B. S. AIKMAN.

PUMP AND PUMPING SYSTEM.

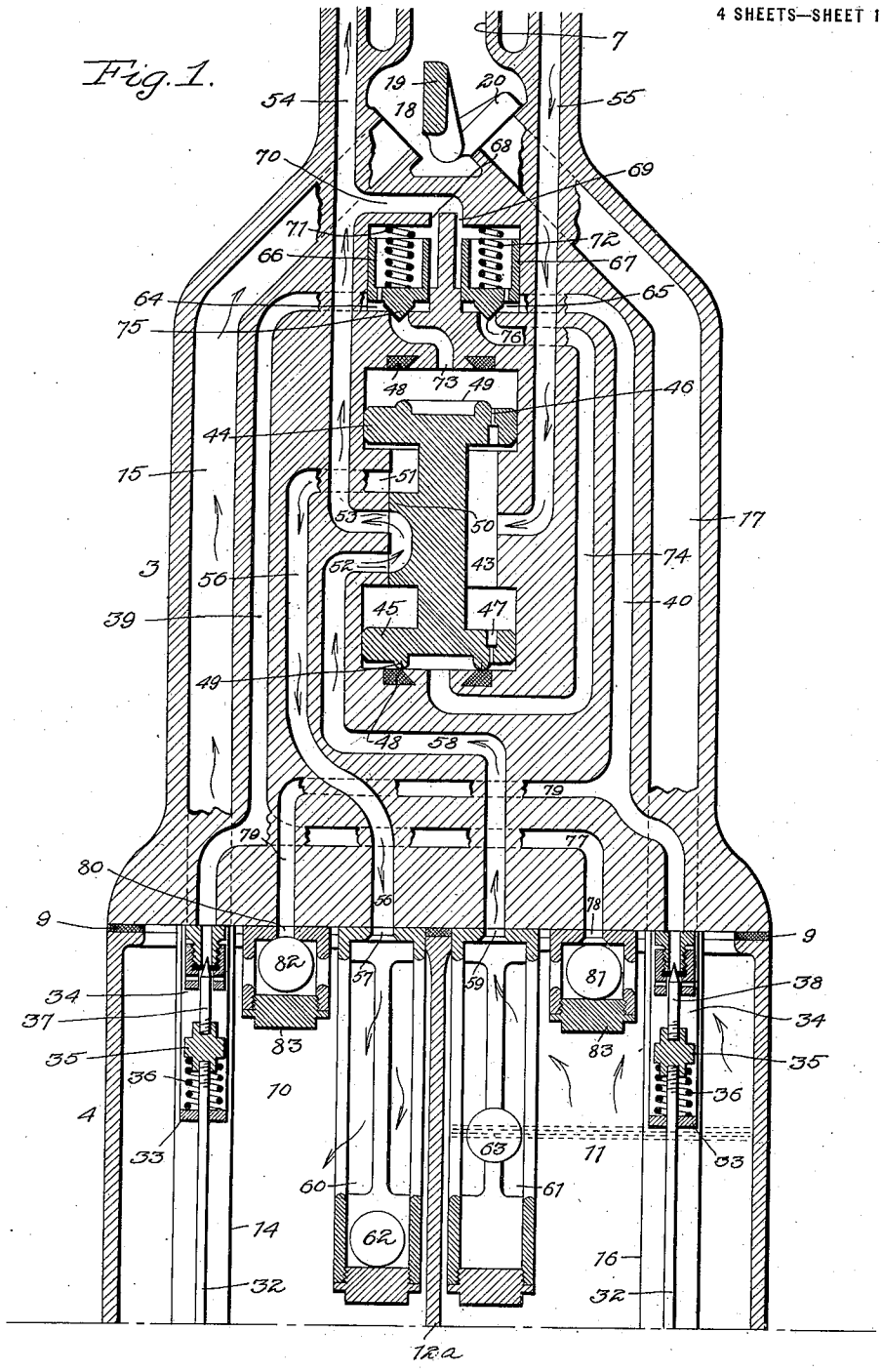
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1,356,684.

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4 SHEETS—SHEET 1.

Fig. 1.




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4 SHEETS—SHEET 2.

Fig. 2.

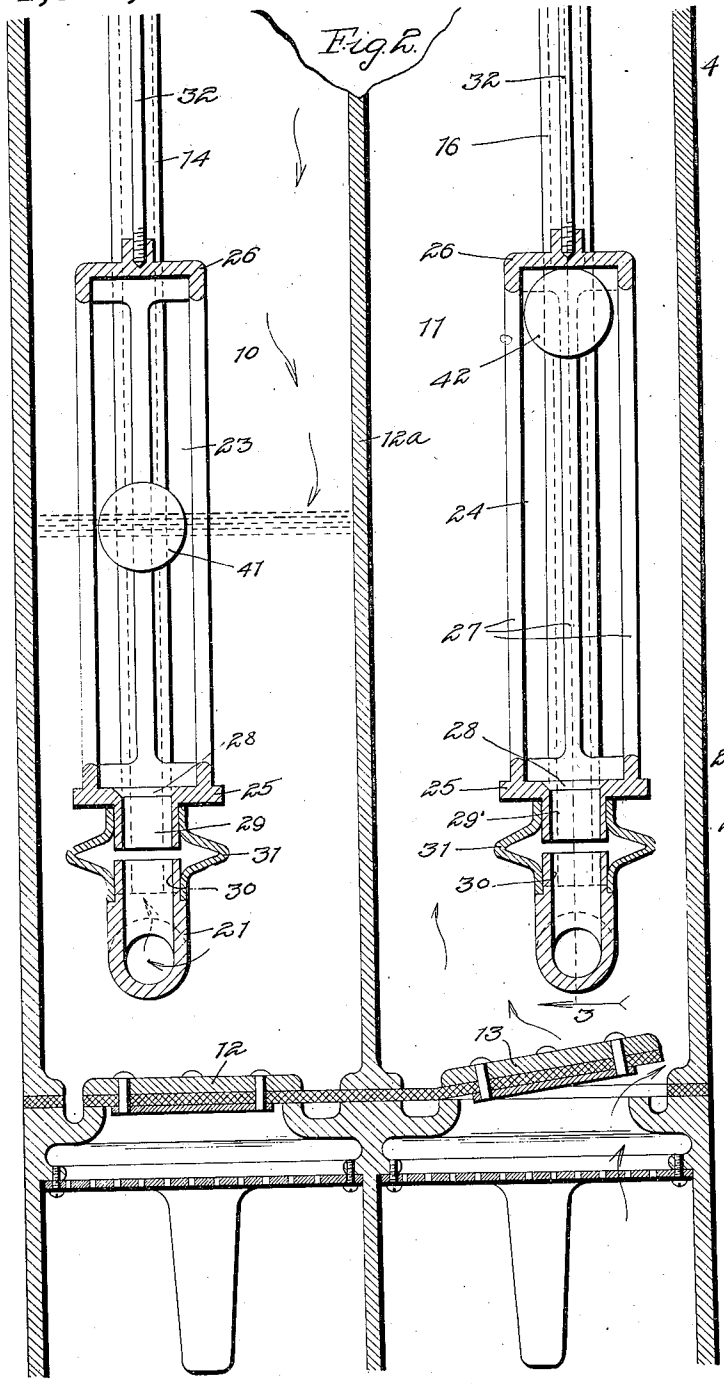
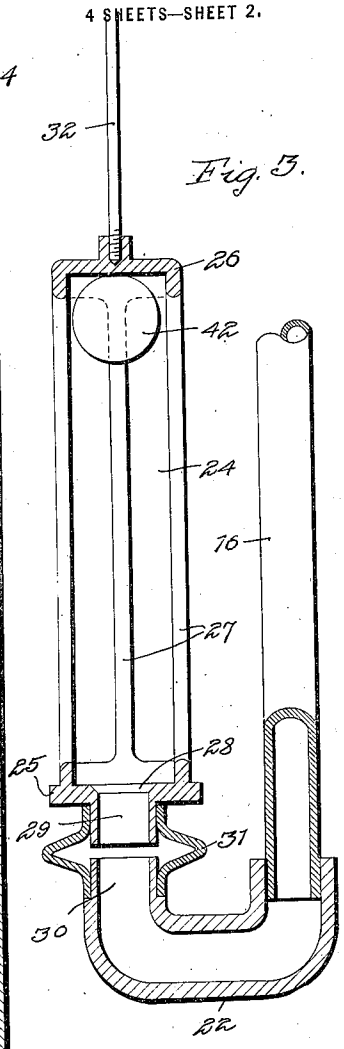



Fig. 3.




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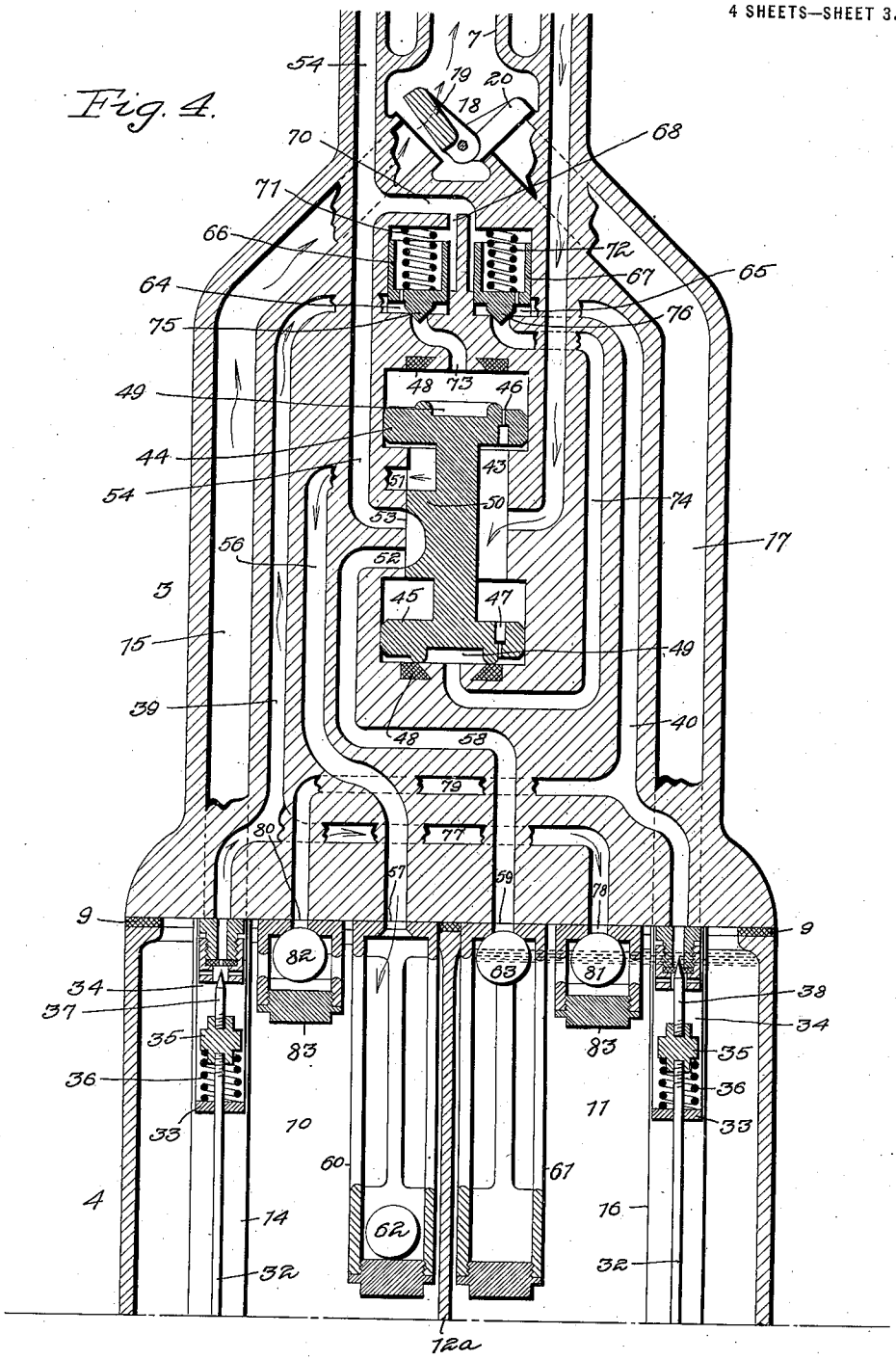
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4 SHEETS—SHEET 3.

Fig. 4.




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4 SHEETS—SHEET 4.

Fig. 5.

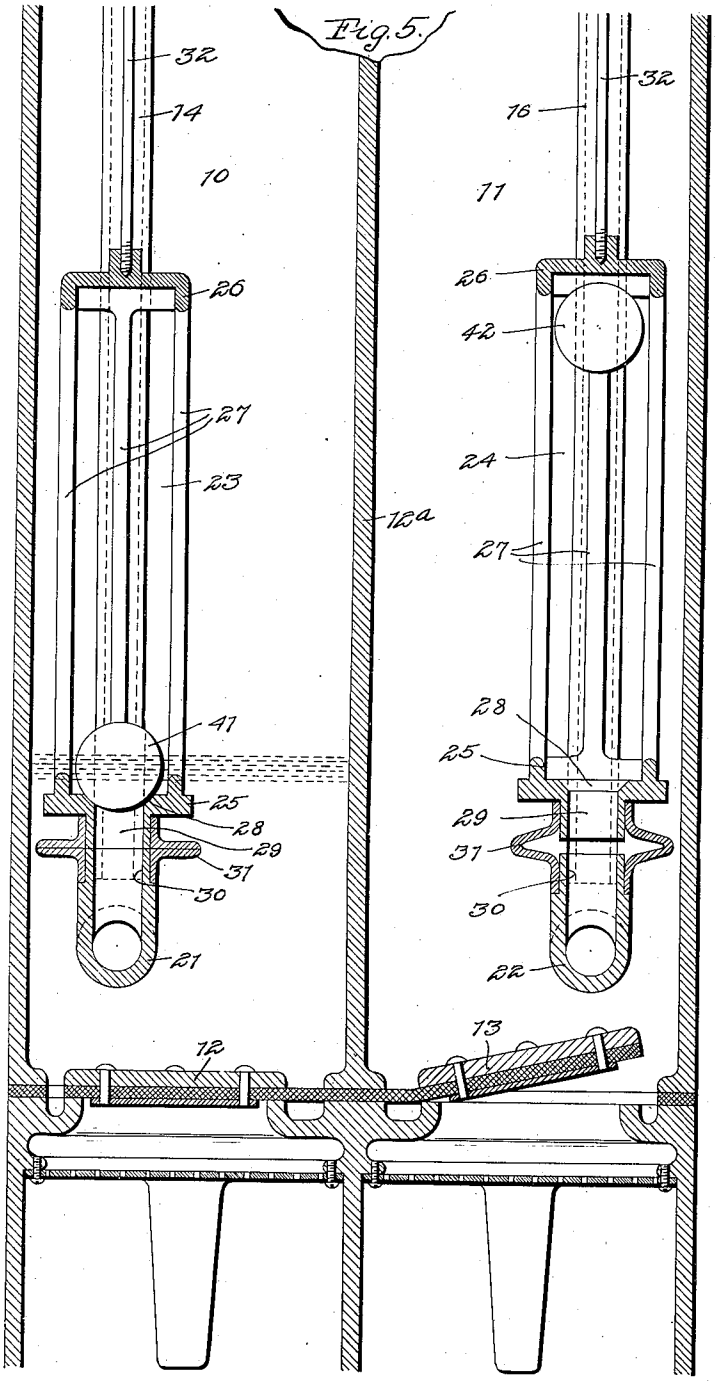
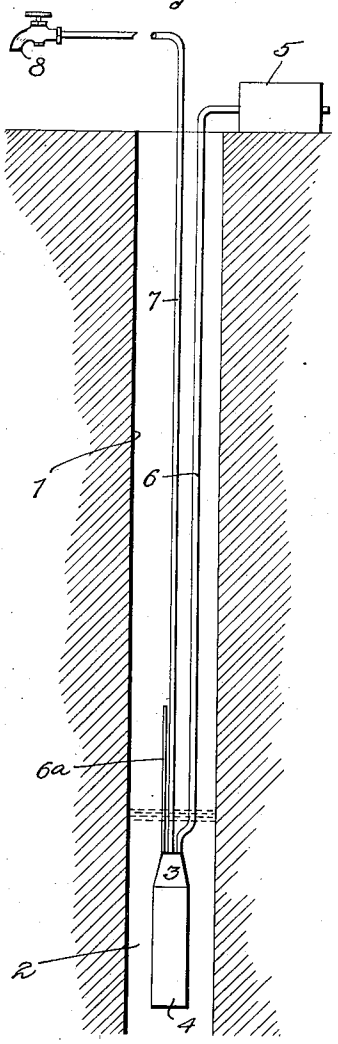



Fig. 6.




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# UNITED STATES PATENT OFFICE.

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## PUMP AND PUMPING SYSTEM.

1,356,684. Specification of Letters Patent. Patented Oct. 26, 1920.

Application filed October 9, 1915. Serial No. 54,960.

*To all whom it may concern:*

Be it known that I, BURTON S. AIKMAN, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented a certain new and useful Improvement in Pumps and Pumping Systems, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to that class of pneumatic pumps which are intended to supply water directly to faucets or other normally closed outlets at the variable and arbitrary demand of the users, without the intervention of special storage. In other words, the device is intended to operate when water is required at one or more outlets and to remain at rest at all other times; and this, regardless of whether the outlet demand shall equal the full capacity of the pump or whether it be nominal as the result of a minimum use or from mere uncontrolled leakage.

It is well known to those skilled in the art, that there are various forms of pneumatic pumps having in common substantially the same features or their equivalents, all of which are capable of successful operation for the continuous pumping of water into an open tank or elsewhere, but which, for various reasons, are liable to fail under the conditions specified.

Stated generally, the object of my invention is to overcome these difficulties and uncertainties by providing simple and effective means for shifting a normally balanced air reversing valve through the action of the air pressure in conjunction with the movement of the water in separate chambers to be alternately filled and emptied, to cut off the water discharge at a predetermined level from the chamber being emptied, to provide means to be actuated at a predetermined time by the direct air pressure for closing the water outlet in the discharging chamber, to simultaneously open an air-vent from said chamber to initiate the action of a normally closed supplemental valve for disturbing the equilibrium in the air-reversing valve-chamber, to provide means for permitting the air from said vent to escape until the companion water-chamber is filled, to provide means for shutting off the escape of said air when said companion water chamber is filled so as to permit the pressure of the air escaping from said vent to build up to initiate the movement of said supplemental valve, and finally to provide means for enabling the air from one end of the main valve chamber to act upon pressure controlled means, such for example as an enlarged area of said supplemental valve, to insure the complete opening of the latter, thereby disturbing the equilibrium of the piston controlling the main valve and causing it to be shifted to the full limit of its movement;—all of which is hereinafter more particularly described and definitely pointed out in the claims.

In the drawings,—

Figure 1 is a central vertical sectional view, partly diagrammatic in character, of the "head" of a pneumatic pump embodying the features of my invention, together with the upper portion of the water chambers;

Fig. 2 is a like sectional view taken in the same plane, of the lower portion of the water chambers, being a continuation of Fig. 1, said figures showing the movable parts in the respective positions which they would occupy when one chamber is being discharged and partially filled.

Fig. 3 is a vertical sectional view in detail taken upon the line 3—3, Fig. 2, viewed in the direction of the arrow there shown;

Fig. 4 is a view corresponding to that shown in Fig. 1 except that some of the parts are shown in different positions;

Fig. 5 is a view corresponding to that shown in Fig. 2 except that some of the parts are shown in different positions; and

Fig. 6 is a diagrammatic view showing a section of a well with a pump therein, together with the air and water discharge connections.

Referring to the drawings, 1, Fig. 6, indicates a well having a pump, generally designated by 2, submerged therein. Said pump is provided with a head portion generally designated by 3, and a water-chamber portion generally designated by 4; said part 3 being also shown in Figs. 1 and 4, and said part 4 in Figs. 1, 2, 4 and 5. An air-supply tank 5, Fig. 6, connected in the usual way with a source of air supply, is arranged to communicate with the head 3, by means of a pipe 6, and to exhaust through a pipe $6^a$ above the water level, while a water-dis-

charge pipe 7 is led upwardly from said head into communication with one or more valve-controlled discharge outlets such, for example, as the faucet 8.

The pump-head 3, which may be cast from brass or other suitable material, comprises a casing or container for the main valve mechanism. Said head is bolted or otherwise secured by means of a tight joint 9 to the part 4, which consists of a hollow cylinder divided into counterpart water-chambers 10 and 11, by means of a central partition $12^a$. Said chambers are provided, respectively, with water inlet valves 12 and 13. A water discharge-pipe 14 is located in the chamber 10 and connected at the upper end in any well known way with a discharge passage 15, in the head, while a like discharge-pipe 16, in the chamber 11, is connected at the upper end in like manner with a similar discharge passage 17. Said discharge passages are arranged to communicate with a chamber 18, which is in communication with the common discharge pipe 7. Check valves 19 and 20, respectively, are located at the discharge openings of the passages 15 and 17.

A U-shaped tubular fitting 21 is rigidly attached to the lower end of the pipe 14, and a like fitting 22 is secured in the same manner to the pipe 16. Located above said fittings, respectively, are valve cages which are identical in construction, but which, for purposes of distinction hereafter will be generally designated as 23 and 24. To the other corresponding parts, however, except the valves, will be given like reference numerals. Each of said cages is provided with an annular base portion 25 connected with a head member 26, by means of rods 27. Said base portion is provided with a valve-seat 28, from which is extended downwardly a tubular member 29 which is concentric with a tubular part 30, upon the U-shaped fitting above which it is located. An expansible or bellows connection 31, formed from india rubber or other flexible material, serves to connect the parts 29 and 30 so as to provide for a limited vertical movement of the former for the purpose hereinafter stated. The movable base member 29 which forms the water outlet for the cylinder and which has the valve seat 28, is mounted at such a height in the cylinder that it always remains below the level of the water in the chamber. Tapped into the head 26 of each of said cages is a rod 32. Said rods are extended upwardly through horizontal lugs 33, of stationary brackets 34, into heads 35. Coiled springs 36 are interposed between the parts 33 and shoulders upon said heads. A needle-valve 37, held normally closed by the spring 36, is attached to the head 35 in the chamber 10, and a like valve 38 is attached to that in the chamber 11. The valve 37 is in communication with an air passage 39 formed in the pump head, while the valve 38 is connected in like manner with an air passage 40, each of which will be further described.

The pilot valves 37, it will be noted, are arranged to seat with the pressure of the motive fluid that they control. That is to say, these valves are pressed against their seats by the excess of pressure within the pumping chambers over that of the pressure prevailing in the exhaust passageways. Hence, the greater the pressure in the chamber, the greater will be the force tending to hold the particular pilot valve to its seat. A valve of this character is highly advantageous, first because it is automatically held tight by the pressure, and second it is self cleaning by the action of the compressed air brushing off any matter which might be on the valve or seat. However, the greater the pressure, the greater will be the power required to pull such a valve from its seat. If a float were employed, the resistance of the valve would increase with the increase of pressure, but the power of the float would remain constant. Consequently, if the pressure should be increased beyond a certain point the float would be incapable of operating the valve. By the employment of a pressure operated motor utilizing the same pressure acting upon the valve, the power of the motor increases with the increase of pressure, so that the motor is always able to operate the pilot valve with a predetermined margin of excess power available. The spring 36 makes the return stroke of the motor and applies the valve 37 to its seat, but after the valve is once applied to seat, the pressure acts in a direction to hold it tight. In pulling the valve off seat, a point will be reached when the power of the motor is just equal to the pressure of the spring at that point in the operation, the valve 37 is held to its seat solely by the pressure of the motive fluid.

Within the cage 23 in the chamber 10 is located a ball or float-valve 41, while within the corresponding chamber of the cage in the chamber 11, is placed a like ball 42. Said balls are preferably formed from pure Pará rubber, and are adapted to fit upon the seats 28, or to rise with the water in the chambers,—being guided by the connecting members 27.

The movable base member 29 with the connected parts constitutes a fluid pressure operated motor controlled by the valve 41 for operating the air valve 37. The ball valve 41 floats with the major part thereof submerged so that the engagement between this valve and its seat is always maintained below the level of the water in the chamber for both pressure and exhaust, as is clearly shown in Fig. 5.

Formed in the head 3 is a valve-chamber 43, said chamber being enlarged at the ends for the reception of piston heads 44, 45 rigidly connected in any well known way. One of said piston heads is preferably larger in diameter than the other, so as to form a differential area for the purpose hereinafter stated. Small bores 46, 47, are formed in said heads to permit air to pass from the central portion of the chamber to the outer ends. Packing rings 48 are formed in opposite ends of said chamber adapted to be engaged by annular beads 49 upon the outer ends of said pistons. A slide-valve 50, of well known construction, is operatively secured to the connecting member, as shown, between the piston-heads, to control the opening and closing of inlet ports 51, 52, and to bring them alternately into communication with an exhaust port 53, leading to an exhaust conduit 54. The air-pipe 6, Fig. 6, is in communication with a live-air or inlet passage 55, Figs. 1 and 2, leading to the valve chamber 43.

The port 51 is in communication with a passage 56 leading to an inlet opening 57 in the chamber 10, and the port 52 is in communication with a like passage 58, leading to an inlet opening 59, in communication with the chamber 11.

Valve cages, generally designated by 60 and 61, of the same character as the cages 23 and 24, are secured in any suitable way to the head 3 and extended downwardly into the chambers 10 and 11, respectively. Float valves or balls 62, 63, are located in said cages.

The air passages 39 and 40 are in communication, respectively, with chambers 64 and 65 beneath the annular faces of supplemental valves 66 and 67 adapted to normally close openings 68 and 69, leading through a passage 70 to the exhaust passage 54. Said valves are held normally closed by means of springs 71, 72. An air passage 73 leads from the upper end of the piston-chamber to the supplemental valve-chamber 64, while an air passage 74 leads in turn from the opposite end of the piston-chamber to the chamber 65, beneath the valve 67. Valves 75, 76, of relatively small superficial area compared to that of the valves 66, 67, are formed upon the lower ends or faces of said last named valves and are arranged to normally close the passages 73, 74 against the air pressure from the piston-chamber, for the purpose hereinafter stated.

Extending laterally from the air passage 39, and thence downwardly, is a branch conduit or passage 77, leading to an opening 78 in communication with the chamber 11, while a like passage 79 is carried from the passage 40 to an opening 80 in communication with the chamber 10. The valve opening 78 is provided with a suitable seat and is adapted to be closed by a ball-valve 81, while the opening 80 is adapted to be closed in like manner by a ball-valve 82. Each of the ball-valves 81 and 82 is inclosed in an open cage 83, similar to the other valve cages described except that they are of such length as to permit only a slight vertical movement so as to enable the valves to be closed either by air or water pressure, as hereinafter described.

The operation of the device is as follows:

Air under pressure having been admitted through the pipe 6 and passage or duct 55, enters the valve-chamber 43. Assuming the pistons 44 and 45 to be positioned as shown, the air passes through the openings 46 and 47 into the end-chambers; but inasmuch as the bead 49 upon the head 45 is in contact with the packing 48, the area of the piston 45 upon which the air is permitted to act, is less than that upon the piston 44, and hence said pistons are retained by air-pressure in the extreme position shown, with the valve 50 positioned to open the port 51, thereby permitting the live air to flow through the duct 56 into the chamber 10, while the port 52 is open to the exhaust duct 54, thereby permitting the air to escape from the chamber 11 through the exhaust opening 59. Under these conditions, the inlet valve 12 in the chamber 10 is closed by reason of the air pressure upon the water-surface, while the discharge opening through the fitting 21 is open. Upon the admission of air to the chamber 10, the valve 82, having been previously held closed by the action of the water in the filled chamber, remains upon its seat, where it is retained by the pressure of the air which tends to escape through the passage 79. Upon opening a faucet, the pressure of the air causes the water to be discharged through the part 21, pipe 14 and passage 15, to the main discharge-pipe 7, and thence to the faucet, the check-valve 19 being open and the valve 20 closed, as shown in Fig. 1. While the chamber 10 is being emptied and while the ball-valve 41 remains unseated, it is obvious that the needle-valve 37 will be kept closed by the action of the spring 36. As soon, however, as the water in the chamber 10 is lowered sufficiently to permit the ball 41 to rest upon the seat 28, the air-pressure, acting upon the ball, will force the cage 23 downwardly until the bottom of the part 29 is in contact with the top of the part 30, which movement is permitted by the flexible connection 31. The ball valve 41 seats upon the valve seat 28 while the level of the water is above the same. Thus a water seal is maintained between the motor and the air in the pump cylinder, which water seal prevents the blowing of air into the water discharge main during pressure condition in the cyl-

inder. This water seal is maintained both upon pressure and exhaust, and uniform operation under all conditions prevails. The downward pull of the cage upon the rod 32 serves to open the valve 37, thereby permitting the compressed air to escape into the passages 39 and 77. Should the valve 81 be open, as it may be at this instant, as shown in Fig. 1, the freed air will escape through the passage 77 and valve opening 78 into the chamber 11, and thence outwardly through the duct 58 and main valve to the exhaust, the purpose of this feature being to allow the filling chamber to be completely filled before the main valve is reversed.

During the operation described of discharging the chamber 10, it will be understood that the submergence pressure in the well will cause the chamber 11 to fill. I prefer that the several valve openings in the two chambers should be so proportioned with respect to each other that when the pump is in continuous action the time for discharging one chamber shall be not more, but rather appreciably less than that for filling the other. Such a construction would enable the valve 81 to be open at the instant of opening the vent-valve 37, in which case there would be a zero pressure in the chamber 64 beneath the valve 66, and said valve would remain seated until the rise of the water in the chamber 11 would cause the seating of the valve 63, when the pressure in the duct 39 would build up until the tension thereof would be sufficient to initiate the action of the valve 66 and open the valve 75.

In Figs. 4 and 5, the several valves are shown as they would appear for an appreciable instant after the closing of the valve 41, the opening of the valve 37 and the closing of the valve 81. This condition would continue long enough to cause the building up of the pressure beneath the valve 66, which is shown as still closed, but lifted sufficiently to open the valve 75 and release the air from the end chamber above the piston 44. The opening of said last-named valve permits the air pressure from the piston chamber to act directly upon the relatively large area of the valve 66, thus insuring the opening thereof to the full limit, when the air from the end of the piston chamber, as well as that from the duct 39, is free to exhaust through the passages 68 and 70, and main exhaust passage 54. The instant the valve 66 is opened the equilibrium in the piston-chamber will be disturbed, when the pressure in the opposite end chamber will cause the double-headed piston to be shifted to its full limit, thereby actuating the main valve 50, which will cause the port 52, in communication with the chamber 11, to be opened for the admission of live air to discharge said chamber, while permitting the air from the chamber 10 to exhaust through the port 57 and duct 56. As soon as the air pressure is relieved from the chamber 10, the valve 37 will be seated. It is obvious that the check-valve 20 will remain closed until the controlling valve 50 is reversed, but in view of the fact that the valve 41 is seated and the valve 37 open, the check-valve 19 is shown as it would appear when in the act of closing.

The cycle of operation described is such as would occur when a faucet has been open and kept open long enough to empty one and fill another chamber. Should it be kept open for a lesser period, the action would be modified to the extent that while the one chamber might be partially emptied as a result of one or more openings of the faucet, such delay would not interfere with the filling of the other, which might be filled minutes, hours or days before the emptying of its fellow, so as to cause the shifting of the main valve. In such case there would be no temporary escape of air from the needle-valve to the exhaust pending the filling of the adjacent chamber, and hence the air thus released from the emptied chamber would act directly to initiate the opening of the supplemental valve to which it would pass.

From what has been stated it will be apparent that whether the water be discharged at the maximum capacity of the pump or at the slowest possible rate, such, for example, as would be caused by mere faucet leakage, the live air cannot "blow over" into the water discharge-pipe, but the controlling valve will be shifted with certainty whenever the proper time occurs for such action.

The fact that the air released from the end-chamber of the piston is suddenly admitted to supplement that from a given vent-valve to open a supplemental valve, is important in that the sudden impulse or stress imparted thereby to the relatively large area of the supplemental valve, serves to insure the opening of the latter, which might remain closed in the event of a more gradual accumulation of pressure.

By reason of my improved construction, I am enabled to overcome certain important difficulties associated with pumps of this class. Should the water recede in the well so as to expose the inlet valves, it will cause many pumps of this class to "race" and to so wear the parts as to necessitate their repair, which is often a matter of grave concern when it is considered that the pump is at the bottom of a deep well. Again, under the conditions assumed, the pump-valve may get upon a "dead-center" and fail to operate.

In case of the non-submergence of my pump the most serious thing that could happen would be a loss of air through one of the vent-valves, as the pump would stop when emptied of water, while the valve-operating pistons, being differential, would cause the main valve to assume an operative position ready to continue its work upon the rise of water in the well. Moreover, the construction is such as to prevent a premature shifting of the main valve, and hence the complete filling of the successive chambers before the position of the valve is reversed.

I claim:—

1. In a pump, a pair of liquid chambers, inlet and outlet means for each chamber, an exhaust passageway, and a pressure medium passageway for each chamber, a pressure motor for said chambers, valve mechanism operated by said pressure motor to control the connection of said chambers with said passageways, and means directly mechanically related to the high level of the liquid in each chamber controlling the effective application of pressure to said pressure motor and means directly mechanically related to the low level of the liquid in each chamber controlling the exhaust from said pressure motor.

2. A pneumatic pump having water chambers adapted to be alternately filled and emptied, a source of motive fluid under pressure in communication with said water chambers, reversing valve mechanism for shifting said fluid to one and permitting it to exhaust from the other chamber, and means in each of said chambers operated directly by the rise of liquid in said chambers for reversing said valve mechanism, and means in each of said chambers operated directly by the fall of liquid in said chambers for reversing said valve mechanism.

3. A pneumatic pump having water chambers adapted to be alternately filled and emptied, a source of motive fluid under pressure in communication with said water chambers, a reversing-valve for shifting said fluid to one and permitting it to exhaust from the other chamber, a normally balanced piston for actuating said valve, supplemental normally-closed pressure-controlled valves for controlling the escape of motive fluid from the ends of said piston in opposite directions, means for admitting at a predetermined time motive fluid to the pressure-controlled means of one of said valves from the water chamber undergoing discharge to initiate the opening of said valve, and means for directing against said pressure-controlled means the escaping motive fluid released by the opening of said valve from one of the end chambers of said normally-balanced piston.

4. A pneumatic pump having water chambers adapted to be alternately filled and emptied, a source of motive fluid under pressure in communication with said water chambers, a reversing valve for shifting said fluid to one and permitting it to exhaust from the other chamber, a normally balanced piston for actuating said valve, supplemental normally-closed pressure-controlled valves for controlling the escape of motive fluid from the ends of said piston in opposite directions, means for admitting at a predetermined time motive fluid to the pressure-controlled means of one of said valves from the water-chamber which is being discharged to initiate the opening of said valve, and means for causing the pressure of said motive fluid so admitted to remain substantially at zero until the companion water chamber is filled.

5. A pneumatic pump comprising two water chambers having valved inlets and outlets and valved discharge-pipes, a main reversing valve, a normally balanced duplex piston mounted in the valve chamber for shifting said reversing valve, normally-closed pressure-controlled auxiliary valves arranged to close against the pressure in the end chambers of said pistons, means for yieldingly holding said valves closed, and means for alternately opening said valves by the pressure of the air from the emptying water chamber when the water therein reaches a predetermined level therein.

6. An apparatus for pumping liquids comprising a plurality of liquid-receiving chambers having valved liquid inlet openings and a liquid discharge conduit, a source of compressed actuating fluid in operative communication with said chambers, a main reversing valve in the line of said actuating fluid, a normally-balanced piston for shifting said main valve, an actuating fluid exhaust passage in communication with said receiving chambers, normally-closed auxiliary valves in communication with said exhaust passage, said valves having duplex differential areas, the smaller to control communication with said piston-chamber and the larger communication to said exhaust passage, conduits leading from the opposite ends of said piston-chamber to said supplemental valves respectively, actuating-fluid escape conduits leading from said liquid chambers into communication with the larger area of said supplemental valves, means for normally closing said conduits, and means for opening that one of them which is in the liquid-discharging chamber when the surface of the liquid therein shall have reached a predetermined level.

7. A pneumatic pump comprising double liquid chambers each having a valved liquid inlet, a discharge pipe in communication

therewith, an air reversing valve in communication with said chambers, a source of compressed air in communication therewith, a normally-balanced double-headed piston for actuating said valve, a normally-closed supplemental valve in communication with each of said chambers, said valves having differential areas, conduits leading from opposite ends of said piston-chamber to the smaller area of said valves respectively, conduits leading from said liquid chambers to the larger area of said valves, means for normally closing communication between said conduits and said liquid chambers, and means for opening said communication at a predetermined time with the fluid chamber which is being discharged.

8. A pneumatic pump comprising liquid-holding chambers adapted to be alternately filled and discharged, said chambers each having a valved liquid inlet, a discharge pipe in communication therewith, an air reversing valve in communication with said chambers, a source of compressed air in communication therewith, a normally-balanced double-headed piston for actuating said valve, a normally-closed supplemental valve in communication with each of said chambers, said valves having differential areas, conduits leading from opposite ends of said piston-chamber to the smaller area of said valves respectively, conduits leading from said liquid chambers to the larger area of said valves, means for normally closing communication between said conduits and said liquid chamber, means for opening said communication at a predetermined time with the liquid chamber which is being discharged and means for closing the liquid discharge opening of said chamber.

9. A pneumatic pump in which is comprised valved water chambers adapted to be alternately filled by submergence pressure and emptied by compressed fluid pressure, a main air reversing valve, a normally balanced piston for actuating said valve, a source of compressed air in communication with said piston, supplemental valves, one for each of said chambers, conduits leading from opposite ends of the casing of said piston to said valves respectively, means for yieldingly closing said valves against the pressure in said conduits, pressure actuated means for opening said valves to an exhaust, said means being in normally closed communication with said conduits, conduits leading from said water chambers to said pressure-actuated means, normally closed valves in said water chambers for closing communication between said chambers and conduits and means for opening at a predetermined time the valve in the water chamber which is being emptied to permit the escaping air to initiate the movement of said pressure-actuated means and permit the air to escape from the end of the piston chamber to coact therewith in fully opening said valve to the exhaust.

10. A pneumatic pump in which is comprised water chambers adapted to be alternately filled by submergence pressure and emptied by the action of compressed fluid, a main reversing valve, a normally balanced piston for actuating said valve, a source of compressed air in communication with said piston, an exhaust conduit in communication with said chambers and said reversing valve, conduits leading from the ends of the chamber of said piston to said exhaust, interposed supplemental valves for normally closing said conduits, pressure-actuated means for opening said valves, conduits leading from said water chambers to said pressure-actuated means, normally closed valves in said water chambers for closing communication between said chambers and said conduits, means actuated by the pneumatic pressure in the discharging water chamber for closing the water outlet and opening said valve to admit air to said pressure-actuated means to open said supplemental valve and cause the shifting of the main valve.

11. A pneumatic pump comprising water chambers adapted to be alternately filled by submergence pressure and emptied by pneumatic pressure, a source of compressed air, an exhaust, a main reversing valve for alternately connecting one of said chambers with said air and the other with the exhaust, a normally balanced piston for actuating said valve, conduits leading from opposite ends of said piston to said exhaust, interposed supplemental valves for normally closing said conduits, pressure-actuated means for opening said valves, conduits leading from said water chambers to said pressure-actuated means, normally closed valves in said water chambers for closing communication between said chambers and said conduits, means actuated by the pneumatic pressure in the discharging water-chamber for closing the water outlet and opening said valve to admit pressure to said pressure-actuated means, a by-pass leading from the conduits connecting said water chambers with said pressure-actuated means to the opposite water chamber, pressure-actuated valves for closing said by-pass, and float valves for closing the exhaust from the filling chamber when the latter becomes filled.

12. A pneumatic pump comprising valved water chambers adapted to be alternately filled by submergence pressure and emptied by pneumatic pressure, a main air reversing valve, a normally balanced double-headed piston for shifting the same, an exhaust, normally-closed pressure-controlled auxiliary valves communicating with the ex-

haust, one for each piston-head, said valves being arranged to normally prevent the escape of air from the end chambers of said piston, the same being provided with differential areas, the smaller of which is arranged to oppose said pressure in said chambers, means for yieldingly holding said valves closed, and means for admitting air at a predetermined time from a chamber being emptied against the larger area of the auxiliary valve in communication with said chamber to initiate the opening of said valve and permit the escape of air from one end of said piston chamber into contact with said differential area.

13. A pneumatic pump having water chambers adapted to be alternately filled and emptied, a source of motive fluid under pressure in communication with said water chambers, a reversing valve for shifting said fluid to one and permitting it to exhaust from the other chamber, a normally balanced piston for actuating said valve, normally closed supplemental valves for alternately controlling the escape of motive fluid from opposite ends of said piston, float valves for closing the water outlet from said chambers when the water descends to a predetermined level, a valve casing for each of said float valves, flexible means for permitting a limited movement of said valve casing when air pressure is exerted upon a seated valve, a vent valve for permitting an escape of air from a discharging chamber to one of said supplemental valves, means for connecting said vent valve with said float-valve casing and yielding means for holding said vent valve normally closed.

14. A pneumatic pump having water chambers adapted to be alternately filled and emptied, a source of compressed motive fluid in communication with said water-chambers, a reversing valve for shifting said fluid to one and permitting it to exhaust from the other chamber, means controlled by the escape of air from a vent-valve in a discharged chamber for shifting said reversing valve, a normally closed vent valve in each of said chambers, an air conduit leading from said vent valve to said means for shifting said reversing valve, a float-valve in each of said chambers for closing the water discharge opening therein when the water descends to a predetermined level, a movable valve casing adapted to be actuated by air pressure upon said float-valve when seated therein, said casing being connected with said vent-valve, a branch conduit leading from each vent valve to the adjacent water chamber for permitting a temporary escape of air to the exhaust, and a float-valve in each chamber for closing the opening leading thereto from said branch conduit.

15. A pneumatic pump having water chambers adapted to be alternately filled and emptied, a source of compressed motive fluid, conduits for conveying the same to and from said water chambers, a reversing valve in the line of said fluid supply for shifting said fluid to one chamber while permitting it to exhaust from the other, a valve controlling motor, means controlled by the escape of motive fluid from a water discharging chamber for actuating said motor, normally closed vent-valves in said chambers, float-valves in said chambers for closing the water discharge opening in a discharging chamber when the water is at a predetermined level, movable means actuated by said float valves when under motive fluid pressure for opening said vent valves, a conduit leading from the vent-valve in each chamber to an inlet opening in the adjacent chamber to permit a temporary exhaust of motive fluid therefrom, and float valves in said chambers adapted to close said openings, one by the air pressure in the discharging chamber and the other by the rise of water in the filling chamber.

16. A pneumatic pump having water chambers adapted to be alternately filled and emptied, a source of compressed motive fluid, conduits for conveying the same to and exhausting it from said water chambers, a reversing valve in the line of said fluid supply for shifting said fluid to one chamber while permitting it to exhaust from the other, a motor for reversing said valve, means controlled by the escape of motive fluid from a water discharging chamber for actuating said motor, vent valves in said chambers, yielding means for holding the same normally closed, float valves in said chambers for closing the water-discharge opening in a discharging chamber when the water is at a predetermined level, movable means actuated by said float valves when under motive fluid pressure for opening said vent valves, a conduit leading from the vent valve in each chamber to said valve controlling motor, a branch conduit leading from the vent-valve in each chamber to an inlet opening in the companion chamber, float valves in said chambers for closing said openings, that in the discharging chamber by the pressure of the motive fluid and that in the filling chamber by the rise of water therein, and float valves in said chambers for closing the exhaust openings in the order in which said chambers are filled.

17. In combination, a pair of water chambers, a source of motive fluid, a balanced piston valve controlling admission to and exhaust from said chambers of a suitable motive fluid, said piston valve having leakage ports through the piston heads,

valve means for the cylinders outside each of the pistons for controlling the movement of the piston valve, and means controlled by expulsion of water from one cylinder to cause operation of the piston valve to exhaust said one cylinder and to admit pressure to the other cylinder.

18. In combination, a pair of water chambers, a source of motive fluid, a valve device for alternately admitting motive fluid to and exhausting the same from said water chambers, a duplex cylinder, a duplex balanced piston having heads in said cylinder, said piston governing said valve device, said valve device being adapted to admit and exhaust motive fluid alternately to and from said cylinder, said piston heads having leakage ports for admitting pressure to the cylinders outside the heads, ports in said cylinders, valves for the ports, pressure operated spring-opposed plunger means connected to said valves, said plunger means being governed by expulsion of water from the chambers alternately.

19. In combination, a pair of water chambers, a source of motive fluid, a valve device, a duplex cylinder, a duplex balanced piston having piston heads in said cylinder governing said valve device, said valve device being adapted to admit and exhaust motive fluid alternately to and from said cylinders, said piston heads having leakage ports for admitting pressure to the cylinders outside of the heads, ports in said cylinders, valves for the ports, means on each piston head for covering the ports, pressure operated spring-opposed plunger means connected to said valves, said plunger means being governed by expulsion of water from the chambers alternately.

20. In a pump, a liquid chamber having inlet and outlet means, an exhaust passageway, a pressure medium passageway, a pressure motor, valve mechanism operated by said pressure motor to control the connection of said chamber with said passageways, and a floating ball valve governed by high level of liquid in the chamber controlling the effective application of pressure to said pressure motor, and a floating ball valve governed by low level of the liquid in the chamber controlling the exhaust from said pressure motor.

21. In a pump, a working cylinder having admission and exhaust valve means for motive fluid, a motor device governing said valve means, said motor device comprising a movable member having an outlet for the discharge of liquid from the cylinder, a floating ball valve adapted to obstruct the discharge outlet and cause movement of the motor device to govern exhaust of the motive fluid, and a floating ball valve responsive to high level governing the admission of motive fluid to the cylinder.

22. In a pump, a working cylinder having inlet and discharge means for liquid, means for admitting and exhausting motive fluid, and a pair of floating ball valves in the cylinder, one of said ball valves being responsive to low level in the cylinder to govern the means for exhausting the working cylinder, the other of said ball valves being responsive to high level in the cylinder to control the means for admitting motive fluid to the working cylinder.

23. In a pump, a working cylinder having inlet and discharge valve means for liquid, valve means for admitting and exhausting motive fluid, a pair of floating ball valves in the cylinder, motor means operated by pressure of the motive fluid to actuate said valve means, one of said ball valves being responsive to low level to govern the motor means to cause exhaust of the motive fluid from the cylinder, the other ball valve being responsive to high level in the cylinder to control admission of motive fluid to the cylinder.

24. In a pump, a pair of cylinders, a shiftable valve structure for admitting and exhausting motive fluid to and from said cylinders, a motor device for controlling said valve structure, a pair of floating ball valves for each cylinder, one ball valve being responsive to low level to govern the valve structure to exhaust motive fluid, the other ball valve being responsive to high level to govern admission of motive fluid.

25. In a pump, a pair of cylinders, a shiftable valve structure for admitting and exhausting motive fluid to and from said cylinders, a motor device for controlling said valve structure, a pair of floating valves for each cylinder, one valve being responsive to low level to govern the valve structure to exhaust motive fluid from said cylinder, the other valve being responsive to high level to govern admission of motive fluid to said cylinder, and means in each cylinder responsive to the filling of the cylinder to control the shifting of the valve structure.

26. In a pump, a pair of cylinders, a shiftable valve structure for admitting and exhausting motive fluid to and from said cylinders, a motor device for controlling said valve structure, a pair of floating valves for each cylinder, one valve being responsive to low level to govern the valve structure to exhaust motive fluid, the other valve being responsive to high level to govern admission of motive fluid and means in each cylinder responsive to filling of the other cylinder governing the exhaust of motive fluid from the first cylinder.

27. In combination, a pair of pumping chambers, main valve mechanism for admitting and exhausting pressure to and from the pump chambers, a pressure oper-

ated motor for operating said main valve mechanism, a low level controlled valve in each chamber controlling the operation of the motor, and means for exhausting the pressure from the motor independently of the main valve mechanism.

28. In combination, a pair of pumping chambers, a main valve mechanism for admitting and exhausting pressure to and from the pumping chambers, a pressure operated motor for operating said main valve mechanism, a low level valve in each chamber controlling the operation of the motor, and means for exhausting the pressure from the motor independently of the main valve mechanism, said motor having means to insure that the admission valve for one cylinder is open when it is desired to start the pump.

29. In combination, a pair of pumping chambers, inlet and discharge valves for the chambers, admission and exhaust valve means for admitting and exhausting motive fluid to and from the chambers, a motor comprising a cylinder having a double acting piston movable back and forth in said cylinder, and level controlled means in each chamber for controlling the application of pressure to the corresponding end of the motor cylinder, said admission and exhaust valve means being operated by said motor, said motor and valve mechanism being organized to hold the valve mechanism in such position that the admission valve for one chamber is open when it is desired to start the pump.

30. In combination, a pair of pumping chambers, inlet and outlet valve means for liquid, admission and exhaust valve mechanism for motive fluid, a pressure motor for operating the admission and exhaust valve mechanism, low level means in each chamber for controlling the application of pressure to the motor to govern exhaust of the motive fluid from the particular chamber, and high level means for preventing the admission of liquid from the pumping chambers to the motor.

31. In combination, a pair of pumping chambers, inlet and discharge means for liquid, admission and exhaust valve means for motive fluid, a pressure motor for operating said admission and exhaust valve mechanism, a low level float in each chamber, governing the admission of pressure to the motor to cause exhaust of the particular chamber and high level means for preventing the admission of the incoming liquid to the fluid exhaust passageway of each pumping chamber.

32. In combination, a pumping chamber having inlet and discharge means for liquid and admission and exhaust valve means for motive fluid, a motor for operating the admission and exhaust valve means, and a pilot valve operated by pressure from the chamber governing the effective application of pressure to the motor.

33. In combination, a pumping chamber having inlet and discharge means for liquid and admission and exhaust valve means for motive fluid, a motor for operating the admission and exhaust valve means, a pilot valve governing the effective application of pressure to the motor and means responsive to the level of liquid in the chamber governing the application of pressure to the pilot valve means.

34. In combination, a pumping cylinder having inlet and discharge valves for liquid, admission and exhaust valves for motive fluid, a source of motive fluid, a pressure operated valve motor, adapted to be operated by pressure from the source of motive fluid for operating the admission and exhaust valves, a pilot valve for controlling said valve motor and means operated by pressure of motive fluid from the pumping cylinder for controlling the pilot valve.

35. In combination, a pumping cylinder having inlet and discharge valves for liquid, admission and exhaust valves for motive fluid, a source of motive fluid, a pressure operated valve motor, adapted to be operated by pressure from the source of motive fluid for operating the admission and exhaust valves, a pilot valve for controlling said valve motor, means operated by pressure of motive fluid from the pumping cylinder for controlling the pilot valve, and a low level float valve governing said pressure operated means.

36. In combination, a pumping cylinder having admission and exhaust valves for motive fluid, a valve motor for operating said valves, a pilot valve for the valve motor, and a pressure element for the pilot valve adapted to communicate with the pumping cylinder when the cylinder is in condition to be exhausted.

37. In combination, a pair of pump cylinders having inlet and discharge valves for liquid, a common valve for controlling the admission and exhaust of motive fluid to and from both cylinders alternately, a duplex piston adapted to remain at either end of its stroke for operating said common valve, a pressure motor within each cylinder and a valve for each cylinder operated by the pressure motor for controlling the effective application of pressure to the piston to move the common valve.

38. In combination, a pair of pump cylinders having inlet and discharge valves for liquid, a cylinder, a duplex piston in the cylinder, a reversible valve for admitting and exhausting motive fluid alternately to and from the pump cylinders, said valve being operated by said piston, a pressure motor within each cylinder operated by the

pressure of motive fluid in the cylinder, a pilot valve controlling the effective application of pressure to the duplex piston, and a low level valve governing the effective application of pressure to the pressure motor.

39. In combination, a pair of pump cylinders having inlet and discharge valves for liquid, a reversible pressure motor, a reversible valve operated by said pressure motor, a pilot valve for each cylinder for controlling the operation of said motor, a piston in each cylinder, each piston having a discharge outlet and a low level float valve controlling the outlet in the piston, each piston being connected to the corresponding pilot valve.

40. In combination, a pair of pump cylinders having inlet and discharge valves for liquid, a head member for said cylinders, a reversible motor in said head member, a pilot valve in each cylinder for controlling said reversible motor, a reversible main valve governing the admission and exhaust of motive fluid to and from the cylinders alternately, said head member having a passageway for each pilot valve and a passageway for the main valve to each cylinder, a piston in each cylinder, each piston having an outlet for liquid, a float valve governing the outlet and controlling the effective application of pressure to the piston and means connecting the pistons with the pilot valves.

41. The combination in a pneumatic pump, a vertical cylinder, a depending air outlet pipe within the cylinder, a member carried by the lower end of said pipe and having a valve seat, a vertically movable sleeve within the cylinder, the upper end of the sleeve having means engaging said member to guide the sleeve, spring means between said means and said member for yieldingly raising the sleeve, and valves carried by the upper end of the sleeve to seat against said valve seat, a piston at the lower end of the cylinder and attached to the lower end of the sleeve, the sleeve having openings therein for the passage of water therethrough, the piston having a central opening, and a buoyant valve movable within the sleeve and seatable over the opening of the piston.

42. A pump embodying a chamber having a check-valved liquid inlet, a pressure fluid inlet, a liquid outlet and a pressure fluid outlet, means for closing the pressure fluid outlet, pressure fluid operated means for moving said means to open position when the liquid has been forced from the chamber through the liquid outlet, and a pressure fluid operated valve for the pressure fluid inlet, operable to momentarily shut off the flow of pressure fluid into said chamber, after the first mentioned means is moved to open position.

43. A pump embodying a chamber having a check-valved inlet, a pressure fluid inlet, a liquid outlet and a pressure fluid outlet, means for closing the pressure fluid outlet, means operated by the pressure fluid for moving said means to open position when the liquid has been forced from the chamber through the liquid outlet and means operated by the pressure fluid for momentarily shutting off the flow of pressure fluid from its inlet to the chamber during the interim of pressure fluid discharge after the first mentioned means is moved to open position.

44. In a pneumatic pump, the combination with a pair of pumping chambers, each provided with water inlet and outlet valves of a main air valve a fluid motor for actuating said air valve, and a valve for controlling said motor said valve having a seat mounted in the lower part of one of the pumping chambers below the low water level therein for pressure and exhaust so that a water seal will be maintained between the air in the pump chamber and the seat of said control valve.

45. In a pneumatic pump, the combination with a pair of pumping chambers, each provided with water inlet and outlet valves, of a main air valve, a fluid motor for controlling the shifting of said air valve, said motor being mounted in the lower part of the pump chamber below the low water level therein for pressure and exhaust so that a water seal will be maintained between the motor and the air in the pump chamber, and a float actuated valve to control the application of pressure to the motor.

46. In a pneumatic pump, the combination with a pump chamber and a valve for admitting compressed air to said pump chamber, of fluid actuated means for operating said valve, and means adapted to move said fluid actuated means and said valve to retain the valve in one of its extreme positions for starting the operation of the pump.

47. A fluid pressure pump comprising a pair of chambers adapted to be successively filled with liquid and to be successively emptied, a valve mechanism for admitting fluid pressure into each chamber when filled to expel the liquid therefrom said mechanism being reversible to direct pressure first into one chamber and then into the other, liquid outlets in the lower ends of said chambers, normally raised collapsible passage members forming extensions of said outlets, movable floats in the chambers adapted to contact with and close said passage members as they approach their limits of downward movement, whereby said floats may then serve as pistons to be shifted downwardly by the pressure in the chambers, normally closed valves for allowing the escape of pressure from the chambers to reverse the valve mechanism, and upright valve operat-

ing rods rising from the passage members to the valves and secured to the former, said rods also serving as guides for the floats.

48. A fluid pressure pump comprising a pair of chambers adapted to be successively filled with liquid and to be successively emptied, a valve mechanism for admitting fluid pressure into each chamber when filled to expel the liquid therefrom, said mechanism being reversible to direct pressure first into one chamber and then into the other, liquid outlets in the lower ends of said chambers, normally raised collapsible passage members forming extensions of said outlets, movable floats in the chambers adapted to contact with and close said passage members as they approach their limits of downward movement; whereby said floats may then serve as pistons to be shifted downwardly by the pressure in the chambers normally closed valves for allowing the escape of pressure from the chambers to reverse the valve mechanism, valve operating means connecting the valves and the passage members.

49. A fluid pressure pump comprising a pair of chambers adapted to be successively filled with liquid and to be successively emptied, a valve mechanism for admitting fluid pressure into each chamber when filled to expel the liquid therefrom, said mechanism being reversible to direct pressure first into one chamber and then into the other, liquid outlets in the lower ends of said chambers, normally raised collapsible passage members forming extensions of said outlets, movable floats in the chambers adapted to contact with and close said passage members as they approach their limits of downward movement, whereby, said floats may then serve as pistons to be shifted downwardly by the pressure in the chambers, normally closed valves for allowing the escape of pressure from the chambers to reverse the valve mechanism, upright valve operating rods rising from the passage members to the valves, said rods being secured to said members.

50. A fluid pressure pump comprising a pair of chambers adapted to be successively filled with liquid and to be successively emptied, a valve mechanism for admitting fluid pressure into each chamber when filled to expel the liquid therefrom, said mechanism being reversible to direct pressure first into one chamber and then into the other, liquid outlets in the lower ends of said chambers normally raised vertically movable passage members connected to said outlets, vertically movable floats in the chambers adapted to contact with and close said passage members as they approach their limits of downward movement, whereby said floats may then serve as pistons to be shifted downwardly by the pressure in the chambers, normally closed valves for allowing the escape of pressure from the chambers to reverse the valve mechanism and upright valve operating rods rising from the passage members to the valves and secured to the former, said rods also serving as guides for the floats.

51. A fluid pressure pump comprising a pair of chambers adapted to be successively filled with liquid and to be successively emptied, a valve mechanism for admitting fluid pressure into each chamber when filled to expel the liquid therefrom, said mechanism being reversible to direct pressure first into one chamber and then into the other, liquid outlets in the lower ends of said chambers, normally raised vertically movable passage members connected to said outlets, vertically movable floats in the chambers adapted to contact with and close said passage members as they approach their limits of downward movement, whereby said floats may then serve as pistons to be shifted downwardly by the pressure in the chambers, normally closed valves for allowing the escape of pressure from the chambers to reverse the valve mechanism, valve operating means connecting the valves and the passage members.

52. A fluid pressure pump comprising a pair of chambers adapted to be successively filled with liquid and to be successively emptied, a valve mechanism for admitting fluid pressure into each chamber when filled to expel the liquid therefrom, said mechanism being reversible to direct pressure first into one chamber and then into the other, liquid outlets in the lower ends of said chambers, normally raised vertically movable passage members, connected to said outlets vertically movable floats in the chambers, adapted to contact with and close said passage members as they approach their limits of downward movement, whereby said floats may then serve as pistons to be shifted downwardly by pressure in the chambers, normally closed valves for allowing the escape of pressure from the chambers to reverse the valve mechanism upright valve operating rods rising from the passage members to the valves, said rods being secured to said members.

53. A fluid pressure pump comprising a pair of chambers adapted to be successively filled with liquid and to be successively emptied, a valve mechanism for admitting fluid pressure into each chamber when filled to expel the liquid therefrom, said mechanism being reversible to direct the pressure first into one chamber and then into the other, liquid outlets in the lower ends of the chambers, normally raised vertically movable passage members connected to said liquid outlets, vertically movable floats in the chambers adapted to contact with and

close said passage members as they approach their limits of downward movement, whereby said floats may then serve as pistons to be shifted downwardly by the pressure in the chambers, normally closed valves in the upper ends of the chambers for allowing the escape of pressure to reverse the valve mechanism, and upright valve operating rods secured at their lower ends to the passage members and having their upper ends connected with the valves, the floats being guided to seat upon said passage members.

54. In combination, a pump chamber having a main admission and exhaust port, a main valve for said port, motor means for operating said main valve, a pressure operated motor controlled by low level of water within the chamber, a vent valve operated by said pressure motor for controlling the reversal of said main valve, and auxiliary valve means for insuring a full throw of the main valve by said motor means.

55. In combination, a pump chamber having liquid inlet and outlet check valves, a main air valve for controlling admission and exhaust of motive fluid, motor means for said main valve, a vent port communicating with the chamber, a vent valve controlling the port, a fluid pressure motor communicating with the interior of the pump chamber and controlled by low level conditions therein for opening the vent valve and a quick-acting valve controlled by the vent valve for governing the operation of the motor means to cause a complete reversal of the main valve.

56. In combination, a pump chamber having liquid inlet and outlet check valves, a port for admitting motive fluid, another port for permitting the escape of motive fluid from the pump chamber, a valve controlling said last port, said valve being pressed against its seat by pressure, and a pressure motor controlled by low level conditions within the chamber and adapted to be operated by pressure within the chamber for moving said valve off of seat, said pressure motor comprising a flexible diaphragm member.

57. In a pump of the character described, a pump member having water inlet and discharge valves, a main admission and exhaust passageway, a valve controlling the connection of said passageway with pressure or exhaust, a motor for operating said valve, and a float controlled by high level conditions within the chamber for closing off said passageway to permit pressure to accumulate in the top of the chamber to cause operation of the motor.

58. In combination, a pair of water chambers having the usual inlet and discharge water valves, vent passages for permitting the escape of pressure from said chambers, valves seating with pressure within the chambers controlling said vent passages and motor means operated by pressure within the chambers and controlled by low level conditions therein for moving said valves away from their seats against the pressure within the chambers.

59. In combination, a pair of pump chambers having the usual liquid inlet and discharge valves, a main valve for admitting motive fluid to and exhausting the same from the chambers alternately, a fluid pressure motor for operating said main valve mechanism, vent valves controlling said pressure motor, said vent valves being pressed against their seats by pressure of motive fluid within the chambers, motor means comprising movable seat members below the low water level within the chambers, through which seat members the water is discharged from the chambers, and float means responsive to low level conditions for closing said seat members and subjecting them to the pressure within the chambers for opening said vent valves.

60. In combination, a pump having a pump chamber with the usual liquid inlet and discharge check valves, an air port leading from the chamber, said air port serving to permit pressure from within the chamber to escape, a valve member pressed against its seat by the pressure of the motive fluid within the chamber, said valve controlling said port, a spring for applying the valve to its seat and a fluid pressure motor for moving the valve from its seat against the pressure of the motive fluid within the chamber, said pressure motor being controlled by low level conditions within the chamber to operate said valve, and a main valve member adapted to be operated by the air permitted to escape from said valve member.

61. In a pump a pumping cylinder having inlet discharge valves for liquid, a main motive fluid control valve, a fluid operative motor for operating said main valve, a pilot valve within the cylinder, said pilot valve seating with the pressure of the motive fluid, a fluid operative motor for said pilot valve and a level controlled valve governing the operation of said last motor.

62. In combination, a pumping cylinder having check valves for liquid, a main valve for motive fluid, a pressure motor for operating said main valve, a pilot valve controlling said motor, a second pressure motor for operating said pilot valve, and a valve controlled by the discharge of water from the pumping cylinder for governing the operation of said second pressure motor.

63. In a pneumatic pump having a pumping chamber with check valves for liquid, a main air valve, a main pressure motor for said valve, a pilot valve controlled by low

level of liquid in the chamber, and a control valve governed by the discharge of air from the chamber for governing said main motor, said control valve being actuated only when air escapes freely through the pilot valve.

64. In combination, a pumping chamber having the usual liquid inlet and outlet check valves, a main air valve, a main motor for operating said air valves, a control valve governing the effective application of pressure to the main motor a pilot valve controlled by a low level of liquid in the chamber for operating said control valve, said control valve having a bleeder port to prevent leakage from the pilot valve actuating the control valve.

65. In combination, a pumping chamber having check valves for liquid, a main air valve, a main pressure motor for operating the main valve, a pilot valve, a motor for the pilot valve, said motor being controlled by low level of liquid in the chamber, and a fluid pressure operated control valve governed by the discharge of air at a predetermined rate from the chamber through the pilot valve, said control valve governing the effective application of pressure to the main motor.

66. In combination a chamber having the usual check valves for liquid, a main air valve, a main motor for operating said air valve, a pilot valve controlled by a low level of water in the chamber for controlling the main motor, and a control valve having a differential pressure member and a leakage port said control member controlling the effective application of fluid pressure to the main motor.

67. In combination a main air valve having a balanced duplex piston for operating the same, ports controlling the exhaust of motive fluid from the ends of the balanced piston, valves governing said ports and low level control vent valves governing the operation of said control valves.

68. In combination, a pumping chamber, a main air valve mechanism for said pumping chamber, a motor for operating said main valve mechanism, a vent valve communicating with the interior of the pumping chamber for causing operation of the motor, said vent valve being controlled by a low level of liquid in the chamber, and a bleeder port for preventing leakage of the low level controlled vent valve from operating the motor.

69. In a pneumatic pump the combination with one pump chamber of a second pump chamber, each of said pump chambers being provided with water inlet and outlet valves and air inlet and exhaust valves, two fluid pressure motors differing in power for operating said valves and means to control the said fluid pressure motors to cause the actuation of the air inlet and air exhaust valves when the water in the main pump chamber reaches predetermined levels.

70. In a pneumatic pump the combination with the main pump chamber of a supplementary pump chamber, each of said pump chambers being provided with water inlet and outlet valves and air inlet and air exhaust valves, two fluid pressure motors differing in power and responding to conditions existing in the main pump chamber to actuate the air inlet and air exhaust valves, two fluid pressure motors differing in power and responsive to conditions existing in the main pump chamber to actuate the air inlet and air exhaust valves from both pump chambers, and means to control the said fluid pressure motors to cause the actuation of the air inlet and air exhaust valves when the water in the pump chamber reaches predetermined levels.

71. In combination, a pair of pumping chambers connected to a common discharge main, said chambers having each intake and discharge check valves for liquid, air valve mechanism for admitting and exhausting compressed air to and from these chambers alternately, and a high level float in one chamber controlling the exhaust of pressure from the other chamber.

72. In combination, a pair of pumping chambers connected to a common discharge main, said chambers having each intake and discharge check valves for liquid, air valve mechanism for admitting and exhausting compressed air to and from the chambers alternately, a low level float in one chamber governing the exhaust of said one chamber and the admission of compressed air to the other chamber, and a high level float in one chamber for governing the exhaust of the other chamber and the admission to said one chamber.

73. In combination, a pair of pumping chambers connected to a common discharge pipe, each chamber having inlet and discharge valves for liquid, a main air valve mechanism comprising means for admitting and exhausting compressed air to and from the chambers alternately and two motor pistons for shifting said means, high level means in one chamber for controlling the operation of one of said motor pistons to cause exhaust of the other chamber and low level means in said one chamber for controlling the other motor piston to cause exhaust in said one chamber.

74. In combination, a pair of pumping chambers connected to a common discharge pipe, each chamber having inlet and discharge valves for liquid, a main air valve mechanism comprising means for admitting and exhausting compressed air to and from the chambers alternately and two motor pistons for shifting said means, high level

means in one chamber for controlling the operation of one of said motor pistons to cause exhaust of the other chamber and low level means in said one chamber for controlling the other motor piston to cause exhaust in said one chamber, and a low level valve in the other chamber for preventing the air in said chamber from blowing into the discharge pipe when said chamber is emptied.

In witness whereof I hereunto subscribe my name this 28th day of September A. D. 1915.

BURTON S. AIKMAN.