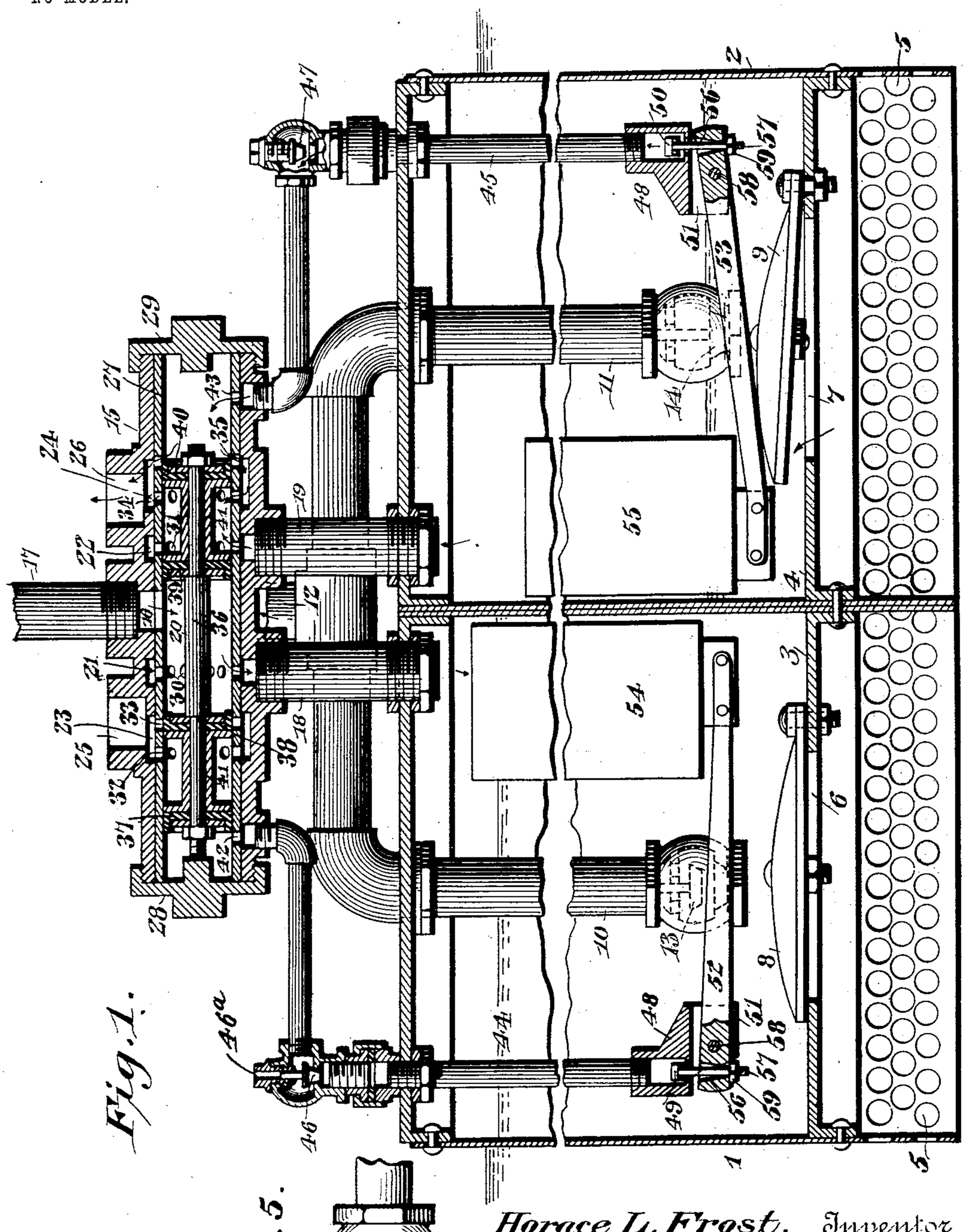

Fig. 1.

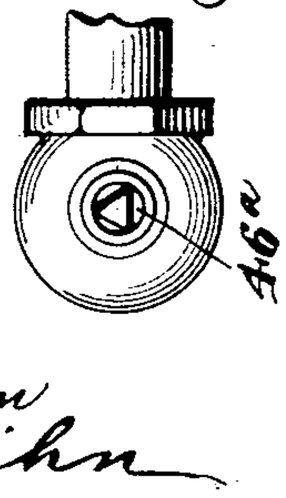

Fig. 5.

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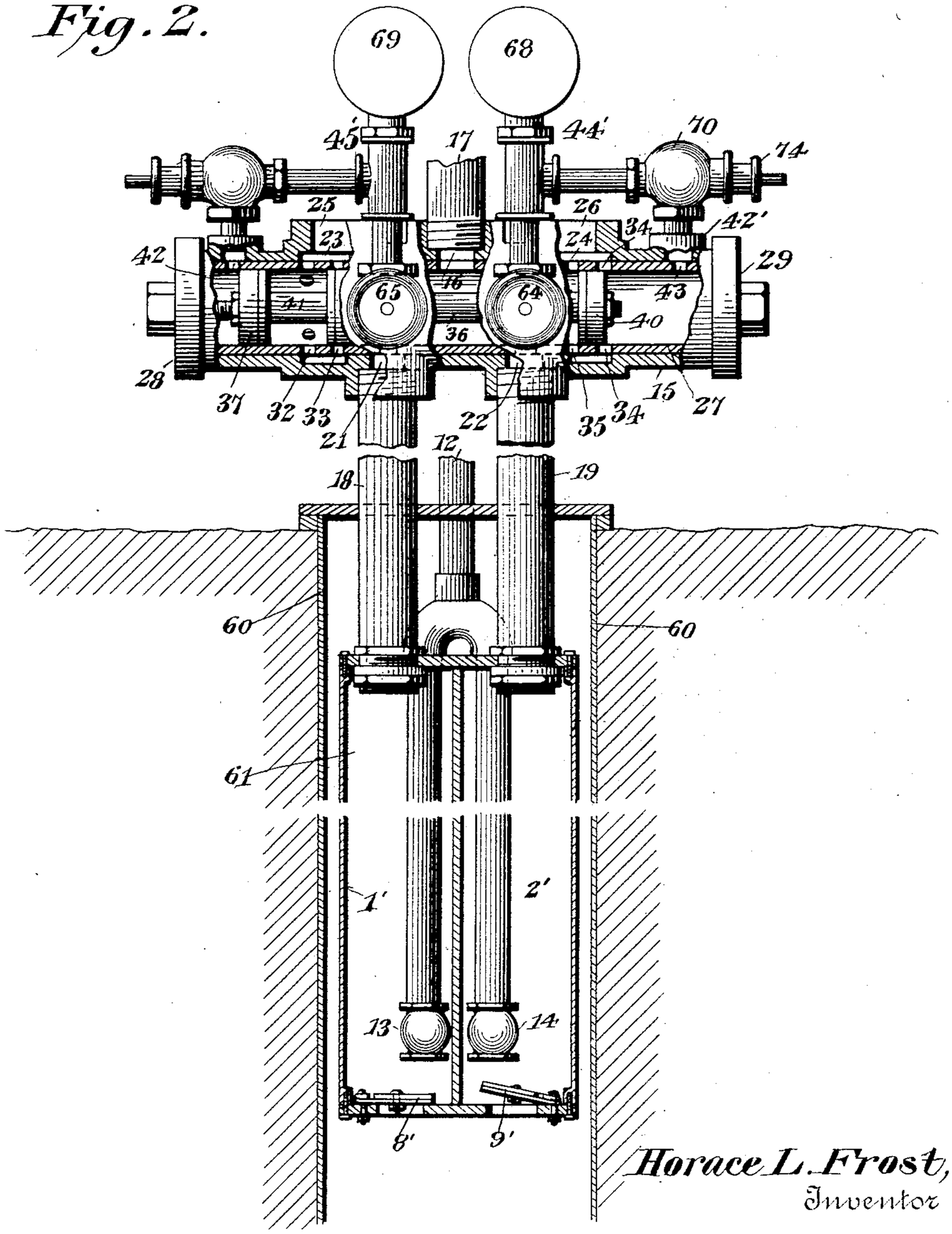
NO MODEL. 3 SHEETS—SHEET 2.

Fig. 2.



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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 3.

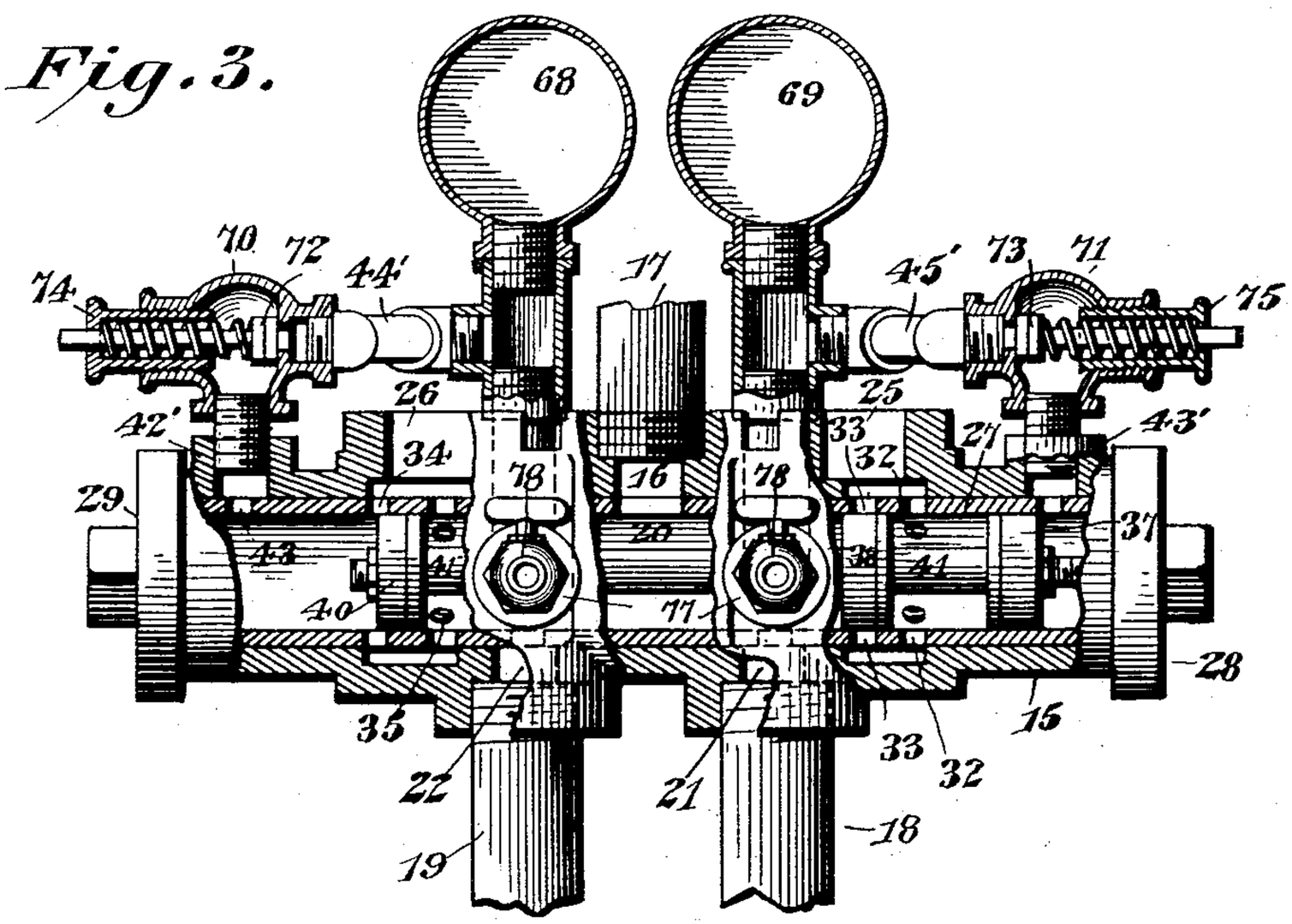
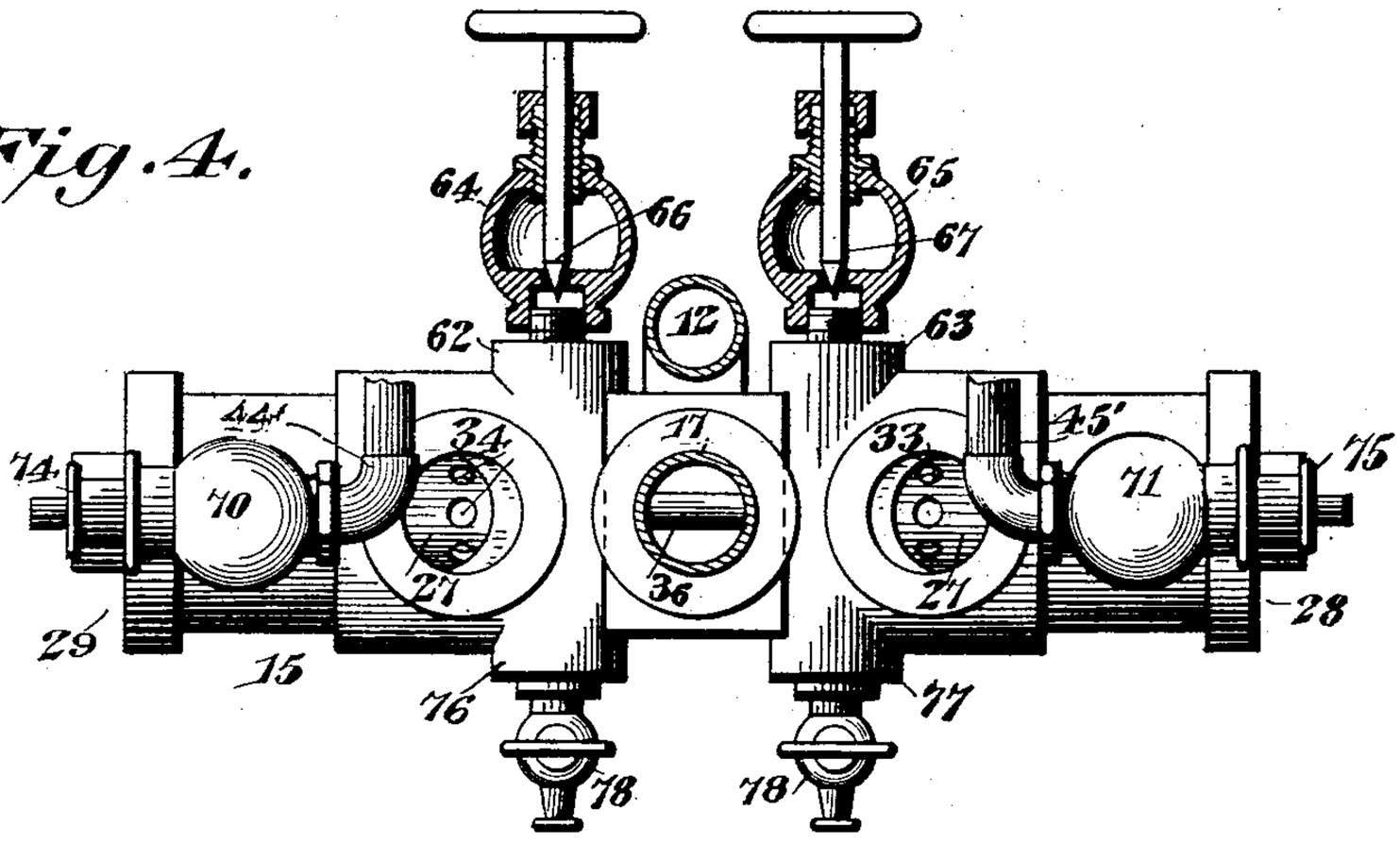


Fig. 4.



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No. 751,626. Patented February 9, 1904.

UNITED STATES PATENT OFFICE.

HORACE L. FROST, OF BRISTOL, TENNESSEE.

WATER-ELEVATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 751,626, dated February 9, 1904.

Application filed October 3, 1901. Serial No. 77,480. (No model.)

To all whom it may concern:

Be it known that I, HORACE L. FROST, a citizen of the United States, residing at Bristol, in the county of Sullivan and State of Tennessee, have invented a new and useful Water-Elevating Apparatus, of which the following is a specification.

This invention relates to improvements in water-elevating apparatus of that type in which the water is elevated alternately from a pair of water tanks or compartments by compressed air controlled in its alternate passage to the interior of the tanks above the water by automatically-operated controlling mechanism.

The object of the invention is to improve the construction and to render more efficient the operation of the controlling mechanism by providing the apparatus with a controlling-valve and valve-mounting of novel construction and by effecting the automatic shifting of said valve to effect the alternate supply and exhaust of air from the water-tanks through the medium of novel automatically-operated mechanism for leading compressed air into one end or the other of the valve-casing when one or the other of the chambers has been delivered of a predetermined quantity of water.

A further object of the invention is to provide novel means for leading compressed air from one of the water-tanks to the controlling-valve casing to operate the controlling-valve and for preventing the return of air from the valve casing to the tank when the pressure in the latter is reduced, so that the complete movement of the valve will be insured by the expansion of the air behind it.

Further and subordinate objects of the invention will hereinafter more fully appear as the necessity for their accomplishment is developed in the succeeding description of those preferred forms of my invention which I have illustrated in the accompanying drawings and which are embraced within the scope of the appended claims.

In said drawings, Figure 1 is a sectional view through one form of my apparatus complete, certain of the parts being shown in elevation. Fig. 2 is an elevation of a somewhat-modified form of my apparatus adapted more particularly for use in bored wells, the walls of the well and the casing thereof, as well as the tank of the apparatus, being shown in section. Fig. 3 is an elevation, partly in section, of the controlling-valve casing and certain of its connected parts; and Fig. 4 is a plan view, partly in section, of the subject-matter of Fig. 3. Fig. 5 is a detail plan view of one of the relief-valve casings and its valve.

Like numerals of reference are employed to designate corresponding parts throughout the views.

Referring more particularly to that form of apparatus illustrated in Fig. 1, 1 and 2 indicate separate tanks or the compartments of a double tank below the bottom walls 3 and 4, of which the side walls of the tanks are made foraminous, as indicated at 5. The bottom walls 3 and 4 are provided with comparatively large ingress-openings 6 and 7, closed by upwardly-opening flap-valves or ingress-valves 8 and 9, serving to control the ingress to the tanks of water in which the tanks are wholly or partially submerged. The water is delivered from the tanks 1 and 2 through the depending branch pipes 10 and 11 of a common delivery or stand pipe 12, through which the water is raised to the desired height. The lower ends of the branch pipes 10 and 11 of the stand-pipe 12 are equipped with inwardly and upwardly opening check-valves 13 and 14, disposed adjacent to the bottom of the double tank, but removed from the valves 8 and 9 a sufficient distance to prevent interference with their movement. The water led into the tanks through the ingress-openings 6 and 7 is forced into and through the branch pipes and the water-delivery pipe by fluid-pressure, preferably compressed air, and I shall now proceed to describe the mechanism by means of which the elevating fluid will be automatically supplied to and exhausted from the tanks or compartments 1 and 2 alternately in order that the elevation of the water may be made continuous.

Located at any suitable point, either remote from or in close proximity to the tanks, I provide an elongated cylindrical valve-casing 15, having a primary ingress or supply port 16 preferably midway between its ends and in

communication with an air-pipe 17, leading to an air-compressor or other souce of supply from whence the compressed air or other motive fluid is led to the interior of the valve-casing 15 for delivery to the tanks 1 and 2 alternately through the air-supply pipes 18 and 19, passed through the upper walls of the tanks and screwed at their ends into suitable fittings upon the valve-casing 15. Within the controlling-valve casing is mounted for reciprocation a controlling-valve 20, designed in different positions thereof to effect the supply of motive fluid to the tanks and the exhaust of the fluid therefrom, and in the preferred form of my invention (illustrated in Fig. 1) the shifting of the valve is effected by the admission of compressed air into one end or the other of the valve-casing after the utilization of said air to force a predetermined quantity of water from one of the tanks. Returning, however, for the present to the description of the controlling-valve casing and its valve, the air-supply pipes 18 and 19 are disposed in parallel relation and at opposite sides of the plane of the air-pipe 17 to present them opposite to and in communication with annular supply-channels 21 and 22, formed in the interior face of the casing 15 at opposite sides of the main supply-port 16. Beyond the channels 21 and 22 the interior face of the casing 15 is formed with somewhat-wider annular exhaust-channels 23 and 24, communicating with the primary exhaust-ports 25 and 26, piercing the wall of the casing at the upper side thereof. Within the valve-casing is fitted a longitudinally coextensive lining-sleeve 27, held in place by the casing-heads 28 and 29 and provided with a suitable opening constituting a continuation of the primary supply-port 16. Opposite the annular supply-channels 21 and 22 the lining 27 is pierced by annular series of openings 30 and 31, and opposite each of the exhaust-channels 23 and 24 the lining is pierced by two series of openings 32 and 33 and 34 and 35, the purpose of which construction will appear more clearly hereinafter.

The controlling-valve 20 comprises a central core or stem 36, upon which are mounted four circular heads 37, 38, 39, and 40, defined at the opposite ends of the spools 41 and provided with suitable packing in contact with the interior face of the lining. The terminal heads 37 and 40 are of less thickness than the distance between the two annular series of openings opposite the adjacent exhaust-channel, so that in each extreme position of the valve one or the other of these terminal heads will be located in position to permit the exhaust of the air from the interior of the casing through both series of openings in the lining opposite one of the exhaust-channels and thence by way of the exhaust-channel to the adjacent exhaust-port in the valve-casing.

Adjacent to the opposite ends of the valve-casing 15 the lining 27 is pierced by the ports 42 and 43, through which compressed air is admitted to the interior of the valve-casing beyond the terminal valve-heads. The air thus admitted is supplied from the interior of the tanks 1 and 2 through the escape-pipes 44 and 45, tapped into the valve-casing opposite the ports 42 and 43 and extended into the tanks. Each of these pipes is provided at a point intermediate of its ends with a back-pressure relief or check valve 46 or 47, controlling a relief port or opening 46^a, and at the lower end of each escape-pipe is located a valve-casing 48, within which is seated an upwardly or inwardly opening escape-valve 49 or 50, controlling the escape of air into the escape-pipes from the tanks. The valve-casings 48 are located somewhat near the bottom walls of the tanks and are provided with depending bearing-ears 51 for the support of the float-levers 52 and 53, connected at their outer ends to floats 54 and 55 and provided at their inner ends with openings 56, through which extend loosely the depending stems 57 of the escape-valves 49 and 50. The fulcrums 58 of the valve-levers are located closely adjacent to the valve-stems 57, and the lower ends of said stems are provided with nuts 59, which are engaged by the float-levers when the floats are in their elevated positions. By reference to Fig. 1 of the drawings it will be noted that provision is made for the movement of the several levers independently of the valve-stems, the purpose of this being to permit the levers to move out of engagement with the nuts 59 under certain circumstances, and thus leave the valves free to open and close under fluid-pressure. Obviously, however, the valves will be held closed by the levers until the floats have dropped sufficiently to swing the short ends of the levers upwardly away from the nuts 59.

It should be noted that while it is desirable to employ a float for normally locking the relief-valve in its closed position to prevent water from being forced up through the escape-pipe, and thereby effecting the shifting of the controlling-valve prematurely, it is not desirable to operate the relief-valve directly from the float, since such arrangement would require the employment of a float having a buoyancy exactly corresponding to the position at which it is desired to effect the opening of the valve. As it is desirable to have the relief-valve open just as the level of the water drops below the lower end of the escape-pipe, it is possible to utilize the air-pressure for the purpose of opening the valve and to at the same time employ the float as a valve-locking device by effecting a loose connection between the float-lever and valve-stem, as heretofore described. This arrangement, furthermore, obviates the necessity for the employment of a spider-guide for the valve-stems 49 and 50, because while the lever is permit-

ted to move independently of the valve it nevertheless constitutes a guide for the valve-stem, which will insure the proper seating of the valve whenever the latter is unsupported by the compressed air.

I shall now proceed to describe the operation of that form of apparatus shown in Fig. 1 and will incidentally refer to certain peculiarities of construction and arrangement which are thought to possess special novelty. Assuming the parts to be in the position shown in Fig. 1 of the drawings, the compressed air or other expansive motive fluid is led to the interior of the valve-chamber through the air-pipe 17 and passes thence through the annular series of openings 30 into the annular channel 21 and thence through the air-supply pipe 18 to the interior of the tank 1 above the water-line. During this passage of air the valve-head 38 is diposed opposite the series of openings 33 opening into the exhaust-channel 23, and the valve-head 39 is disposed in a plane between the openings 31 and the supply-port 16. The air passing into the valve-chamber from the pipe 17 will thus be prevented from escaping except to the tank 1 in the manner indicated, and the controlling-valve will be balanced by the air-pressure acting in opposite directions against the opposed faces of the heads 38 and 39. The compressed air entering the tank 1 will exert sufficient pressure upon the surface of the water therein to force it into and through the branch pipe 10 and the stand-pipe 12, the ingress-valve 8 being closed and the buoyancy of the float 54 serving to elevate the outer end of the float-lever 52, which will thereby be presented to the nut 59 to prevent the opening of the escape-valve 49. The expulsion of the water from the chamber 1 will finally permit the float 54 to drop sufficiently to swing the float-lever 52 enough to release the escape-valve 49. The pressure of air within the tank or compartment 1 will now raise the escape-valve 49 from its seat and the air will be forced through the escape-pipe 44. After passing the escape-valve 49 the air in the pipe will lift the relief-valve 46 to close the relief port or opening 46[a] and will pass thence into the controlling-valve casing 15 beyond the end of the valve 20 to shift said valve to the opposite end of the casing for the purpose of exhausting the tank 1 and to establish communication between the tank 2 and the source of compressed-air supply. The manner in which the exhaust is effected may best be understood by reference to the tank 2 and its appurtenant parts, since this tank is shown in Fig. 1 as exhausting, while the tank 1 is being delivered of its contained body of water. When the escape-valve 50 and the relief-valve 47 have been raised by fluid-pressure, as shown in Fig. 1 and in the manner described in connection with the valves 49 and 46, the air passes on through the escape-pipe and through the port 43 to the interior of the valve-casing 15. The pressure of air behind the valve will move the latter to the left, this movement serving first to uncover the ports or openings 31, and thus permitting the air within the chamber of tank 2 to escape by way of the pipe 19 and the ports 31 and 34 to the exhaust-port 26 in the casing. The special utility of the loosely-mounted fluid-operated escape-valves will now be apparent. It will be noted that as soon as the controlling-valve moves sufficiently to effect a partial opening of the ports 31 the compressed air within the tank 2 will escape, quickly reducing the pressure within the tank. If now, as in the usual constructions, the escape-valve should be held open by the depressed float, the result would be that the reduction of pressure in the tank would cause a similar reduction of pressure in the escape-pipe and in the controlling-valve casing behind the valve, since, obviously, the air in the casing and pipe would pass back into the tank and escape. This effect would be produced before the controlling-valve had reached the extreme limit of its movement, and the operation of the apparatus would consequently be rendered slow and uncertain. With the valve 50 mounted loosely, however, the reduction of air-pressure within the tank will merely result in the closing of the valve 50 by the pressure of air in the escape-pipe 45. The expansion of the air within the pipe and casing will therefore complete the movement of the controlling-valve without regard to the reduction of pressure in the tank by the escape of the air therefrom. As the valve reaches the limit of its full stroke under the expansive force of the air behind it the valve-head 40 will pass beyond the ports or openings 35 in the casing, so as to permit the escape of air from behind the valve and from the escape-pipe. The reduction of air-pressure within the escape-pipe will permit the relief-valve 47 to drop to the position in which the valve 46 is shown in Fig. 1, thus opening the relief port or opening around the stem of the valve, and if now the controlling-valve is driven back by the escape of air from the tank 1 through the pipe 44 the compression of air behind the valve, which would otherwise oppose its movement, will be prevented by the escape of air through the relief-port, which, however, will be again closed by the raising of the relief-valve 47 under fluid-pressure after the water has again been discharged from the tank 2. To summarize the operation in brief, the water which has risen in the tank 2 through the valve 9 is forced out by air-pressure until the water-level drops below the escape-valve 50. The air will then pass into the end of the escape-pipe, raising the valves 50 and 47, and passing thence into the controlling-valve casing to shift the controlling-valve to the position shown in Fig. 1. The shifting of the valve will permit the air to be exhausted in the tank 2 and will admit compressed air into

the tank 1, from which the water will be forced through the pipe 10 until the water-level is lowered sufficiently to permit the opening of the valve 49 under fluid-pressure and the reversal of the controlling-valve in a manner already explained. Thus the water will be forced through the stand-pipe 12 from the tanks 1 and 2 alternately and in a continuous stream, the operation of the apparatus to effect the alternate supply and exhaust of the tanks or compartments being entirely automatic.

In that form of my apparatus illustrated in Figs. 2, 3, and 4 of the drawings the principle of operation just described is maintained; but as this type of mechanism is designed more particularly for use in connection with bored wells where economy of space is a desideratum the escape or relief pipes are not extended into the tank-compartments, but, on the contrary, lead the air from the annular channels 21 and 22 to the ends of the valve-casing to operate the controlling-valve, and instead of the shifting of the controlling-valve being governed by the level of the water in the tank the escape-pipes are equipped with mechanism capable of adjustment to insure the shifting of the controlling-valve at predetermined intervals of time. In these figures—to wit, 2, 3, and 4—60 indicates a well-casing, 61 an elongated tank subdivided by a central partition defining compartments 1′ and 2′, equipped with ingress-valves 8′ and 9′, into which compartments the air-supply pipes 18 and 19 are led, as in Fig. 1. The arrangement of the controlling-valve casing and the controlling-valve is precisely the same in this construction as in that shown in Fig. 1; but the relief or escape pipes 44′ and 45′ instead of leading from the ports 42 and 43 to the interior of the tanks are led from suitable connections 42′ and 43′ opposite said ports to suitable connections 62 and 63, communicating with the annular channels 21 and 22, formed in the interior face of the valve-casing 15. The compressed air designed to be utilized for the shifting of the valve is led from the annular channels 21 and 22 through the escape-pipes 44′ and 45′ to the opposite ends of the valve-casing, (see Fig. 3;) but in order to prevent the air from becoming effective to throw the valve prior to the lapse of a predetermined interval of time the pipes 44′ and 45′ are provided with valve-casings 64 and 65, equipped with needle-valves 66 and 67, controlling the passage of air through said pipes. By the adjustment of these needle-valves the amount of air escaping from the valve-casing 15 to the escape-pipes is regulated. To further facilitate the controlling of the air-pressure within the escape-pipes, they are provided with suitable expansion-chambers 68 and 69 and adjacent to the connections 42′ and 43′ with pop-valve casings 70 and 71, equipped with spring-pressed pop-valves 72 and 73, having their stems extended through adjustable tension-regulating sleeves 74 and 75, by means of which the resistance opposed to the opening of the pop-valves may be regulated. At the side of the controlling-valve casing opposite the connections 62 and 63 are provided other connections 76 and 77, into which are tapped the pet-cocks 78, communicating with the annular channels 21 and 22 and designed to be employed for dripping or bleeding the apparatus. In this last-described form of my invention the operation is identical with that shown in Fig. 1 except that a portion of the air passing into a tank-compartment finds its way past the needle-valve and enters the escape-pipe—the pipe 44′ or 45′, as the case may be. Immediately upon its entrance into the escape-pipe, however, it is permitted to expand in the expansion-chamber 68 or 69, and therefore a greater or less interval of time will elapse before the pressure within the relief-pipe is sufficient to force back the pop-valve and permit the escape of air into the end of the controlling-valve casing to shift the controlling-valve, and it will appear that both the needle-valve and the tension-regulating mechanism of the pop-valve constitute means for regulating the interval of operation of the apparatus, since the adjustment of the needle-valve controls the quantity of air escaping into the escape-pipe and the regulation of the tension of the pop-valve determines what pressure is necessary to effect the opening of said valve and the ingress of air to the controlling-valve casing behind the piston or valve therein.

It is thought that from the foregoing the construction and operation of my invention will be clearly apparent; but while those forms of the invention illustrated in the accompanying drawings are thought at this time to be preferable I do not wish to limit myself to the structural details defined, but reserve the right to effect such changes, modifications, and variations thereof as may be properly comprehended within the scope of the protection prayed.

What I claim is—

1. In a water-elevating apparatus, the combination with separate water-chambers and water-passages leading therefrom, of means for leading compressed air to the chambers to force the water therefrom, a controlling-valve for the air, escape-passages leading from the chambers to permit the air escaping therefrom to shift the controlling-valve, escape-valves controlling the escape of air through said escape-passages, and valve-retaining means movable independently of the escape-valves and designed to prevent the opening of the valves by said fluid-pressure within the chambers until the water has dropped to a predetermined level.

2. In a water-elevating apparatus, the combination with a pair of tanks provided with

ingress-valves, and with valve-controlled water-pipes, of air-pipes leading into the tanks, a valve-casing communicating with said air-pipes and with a source of compressed-air supply, a shiftable controlling-valve within the valve-casing to control the supply and exhaust of air from the tanks, escape-pipes leading from the interior of the tanks to the interior of the controlling valve-casing beyond the opposite ends of the controlling-valve, escape-valves controlling the escape of air through the escape-pipes and arranged to be opened by the fluid-pressure within the tanks, and means for holding said valves closed until the water-level has dropped to a predetermined point.

3. In a water-elevating apparatus, the combination with a pair of tanks, valve-controlled water-pipes, air-pipes leading to the tanks, and communicating with a source of compressed-air supply, and a controlling-valve controlling the supply and exhaust of air to and from the tanks, of escape-pipes leading from the tanks and arranged to supply air under pressure for shifting the controlling-valve, inwardly-opening escape-valves controlling the passage of air through the escape-pipes, and float-operated means for holding said escape-valves closed until the water-level has dropped to a predetermined point, at which time the valves will be released and permitted to open under pressure.

4. In a water-elevating apparatus, the combination with a pair of tanks, valve-controlled water-pipes, air-pipes leading to the tanks, a controlling-valve casing communicating with the air-pipes and with a source of compressed-air supply, and a controlling-valve within the valve-casing, of escape-pipes leading from the interior of the tanks to the opposite ends of the controlling-valve casing, inwardly-opening escape-valves located at the inner ends of the escape-pipes and designed to open under fluid-pressure, valve-retaining levers having movement independently of the escape-valves but arranged to retain said valves in their closed positions, and means for automatically moving said levers.

5. In a water-elevating apparatus, the combination with a pair of tanks, valve-controlled water-pipes, air-pipes leading to the tanks, a controlling-valve casing communicating with the air-pipes and with a source of compressed-air supply, and a controlling-valve within the valve-casing, of escape-pipes leading from the interior of the tanks to the opposite ends of the controlling-valve casing, inwardly-opening escape-valves located at the inner ends of the escape-pipes and designed to open under fluid-pressure, and float-operated levers having loose connection with the escape-valves whereby said valves will be held closed by the levers until the water-level has dropped to a predetermined point, and will thereafter be opened by the fluid-pressure within the tanks.

6. In a water-elevating apparatus, the combination with a pair of tanks provided with ingress-valves, and with valve-controlled water-pipes, of air-pipes leading into the tanks, a controlling-valve casing communicating with said air-pipes and with a source of compressed-air supply, a shiftable controlling-valve within the valve-casing to control the supply and exhaust of air through said air-pipes, escape-pipes leading from the interior of the tanks to the controlling-valve casing, escape-valves controlling the passage of air through the escape-pipes, said valves being opened by fluid-pressure, float-levers controlling the openings of said valves, and floats connected to the levers, the connection between the levers and valves permitting the closing of the latter independently of the levers when the pressure of air within the escape-pipes exceeds that in the tanks.

7. In a water-elevating apparatus, the combination with the tanks, water-pipes, air-pipes and escape-pipes, of a controlling-valve casing provided with exhaust-ports and communicating with the air-pipes and also communicating at its opposite ends with the escape-pipes, means for leading air under pressure to the valve-casing, and a shiftable controlling-valve located within the casing and controlling the supply and exhaust of air through the air-pipes, said valve also serving, when its movement in one direction is completed, to permit the escape of air through an exhaust-port of the casing from one extremity of said casing, and from the escape-pipe communicating therewith.

8. In a water-elevating apparatus, the combination with the tanks and water-pipes, of a valve-casing formed with annular supply-channels in its interior face, an air-supply port piercing the walls of said casing intermediate of said channels, exhaust-ports piercing the wall of the casing, annular exhaust-channels communicating with the exhaust-ports, air-pipes extending from the tanks and communicating with the supply-channels of the casing, a lining-sleeve fitted within the casing and having an annular series of openings disposed opposite each of the supply-channels and two separated annular series of openings opposite each of the exhaust-channels, a shiftable controlling-valve provided with terminal and intermediate valve-heads fitted within the lining-sleeve, and escape-pipes communicating with the interior of the valve-casing beyond the opposite ends of the valve, said valve being movable to permit the escape of air from the ends of the casing through the exhaust-ports.

9. In a water-elevating apparatus, the combination with a water-chamber, means providing for the ingress and egress of water, means for leading air under pressure to the chamber to force the water therefrom, and a controlling-valve for the air; of an escape-passage leading from the chamber to the con-

trolling-valve to move the same, an escape-valve preventing the return of the air from the passage when the pressure within the chamber is reduced whereby a full stroke of the controlling-valve is assured, and means normally locking the escape-valve against movement.

10. In a water-elevating apparatus, the combination with a water-chamber, means providing for the ingress and egress of the water, means for leading air under pressure to the chamber to force the water therefrom, and a controlling-valve for the air; of an escape-passage leading from the chamber to the controlling-valve to move the same, an escape-valve preventing the return of the air from the passage when the pressure within the chamber is reduced, whereby a full stroke of the controlling-valve is assured, and float-operated locking means for the escape-valve.

11. In a water-elevating apparatus, the combination with a water-chamber, means providing for the ingress and egress of water, means for leading air under pressure to the chamber to force the water therefrom, and a controlling-valve for the air; of an escape-passage for leading air from the chamber to the controlling-valve to move the same and provided with a relief-port, a relief-valve controlling the port and arranged to be closed by air passing through the passage to the controlling-valve, an escape-valve controlling the escape of air to the passage from the chamber, and means for exhausting air from the passage when the proper movement of the controlling-valve has been effected, whereby the relief-valve is permitted to open to relieve the back pressure induced by the return movement of the controlling-valve.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

HORACE L. FROST.

Witnesses:

J. E. BRADING,

H. W. HOBSON.