J. E. RUSSELL.

PNEUMATIC PUMP.

APPLICATION FILED MAY 11, 1917.

1,255,341.

Patented Feb. 5, 1918.

3 SHEETS—SHEET 1.

Fig. 2.

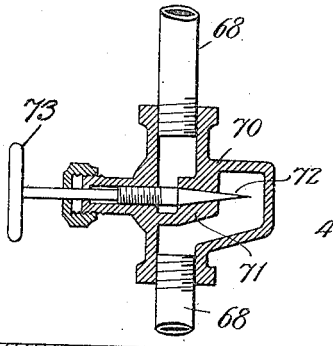
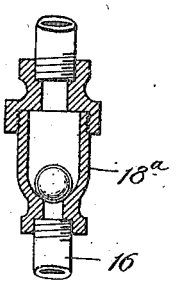


Fig. 3.



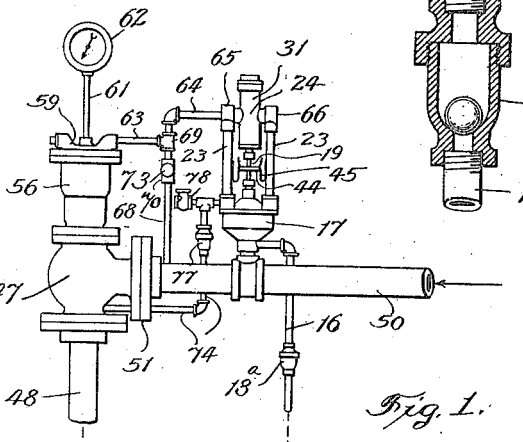
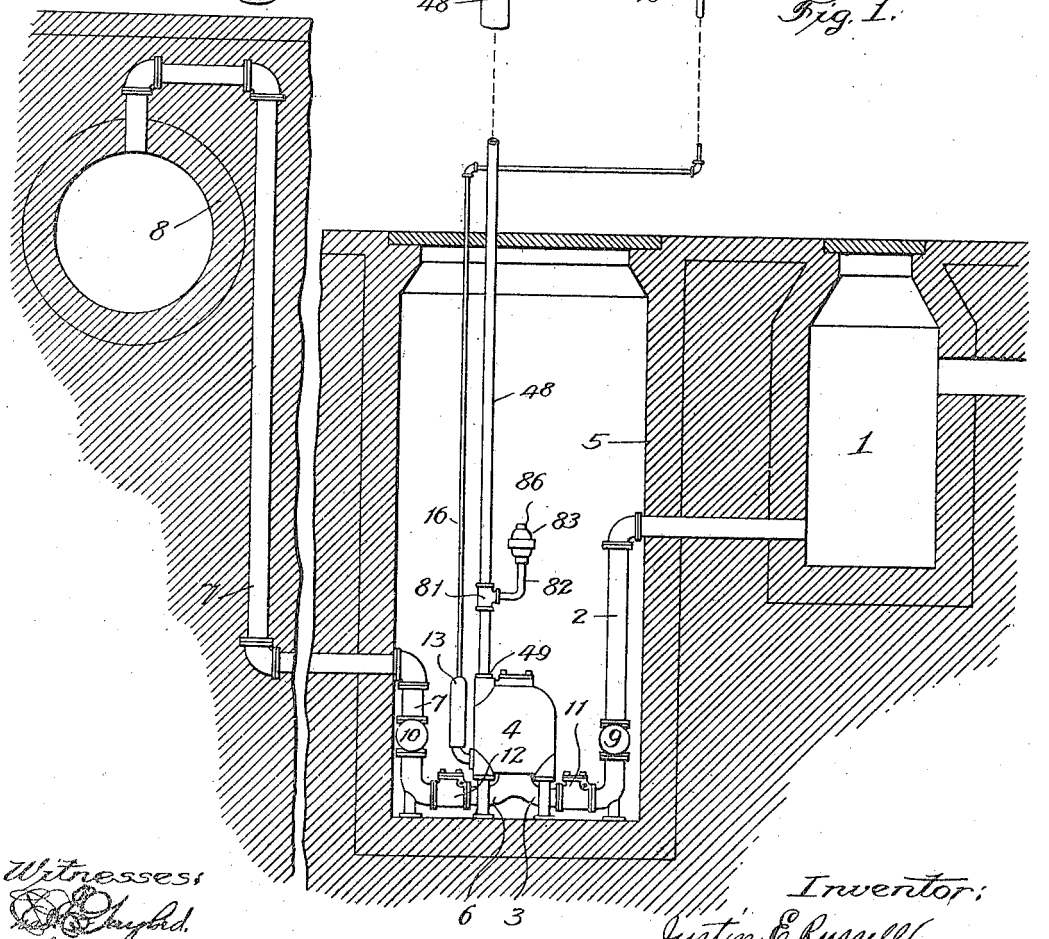


Fig. 1.



Witnesses:

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3 SHEETS—SHEET 2.

Fig. 5.

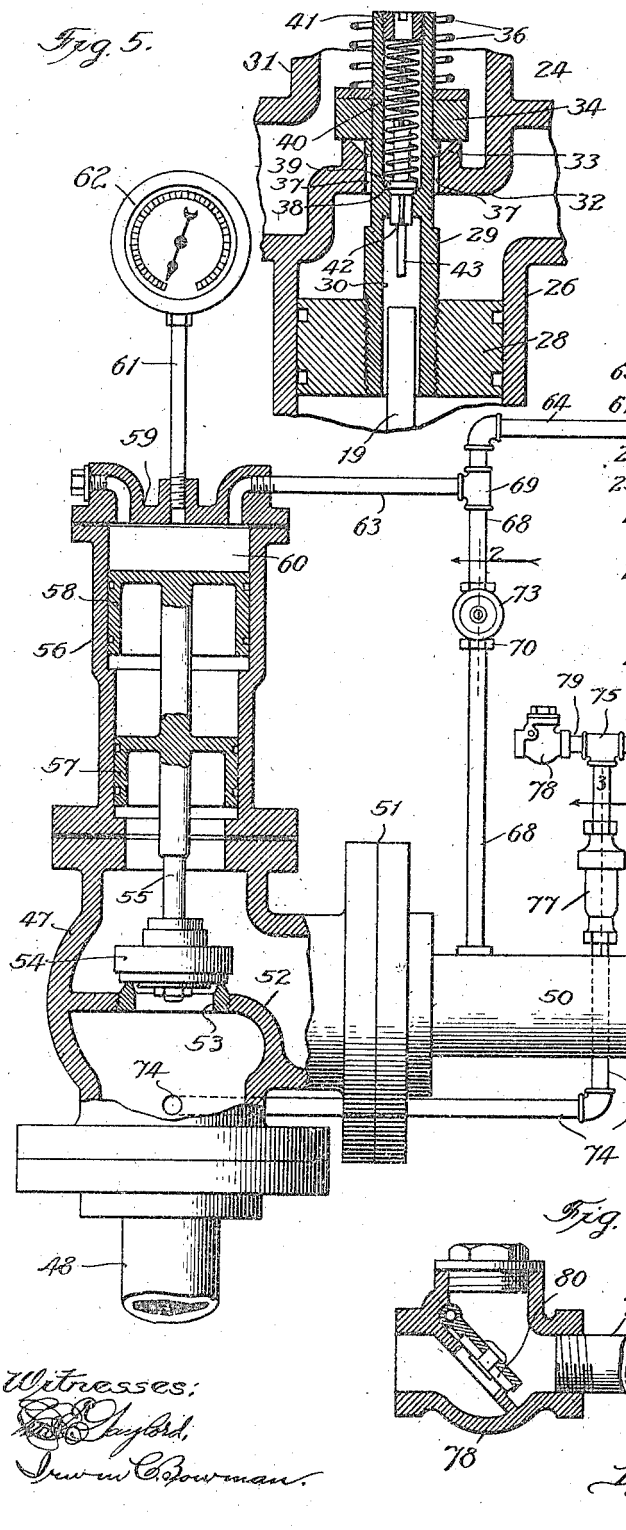

Fig. 4.

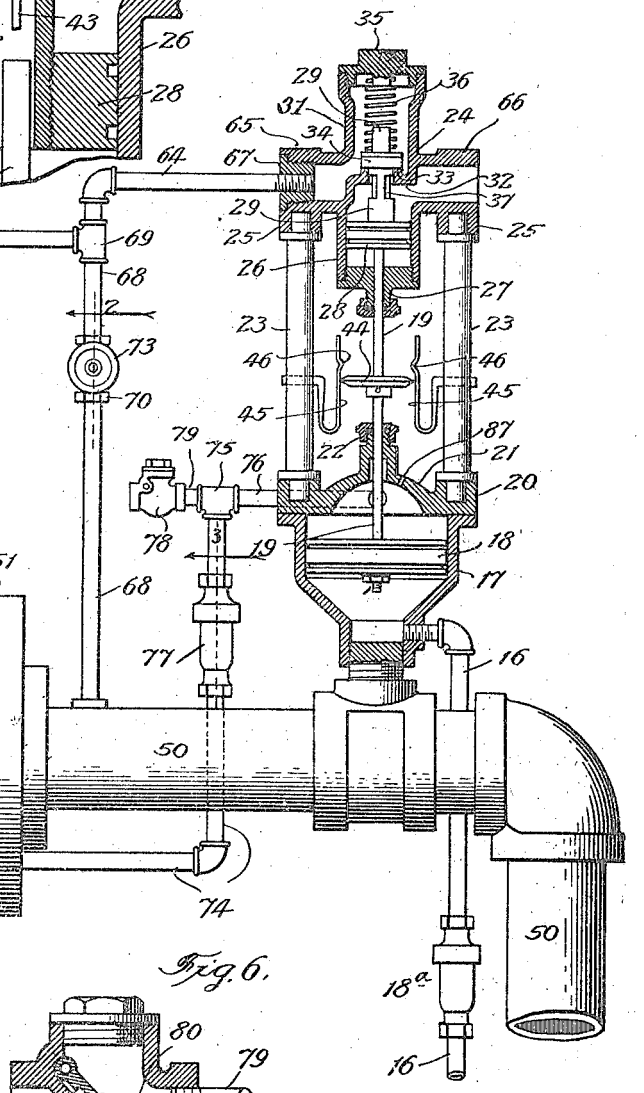

Fig. 6.

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3 SHEETS—SHEET 3.

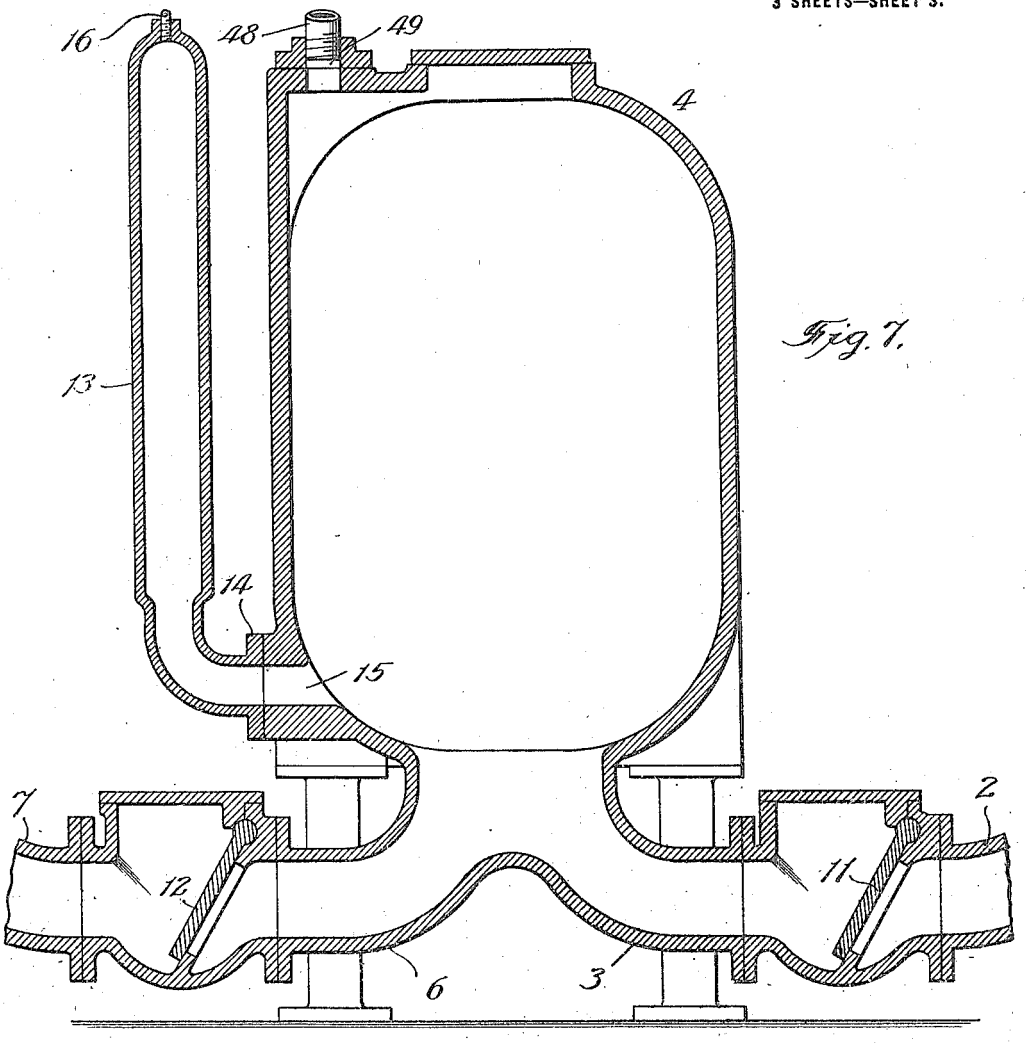

Fig. 7.

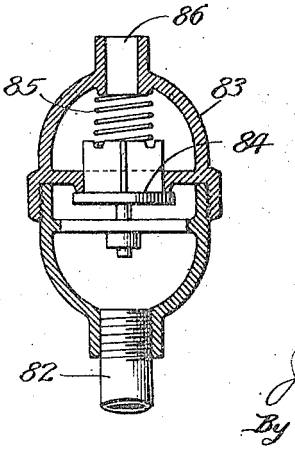

Fig. 8.

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UNITED STATES PATENT OFFICE.

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PNEUMATIC PUMP.

1,255,341. Specification of Letters Patent. Patented Feb. 5, 1918.

Application filed May 11, 1917. Serial No. 167,929.

To all whom it may concern:

Be it known that I, JUSTIN E. RUSSELL, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Pneumatic Pumps, of which the following is a description, reference being had to the accompanying drawings, forming a part of this specification, in which corresponding numerals of reference in the different figures indicate like parts.

The object of my invention is to provide a simple and effective pneumatic pump for elevating liquids but more particularly for use as an evacuator or lifting device for automatically elevating sewage, waste, drain water or other liquids from a sump or conduit at a given level to a conduit, receptacle or point of discharge at a relatively higher level, by means of compressed air; one purpose, among others, being to utilize the liquid inflow or head, from whatever source, as it flows upwardly into a receptacle located at a level below that of the primary source, to compress air for the purpose of actuating a controlling valve for releasing air from a supply constantly under pressure and conveying said air to said receptacle for the purpose of evacuating the liquid from time to time as often as the receptacle becomes filled.

A further object is to provide means for causing the flow of compressed air for evacuating purposes to be cut off at any predetermined interval prior to that of the complete discharge of the evacuating receptacle, so as to enable the air remaining therein to act expansively for the purpose of completing the discharge, thereby providing for a considerable saving of air.

Again, it is my purpose to dispense with the use of floats, valves or other mechanism in the evacuating chamber and to locate all movable controlling elements at points where they may be easily accessible, all of which is hereinafter more particularly described and definitely pointed out in the claims.

In the drawings

Figure 1, is a view partly in section and partly in elevation, the lower portion thereof being drawn upon a reduced scale to permit the several parts in combined relation to be shown in a single view,

Fig. 2, is an enlarged central section of a regulating valve and associated mechanism, taken upon the line 2—, Fig. 4, viewed in the direction of the arrow there shown,

Fig. 3, is a section taken upon the line 3—, Fig. 4, viewed as indicated by the arrow there shown,

Fig. 4, is an enlarged view, partly in section, of the primary controlling valve and connecting parts, the piston for actuating said valve and the differential pistons and valve for controlling the passage of the motor air to the evacuating chamber.

Fig. 5, is an enlarged central sectional view in detail of the controlling valve and piston,

Fig. 6, is an enlarged sectional view of one of the check-valves shown in Fig. 4,

Fig. 7, is an enlarged central section of the evacuating receptacle, the inlet and outlet pipes connected therewith and the air-chamber for entrapping air for compression, and

Fig. 8, is a sectional view in detail of the check-valve located in the main air pipe leading to the evacuating chamber.

Referring to the drawings, 1, Fig. 1, indicates a sump or reservoir for the accumulation of drain-water, sewage or other liquid material, which reservoir is in communication by means of a laterally and downwardly extended pipe 2, with an inlet conduit 3, also shown in Fig. 7, leading to the bottom of a closed evacuating chamber generally designated by 4, located in a well or depression 5, at any predetermined distance below the level of the reservoir 1. A branch conduit 6, leads from the lower portion or bottom of the evacuating chamber to an upwardly extended discharge pipe 7, in communication with a drain or sewer 8, at a higher level than that of the reservoir 1.

A gate-valve 9, of any well known construction, is located in the pipe 2, while a like valve 10, is placed in the pipe 7. Interposed in the inlet conduit 3, near the reservoir 4, is an inwardly opening check-valve 11, better shown in Fig. 7, which is formed to permit liquid to flow from the pipe 2 into said reservoir while preventing its return, and a like valve 12, is located in the outlet conduit 6, which is adapted to open outwardly and close against back-pressure caused by the head in the pipe 7.

An air reservoir 13, is located adjacent to the evacuating receptacle 4, the lower part of which is connected to said receptacle by means of a flanged connection 14, and is in communication with an outlet opening 15,

near the bottom but above the level of the fluid outlet 6. Connected with the top of the air reservoir 13, is a small air tube 16, Figs. 1, 4 and 7, which is in communication with the bottom of a cylinder or piston casing 17, having a piston 18, located therein. A check-valve 18ª, of any well known construction, but preferably of the type shown in Fig. 3, is interposed in the tube 16, to prevent a back flow of air from the chamber of the part 17. The purpose of the piston 18, is to actuate a controlling valve as hereinafter described, and hence its movement is but slight. Said piston is provided with a piston-rod 19, which is extended upward through a cap 20 having a central raised portion 21 to provide a small air-chamber beneath when the piston is raised, and a stuffing-box 22. Upright studs 23 are tapped into the bosses in the cap 20, and serve as supports for a combined piston and valve-casing generally designated by 24, provided with depending bosses 25 into bores in which they are extended and to which they are rigidly attached. The casing 24, is provided with a vertical cylindrical part 26, also shown in Fig. 5, having a cap and stuffing-box 27 upon its lower end through which the valve stem 19, is extended. A piston 28, also shown in Fig. 5, is located in the chamber 26, which piston is provided with a hollow upwardly extended piston-rod 29 having an enlarged bore 30 therein, the diameter of which exceeds that of the piston-rod 19, which is loosely extended therein. A cylindrical portion 31 is extended upwardly from the casing 24 opposite to the cylinder 26, between which extension and cylinder is interposed a web or partition 32 in which is formed a valve-seat 33 for the seating of a valve 34, mounted upon the hollow rod 29. A screw-cap 35, Fig. 4, is threaded into the upper part of the extension 31, while a coiled spring 36, is interposed between said cap and the valve 34, said spring tending to hold said valve normally closed. The stem 29, is cut away at 37 where it extends through the web to provide for the passage of air as hereinafter stated. The hollow piston rod 29 is provided with a valve-seat 38, Fig. 5, upon which is seated a puppet valve 39, held upon its seat by means of a coiled spring 40, the upper end of which bears against a hollow screw-plug 41, through which air may pass to said valve. The valve is provided with the usual guide-wings 42 and a depending stem 43, the lower end of which is placed a predetermined distance above the upper end of the valve-stem 19, so that when the latter is moved upward it will contact with said stem and open the valve against the resistance of the spring 40. It is desirable that this opening action should be accomplished quickly; and inasmuch as the air pressure beneath the piston 18 necessarily accumulates slowly, I have provided the following described means for insuring a quick action of the valve. Mounted rigidly upon the valve stem 19, Figs. 1 and 4, is a disk-like member 44, having thin edges which are in contact with springs 45, 45, rigidly attached to the studs 23, from whence they are bent downwardly and thence upwardly in parallel relation to each other. At a predetermined height above the normal position of said disk, said springs are bent to form cam-shaped surfaces as shown at 46, which surfaces are intended to contact with said disk so as to cause a yielding resistance to the upward movement of the valve-stem. When the air pressure increases sufficiently beneath the piston 18 to overcome the resistance of the springs, the yielding of the latter permits the disk to pass the cams when the resistance ceases, the reverse form of the cams serving to supplement the action of the air so that a quick movement is imparted to the piston which causes the stem 19 to strike a blow upon the stem 43 to open the valve 38. The purpose of this valve will be explained after describing the other features of the compressed air system for evacuating the reservoir 4 and its relation to said valve.

A valve casing 47, has its lower portion connected in a well known way by means of a pipe 48, with the top of the evacuating reservoir 4, as shown at 49, Figs. 1 and 7. A pipe 50, also connected with said valve at 51, is in communication with a source of compressed air, not shown. Within the valve casing 47 is a partition 52, having an opening therein in which is formed a valve-seat 53, upon which is seated a normally closed valve 54, having a valve-stem 55, extended upwardly into the chamber of a cylindrical casing 56, and having rigidly mounted thereon pistons 57 and 58 respectively, of differential area. A cap 59 is attached to the casing 56 and the air-chamber 60, above the piston 58, is in communication by means of a pipe 61, with a pressure gage 62, and also, by means of pipes 63 and 64 respectively and their intermediate connections, with a cylindrical portion 65 of the valve casing 24, which part is in communication with the chamber of the casing 31. A counterpart portion 66 of said casing is in communication with the space above the piston 28 and is open to the atmosphere. The end of the part 65 is closed by means of a screw-plug 67 Fig. 4, into which the pipe 64 is threaded.

A pipe 68 serves to connect the motive air service pipe with a union 69, with which the pipe 63 is also connected. A valve casing 70, shown in section in Fig. 2, is interposed in the pipe 68, which casing is provided with a partition 71 and a needle-

valve 72 constructed in a well known way and adapted to be operated by means of a hand-wheel 73.

A pipe 74, in communication with the valve casing 47 below the partition 52, is extended horizontally and thence upwardly to a union 75, which, in turn is connected by means of a short pipe 76, through the cap 21, with the air chamber above the piston 18. A check-valve 77, corresponding in construction to the valve 18[a], shown in Fig. 3, is interposed in the pipe 74 to prevent a back-flow of air. A valve casing 78, also shown in Fig. 6, is attached to the end of the short pipe 79, threaded into the union 75, which casing is provided with an upwardly opening check-valve 80.

Interposed in the air discharge pipe 48, Fig. 1, is a union 81, with which is connected by means of an upwardly bent pipe 82, a valve-casing 83, Fig. 8, having a check-valve 84 of puppet form, located therein, said valve being held normally open by means of gravity, aided preferably by a light coiled spring 85. The upper part of said casing is open to the atmosphere through a tube 86.

The operation of the device is as follows: As the liquid flows from the receiver 1 through the pipe 2 to the evacuating reservoir 4, the valve 11 opens to permit its passage while the valve 12 is held closed by the back pressure of whatever liquid may be in the discharge pipe 7, the height or "head" of which exceeds that of the reservoir 4 into which the liquid is caused to rise until it is filled. As a result of the rise of liquid in the reservoir, air is entrapped in the air reservoir 13 and is gradually compressed as the liquid rises. Being in free communication with the chamber beneath the piston 18, the tendency is to lift said piston but the latter is yieldingly held down by the cam portions 46 of the springs 45 acting against the edges of the member 44 until the accumulated pressure is sufficient to overcome such resistance, whereupon the piston is moved suddenly upward, which rapid movement causes the rod 19 to strike the stem 43 of the valve 39 which is opened thereby against the action of the spring 40, as well as the resistance of the compressed air in the chamber above it in the casing 31. Upon opening the valve 39, compressed air is premitted to flow downward through the bore 30 of the hollow stem 29 and the space around the stem 19, into the piston chamber beneath the piston 28, thereby raising the piston and opening the valve 34 against the combined pressure of the spring 36 and the compressed air above said last named valve. The compressed air assumed to be above said valve, which also fills the chamber 60 above the piston 58, the pipes 63 and 64 and the chamber of the casing 31, is thereby permitted to escape to the atmosphere through the opening in the part 66 of the casing, thereby relieving the piston 58 from downward pressure. Air being under constant pressure in the service pipe 50, the upward pressure beneath the piston 57 causes a sudden opeing of the valve 54, thereby admitting compressed air to the pipe 48. The sudden pressure in the latter causes the valve 84 to close; and inasmuch as the air cannot escape otherwise, it is forced into the top of the evacuating chamber. This pressure causes the check-valve 11 to close and the valve 12 to open, whereupon the liquid is forced upwardly through the discharge pipe 7 into the sewer 8.

Upon the admission of compressed air to the pipe 48, a portion of it enters the pipe 74 and passes upwardly to the piston chamber above the piston 18, the action serving to close the check-valve 80 against back pressure. The air so admitted causes the piston 18 to be moved downward to its normal position, whereupon the valves 34 and 39 are closed by the action of the springs 36 and 40 respectively, thus providing for the rebuilding of an air pressure above them.

It is essential that the chamber above the piston 18 should be relieved of air pressure in order that the piston therein may be raised when desired. This result may be accomplished by means of a small opening 87, Fig. 4, sufficiently large to permit the air to escape slowly therefrom. A further advantage of this feature is to prevent a building up of pressure in said chamber as a result of possible leakage past the piston.

After the discharge of the liquid from the evacuating chamber it is essential that the valve 54 should be closed so that the reservoir may again be permitted to refill. The closing of said valve may be accomplished automatically as follows: The pipe 68, being in communication with the service pipe 50 as well as with the chamber 60, through the pipe 63, the pressure in the chamber 60 is permitted to build up at any predetermined rate by regulating the area of the opening through the needle-valve 70. As soon as the necessary pressure is established above the piston 58 it causes said piston to be moved downward against the lesser pressure of the piston 57, thereby closing the valve 54. When the reservoir 4 is evacuated, the valve 84 is caused to open, thereby restoring atmospheric pressure in the pipe 48 as well as in said chamber, so that the inflowing liquid from the sump may be free to rise in the evacuating chamber; thereby repeating the operation automatically as often as the evacuating chamber is filled, and this regardless of the rate at which it may be so filled.

In order to insure certainty of action under all conditions, I would recommend that

the spring 85 should be of such strength as to overcome a pressure equal to the head of water in the pipe 7 although I have found by test that in actual practice the inertia of the moving liquid in the ascending column results in a considerable reduction of the pressure in the reservoir.

The feature of the air reservoir 13 and the valve actuating mechanism in connection therewith is of particular importance inasmuch as it eliminates valves and floats, except the two check-valves described, from that portion of the mechanism with which the liquid contacts. The controlling valve mechanism actuated by the air compressed in the reservoir 13, may be at any predetermined distance from the ejector reservoir.

A further advantage of my improvement is that the use of air may be conserved by employing it expansively; only a sufficient volume being used to evacuate the reservoir.

In devices intended for a like purpose, so far as I am aware, a valve adapted to control air or steam pressure, is opened by the movement of a float or bucket when the latter attains a given height and is not closed until the float or its equivalent, has arrived at its minimum level. As a result of such construction, the full pressure of the air is maintained upon the liquid surface from the time of the opening until that of the closing of the inlet air-valve. The quantity of air used therefore, is that due to the volume of water displaced at the maximum pressure of its discharge. My improvement enables the inflow of air to be cut off automatically whenever the surface of the outflowing liquid from the reservoir attains such a level that the expansive action of the air will complete the discharge. The maximum pressure under which the device will be operated must, of course, depend upon the difference in level of the lower part of the ejector reservoir and the maximum level at which the liquid is to be discharged from the delivery pipe. The requisite air pressure being determined, the opening of the valve 70 should be so adjusted as to permit the air pressure to build up in the chamber 60 to a sufficient degree to insure the closing of the inlet valve 54 when the reservoir 4 is but partially discharged, thereby relying upon the expansion of the air to complete the work. I have found in practice under ordinary conditions, that if the motive air is cut off when the level of the liquid is lowered to about the middle of the reservoir or when it is about half discharged, that the expansive action will serve to complete the work, but I do not intend to be limited to any specific level. When the valve 70 is once regulated to insure the best results in a given instance, it will require no further change. The operation will continue automatically as long as liquid flows into the ejector. The rate at which discharges will occur will, of course, depend upon the speed at which the liquid flows into the evacuator from the source of supply.

The device is especially applicable for elevating sewage, draining swamps or ponds or for irrigation purposes. In short, it may be applied to advantage whenever it may be necessary to raise fluid from one level to another.

I do not wish to be limited to the exact construction shown, inasmuch as it may be varied without departing from the spirit of the invention.

Having thus described my invention, I claim:

1. A pneumatic pump comprising, in combination, an evacuating chamber having a liquid inlet at the lower part thereof to permit liquid to rise therein, an outlet conduit leading from said lower part to a higher level, a source of compressed air, a valve for controlling the admission of compressed air to said chamber, an air actuated motor for closing said valve, air-actuated means for opening the same, means for slowly admitting air under pressure to said motor to hold said valve closed, a normally closed controlling valve for releasing air from said motor chamber and means in communication with said evacuating chamber and controlled by air pressure caused by the admission of liquid thereto, for opening said controlling valve.

2. A device of the class described, comprising, in combination, a chamber having a liquid inlet at the lower part thereof to permit liquid to rise therein, an outlet conduit leading to a higher level, a source of compressed air, a valve for controlling the admission of compressed air to said chamber, an air actuated motor for opening the same, a conduit for conveying air under pressure to said motor to hold said valve closed, means for regulating the flow of air in said conduit to control the time required to build up a predetermined pressure against said motor, a normally closed controlling valve for releasing air from said motor and means controlled by the pressure in said evacuating chamber for actuating said valve to release air pressure upon said motor.

3. A device of the character set forth, comprising an evacuating chamber having inlet and outlet conduits for the passage of liquid, a source of compressed air, a valve for controlling the admission of compressed air to said chamber, a motor for closing said valve, said motor being inclosed in an air chamber in constant communication with said source of compressed air, means for arbitrarily limiting the rate of admission of air to said air chamber, means for suddenly releasing the same and

means controlled by the rise of pressure in said evacuating chamber for actuating said air releasing means.

4. A device of the character described, comprising an evacuating chamber having inlet and outlet conduits for the passage of liquid, a source of compressed air, a valve for controlling the admission of compressed air to said chamber, a motor for closing said valve, said motor being in communication with an air-chamber in constant communication with said source of compressed air, an adjustable valve for limiting the rate of flow of compressed air to said air chamber, means for quickly releasing air therefrom and means controlled by the rise of pressure in said evacuating chamber for controlling said air releasing means.

5. A device of the character described, comprising an evacuating chamber having inlet and outlet conduits for the passage of liquid, an air-chamber in communication therewith adapted to have the air therein compressed when liquid is admitted to said chamber, a source of compressed air, a valve for controlling the admission of compressed air to said evacuating chamber, a motor for closing said valve, said motor being inclosed in a casing in constant communication with said source of compressed air, means for arbitrarily limiting the rate of admission of air to said chamber, a normally closed valve for releasing the same and a motor in communication with said air-chamber for opening said valve.

In testimony whereof, I have signed this specification in the presence of two subscribing witnesses, this eighth day of May 1917.

JUSTIN E. RUSSELL.

Witnesses:
DAVID H. FLETCHER,
JENNIE L. FISKE.