

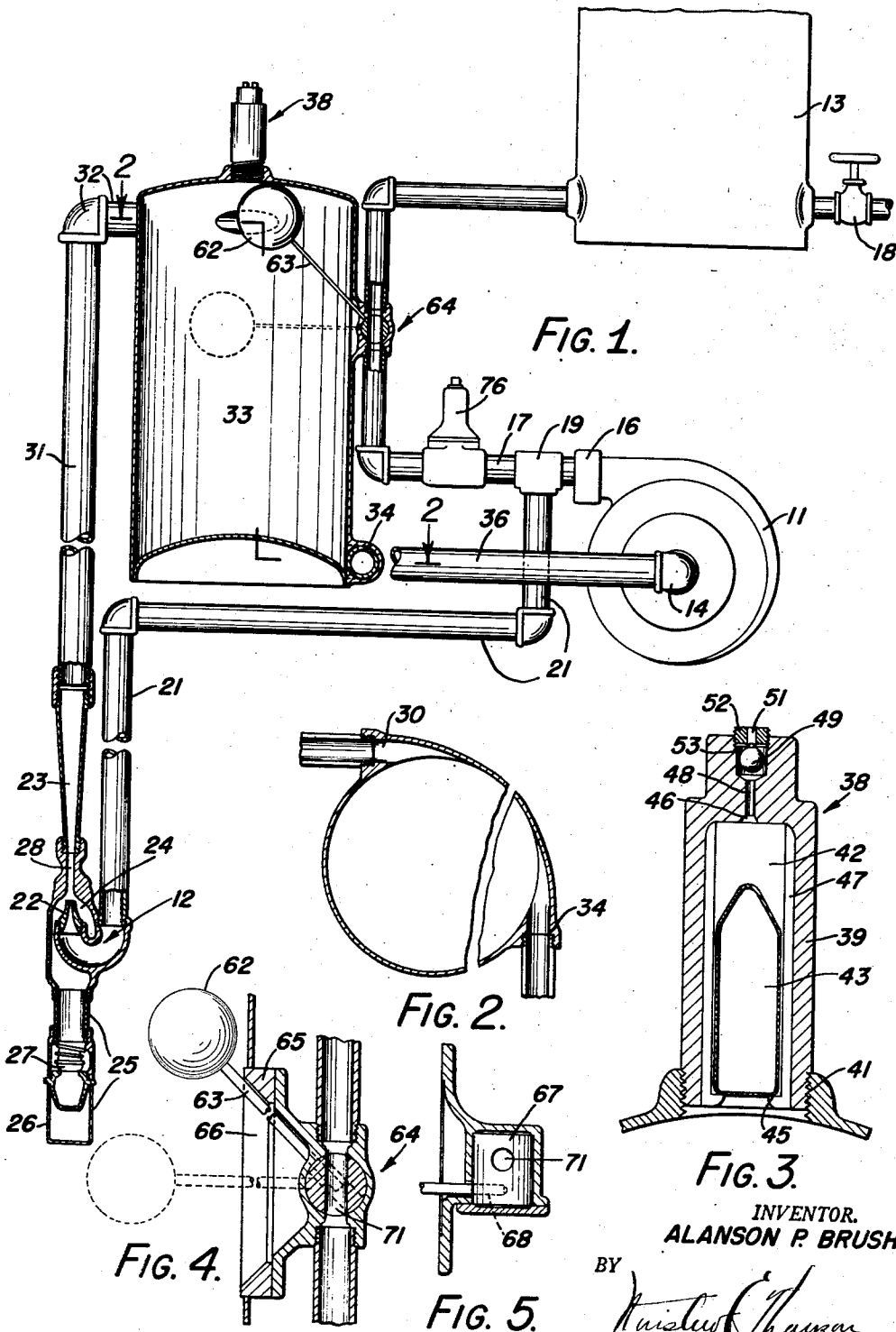
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A. P. BRUSH
APPARATUS FOR CONTROLLING THE OPERATION
OF DOMESTIC WATER SYSTEMS

2,651,259

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

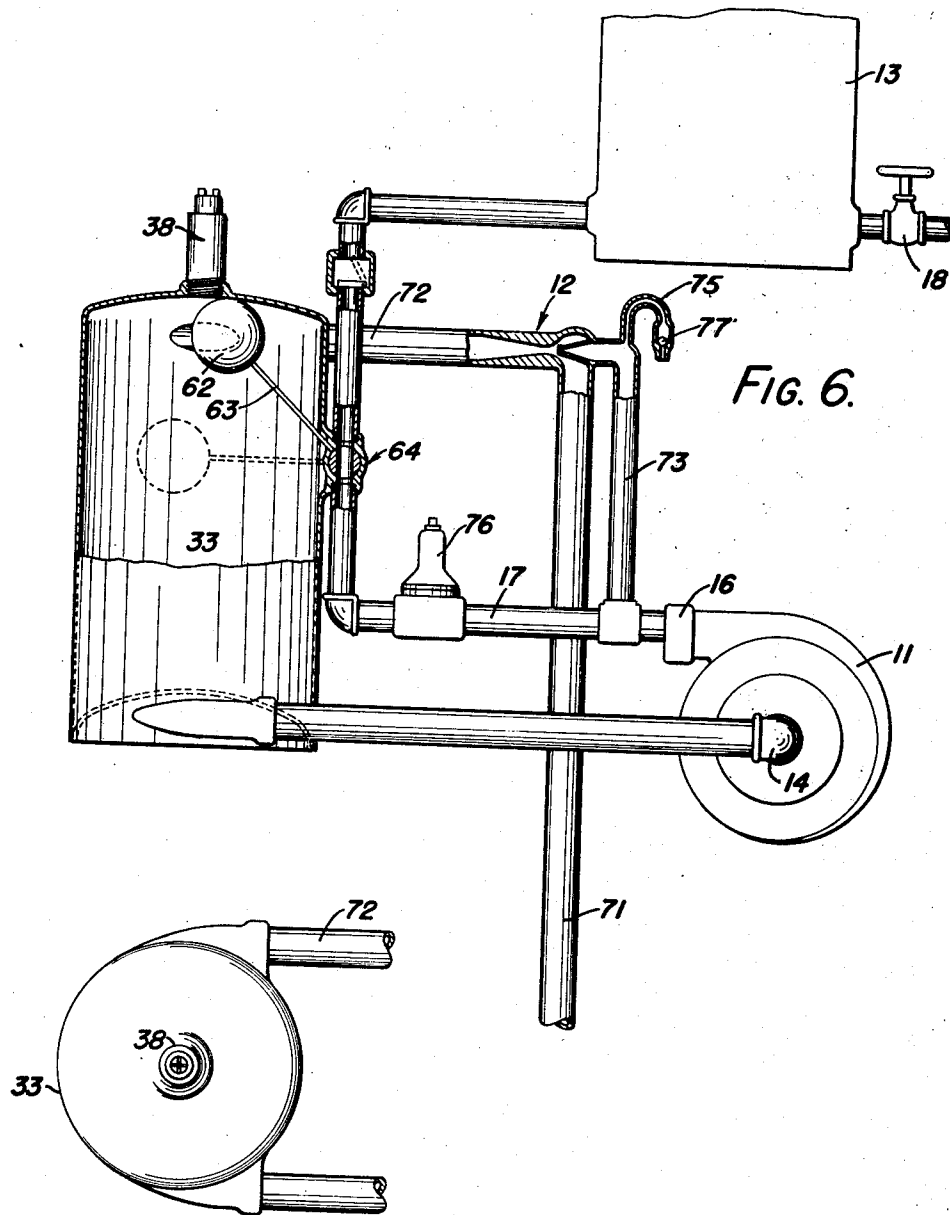


FIG. 7.

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APPARATUS FOR CONTROLLING THE OPERATION OF DOMESTIC WATER SYSTEMS

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Application May 20, 1949, Serial No. 94,407

9 Claims. (Cl. 103-5)

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My invention relates to pumping apparatus or systems and is more particularly directed to a method and apparatus for controlling the operation of a so-called jet-centrifugal system to prevent the system and, in particular, the centrifugal pump thereof from becoming air bound or losing its prime.

The method and apparatus of my invention has been particularly designed for domestic water service for automatically supplying a farm or other building removed from municipal water service facilities, with water from a well, lake or stream. However, the method and apparatus of my invention may have other uses such as the pumping of liquids in industrial plants in which case a pneumatic tank may or need not be employed. The apparatus and method of my invention will be shown and described in connection with the operation of both a deep well system and a shallow well system since broadly the principles of my invention may be applied to both systems.

By a deep well system is meant one in which the jet pump of the jet-centrifugal system is located in the well, the distance from the normal water level to the ground level being usually well in excess of 33.9 feet (the theoretical practical limit of use of a shallow well system). In a deep well system, two drop pipes extend down to the jet pump in the well, one for supplying water under pressure from the centrifugal pump to activate the jet pump and draw water from the well, and the other the suction pipe through which water flows from the jet pump to the centrifugal pump. A shallow well system is one in which the distance from the ground level to the water level is less than 33.9 feet but allowances for losses and adequate margins of safety limit the application of a shallow well system to substantially less than that depth of well.

In a so-called jet-centrifugal system which comprises the combination of a jet pump and a centrifugal pump, the system is extremely vulnerable for its efficient and, in some cases, its continued operation to the presence of air in the system. This air may enter the system in a number of different ways. It may enter the system through leaks in the long lengths of piping which may extend 100 feet or more into the ground. Of course such leaks should be repaired as soon as practical but often-times it is not convenient for the farmer immediately to tear up the piping for repair. It is therefore, desirable that the system be arranged so that it may at least temporarily function to supply water until the farmer has time to shut it down for repair.

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Another way in which air or gases enter the system is through or carried by the water being pumped. A significant portion of water wells contains gases or air, the amount thereof varying from well to well. Most frequently the amount of air present is insufficient to cause conventional jet-centrifugal systems to discontinue their functioning although the presence of air or gas reduces the efficiency of the jet pump, the centrifugal pump and the efficiency of the entire system insofar as its ability to pump its normal water capacity and develop its normal pressure. In other wells, the quantity of air or gases present in the water being pumped is sufficient to prevent the conventional jet-centrifugal system from operating at all. In such cases the air drawn into the system with the water being pumped accumulates in the system by reason of the fact that the air is not removed. This air recirculates back to the jet pump through the pressure pipe and augments the air entering the system with the water drawn from the well. The continuous accumulation of air in the system without any adequate means for its disposal from the system causes the water to become aerated to an extent sufficient that the centrifugal pump becomes air bound and ceases to function. Under such conditions the jet-centrifugal system must be manually reprimed with water.

Still another cause of air entering a jet-centrifugal system arises due to the fact that in dry spells the water level in a great many wells drops. If the drought is of continued duration, the end of the suction pipe may become uncovered due to the fact that the capacity of the system draws water from the well at a faster rate than water enters the well. Under such circumstances the end of the suction pipe may be uncovered for a length of time sufficient to draw enough air into the system to cause the centrifugal pump to become air bound and discontinue functioning. When the water level rises to an extent sufficient to again cover the end of the suction pipe, the system has lost its prime of water and will be incapable of withdrawing water from the well for use.

In the above discussion I have employed the expression "conventional jet-centrifugal system" as meaning one in which no or inadequate means is employed for disposing of the air which may enter the system in any one of the ways described above. The term "conventional jet-centrifugal system" is not intended to mean a system such as shown and described in Mann Patent No. 2,257,507 issued September 30, 1941. In that system means are provided on the discharge side of

the centrifugal pump for continuously removing air from the system; discharging that removed air into the pneumatic tank; and preventing it from recirculating back to the jet pump and accumulating in any substantial quantities likely to cause the system to become air bound. The method and apparatus of my invention, unlike that shown in the above mentioned Mann patent, is designed to remove the air entering the system in any one of the ways mentioned above and discharge it from the system prior to its entry into the suction of the centrifugal pump. The same above described considerations are also applicable to a shallow well system although in a shallow well system the problems are not so acute.

An object of my invention is to provide a novel method and apparatus adapted for both shallow and deep well systems which is simple in construction and operation and adapted to remove automatically from the system any air which may be drawn into the system before it has an opportunity to enter the suction of the centrifugal pump.

Another object of my invention is to provide a jet-centrifugal system for both shallow and deep wells which is reliable in operation and which is designed to prevent any substantial amount of air which may get into the system from circulating through the centrifugal pump and recirculating to and through the jet of the jet pump to the end that the jet pump and the centrifugal pump are maintained at maximum efficiency.

A further object of my invention is to provide a jet-centrifugal system wherein means are provided on the suction side of the centrifugal pump for continuously removing such air as may enter the system to the end that the centrifugal pump is at all times required to handle only water from which substantially all the air has been removed whereby it will continuously function to maintain the system at full efficiency, full water pumping capacity and full pressure regardless of whether air is entering the system; the system further being so constructed and arranged that if the quantity of air entering the system is extremely large, or if the supply of water from the well is entirely cut off, the discharge from the centrifugal pump to the pneumatic tank is automatically closed so as to retain a body of water in the system sufficient that when water in sufficient quantities again enters the suction pipe the system will automatically recover without any attention on the part of the owner thereof and regain its ability to discharge water into the pneumatic tank for use.

My invention further contemplates a jet centrifugal system in which an air separating chamber is employed on the suction side of the centrifugal pump wherein air may separate from the water and be discharged from the air separating chamber, the air separating chamber being provided with a float control arranged to actuate a valve located between the discharge of the centrifugal pump and the pneumatic tank; the valve being retained open when sufficient water is present in the air separating chamber and arranged to close automatically before the water level in the air separating chamber drops to a level such that the centrifugal pump is likely to draw air in any substantial quantities from the air separating chamber, to the end that the system is completely protected and water will at all times be retained therein in sufficient quantities to maintain the system primed.

Other objects and advantages of my invention will be particularly pointed out in the claims and will be apparent from the following description, when taken in connection with the accompanying drawings, in which:

Fig. 1 is a view largely diagrammatic of a deep well jet-centrifugal system having incorporated therein the novel apparatus of my invention and which is adapted to carry out my novel method of protecting the system from becoming air bound;

Fig. 2 is a sectional view taken substantially on the line 2—2 of Fig. 1;

Fig. 3 is an enlarged section of an air escape valve suitable for use with the novel apparatus of my invention;

Fig. 4 is an enlarged sectional view of the float and the float controlled valve adapted to close the delivery from the pump to the pneumatic tank or other point of use under certain conditions of operation;

Fig. 5 is a top plan view of the valve with the housing which contains it being shown in section;

Fig. 6 is a diagrammatic view similar to Fig. 1 showing an arrangement wherein the principles of my invention are incorporated in a shallow well system; and

Fig. 7 is a plan view of a portion of Fig. 6 showing the arrangement of the inlet and outlet to the air separating chamber or air trap.

In the drawings I have shown (Fig. 1) a centrifugal pump 11, a jet pump generally indicated by the numeral 12 and a pneumatic tank 13 comprising the principal parts of a jet-centrifugal pumping system. These same principal parts are duplicated in the shallow well system of Fig. 6.

While I have shown only the exterior casing of the centrifugal pump since centrifugal pumps are well known in the art, it need not be more particularly described. In general, the pump may be mounted with its axis of rotation horizontal or vertical and includes a suction 14 and a discharge 16. While I have shown a centrifugal pump it will be obvious that other types of pumps may be employed. However, since the problem of air handling by the pump and the effects of air getting into the system is not serious in connection with a positive displacement pump, this invention is primarily directed to such systems as employ centrifugal pumps or other non-positive displacement types of pumps. A centrifugal pump will handle only limited quantities of air without losing its prime and even limited quantities of air seriously affect its efficiency and its ability to develop normal pressures.

The discharge of the centrifugal pump is connected by a pipe 17 to the pneumatic tank 13 which may have an outlet faucet 18 and is usually connected by an outlet (not shown) to the house service lines. Any suitable means (not shown) may be provided for admitting air to the system for the purpose of replenishing the air in the pneumatic tank and maintaining a sufficient quantity of air therein to provide the necessary pneumatic cushion for forcing the water under pressure from the pneumatic tank to the point of use.

As shown in the drawings, the pipe 17 is provided with a T 19 preferably located adjacent the centrifugal discharge 16. A pipe 21 is connected to the T and is adapted to convey part of the water discharged by the centrifugal pump under pressure to the jet pump 12.

The jet pump 12 may be of conventional construction and comprises a nozzle 22 and a dif-

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fuser 23. As is well understood in the art, the nozzle converts the pressure energy supplied to it by the centrifugal pump into velocity energy, a stream of water issuing from the tip of the nozzle at high velocity. The velocity of the stream creates a subatmospheric pressure in the space 24 adjacent the nozzle. The pressure of air on the surface of water in the well forces the water up the well pipe 25 through a strainer 26 and a check valve 27 to satisfy the subatmospheric pressure existing in the space 24. The combined streams of liquid, that issuing from the nozzle 22 and that drawn from the well, flow through the mixing chamber 28 of the diffuser where the velocities of the two streams are made more nearly uniform. The combined stream then flows through the outwardly flaring portion of the diffuser where the velocity energy of the water is converted into pressure energy. As is well understood in the art the pressure developed by the jet pump is added to that developed by the centrifugal pump to increase the overall pressure developed by the system, in some cases doubling that pressure.

The water under pressure flows upward through a suction pipe 31. From the suction pipe the flow of water is through an elbow and nipple 32 into an air separating chamber 33 or what might be termed an air trap. As shown at 30 (Fig. 2) the water enters the air separating chamber preferably in a tangential direction. Preferably at the bottom of the air separating chamber 33 an outlet 34 is provided which through suitable connections is connected to a suction pipe 36 which connects with the suction 14 of the centrifugal pump. Preferably the outlet 34 is arranged tangentially of the air separating chamber. The tangential inlet and outlet cause the water to rotate in the air separating chamber which tends to cause the water to seek the outer portions of the air separating chamber while the lighter air tends to flow toward the center of the air separating chamber and rise toward the top thereof.

Adjacent the entrance end of the air separating chamber 33, a baffle may be provided, if desired, for the purpose of cutting down the turbulence in the air separating chamber which might be caused by the water freely entering the chamber. Adequate air separation is dependent upon slowing down the velocity of liquid which in this case is accomplished by the relatively large volume of the air separating chamber 33 and by introducing the water into the air separating chamber in a manner such as to create as little turbulence as possible. Adequate air separation is further assisted by the rotary motion imparted to the water as previously mentioned.

By employing an air separating chamber of relatively large volume, minimizing turbulence and circulating the water in the air separating chamber, substantially all the air is removed from the water except such air as may be held by the water in solution and such small amounts of air as may be held in suspension. This separation occurs prior to the water reaching the bottom outlet 34 from the air separating chamber. Thus the water flowing to the suction 14 of the centrifugal pump through the pipe 36 is substantially air free, regardless of whether air is entering the system in one of the ways above mentioned.

For the purpose of removing air from the system on the suction side of the centrifugal pump and preventing it from passing thereto, I have

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provided the top of the air separating chamber with suitable means for permitting the escape of air from the air separating chamber, whenever a pressure above atmosphere exists in the air separating chamber without permitting escape of water. Such means may comprise a combined air valve and check valve generally indicated by the numeral 38. The valve may comprise a valve body or casing 39 which is connected into the top of the air separating chamber as shown at 41. The casing has a generally cylindrical chamber 42 therein adapted to house a float valve 43.

The float valve element 43 is adapted normally to seat upon a valve seat 46, the upper end of the valve element being partly spherical to provide for accurate seating. The valve chamber has guides 47 with respect to which the float valve is free to float by reason of the clearance allowed and in accordance with the water level existent in the chamber 42. The lower ends of the guides are turned inward to provide a stop 45 for the float valve. Above the valve seat is a bore 48 which terminates in a ball valve chamber having a ball valve element 49 therein. The ball valve chamber except for an air escape passage 51 is closed by a plug 52. The lower end of the plug 52 has a rib or ribs 53 to prevent the ball valve element 49 from closing the air escape passage 51. When air even under a slight pressure enters the space beneath the ball valve element, the ball is lifted to allow the escape of air to atmosphere through the passage 51.

When the system is operating normally with little or no air entering the system, the float valve 43 is maintained against its seat 46 due to the float action of the float. If, however, any air is separated out in the air separating chamber 33, that air rises and enters the float chamber 42 and flows to the top thereof. With any substantial amount of air in the float chamber, the float valve 43 lowers and leaves its seat. This action allows the air to escape until the water level again rises to close the valve 43-46. Thus the valve 43-46 can be open only during periods when a volume of air is in the chamber 42 sufficient to cause the float valve 43 to leave its seat. As soon as the chamber 42 is filled with water the valve 43-46 seats and the system is tightly sealed against the escape of water. The air passing the valve 43-46 rises upward, opens the ball valve 49 and the air is allowed to escape assuming a pressure above atmosphere in the air separating chamber. Whenever a subatmospheric pressure exists in the air separating chamber the ball valve 49 is closed and prevents the entry of air into the system.

The condition illustrated in Fig. 3 is one during which air is entering the system. Under normal conditions of operation, when no air is entering the system in any one of the ways set forth above, the water level will be above that shown and the water level will in fact extend up to the valve 43-46. The condition illustrated in the drawings is one during which relatively large quantities of air are entering the system and the top of the air separating chamber up to the valve 43-46 is filled with air separated from the water entering the system, through the suction pipe. It will be noted that the valve 43-46 is open.

Mounted in the air separating chamber is a float 62 which is connected by a float stem 63 to a cylindrical valve 64. For this purpose the float stem 63 extends through an elongated slot

shaped opening 66 formed in a fixture 65 mounted in the wall of the air separating chamber. The float stem extends into a valve chamber 67. The float stem is threaded into the valve, as indicated at 63. The valve 64 has a through water passage 71.

The air separating chamber 33 and the air handling capacity of the air outlet 38 are sufficient in air separating and removing capabilities to take care of most normal conditions of operation including those encountered in a moderately aerated or gaseous well. That is, the system will continuously operate with the centrifugal pump handling substantially air free water and the air being continuously removed from the air separating chamber in the manner described above.

However, when abnormal well conditions are encountered as in the case of a particularly gaseous well or under drought conditions, the water level may be pumped to below the end of the suction pipe so that air or water mixed with air may enter the system. The air may enter the system in such large quantities that it cannot be exhausted from the air separating chamber rapidly enough. Particularly under the latter condition when air in considerable quantities is entering the suction pipe, the water in the air separating chamber 33 will be depleted and the float 62 will drop. As the float drops, the valve 64 gradually throttles the flow of water to the pneumatic tank and when in its lower position, indicated in dotted lines, the flow of water to the pneumatic tank is entirely cut off.

The system is arranged so that when the valve 64 closes sufficient volume of water is retained in the air separating chamber, the piping and in the pump casing to maintain a body of liquid therein sufficient so that a circulation of water through the system occurs. The valve is arranged for purposes of illustration so that it closes when moved through approximately 45 degrees at which point of closing the air separating chamber still retains a substantial volume of water. That is, the centrifugal pump is flooded and maintains a continuous circulation through the pipe 21, down to the jet pump 12. This flow of water continuously draws in air through the foot valve. This air, as described above, is discharged through the air outlet. Since the discharge of water from the system is cut off, a residual body of water is maintained in the system.

The air separating chamber 33 should be of sufficient volume to replace any water in the system that has been lost due to the foot valve being exposed to atmosphere and air entering the suction pipe. When the valve 64 closes and shuts off the flow to the pneumatic tank, a body of liquid should be retained in the system sufficient in volume to maintain the piping full of water with circulation by the centrifugal pump still continuing. Under such conditions the system will continuously pump air and any water which may be available, discharging the air through the air outlet 38.

When the flow of liquid to the well returns to normal the valve will automatically open and normal pumping will again be restored. Assuming the flow of water to the well is of sufficient quantity, the air will gradually be exhausted from the air separating chamber 33, the float 62 will rise and open the valve 64 at which time water will flow to the pneumatic tank. Should the end of the suction pipe be again exposed to air, as is likely to occur during a dry spell, the float 62 will

again drop to close the valve 64 and retain a body of liquid in the system sufficient to insure starting of the system when the water level again covers the end of the suction pipe. The only condition which may arise which will require the attention of the operator is that an extended dry spell may result in evaporation of the water in the system thus requiring that the system be re-primed.

Thus the system is automatic in operation, being capable of withdrawing, without substantially any possibility of failure, whatever flow of water occurs into the well. Moreover, regardless of the conditions of operation, the flow of water to the centrifugal pump is substantially air free so that the efficiency of the centrifugal pump is maintained. Moreover, the water flowing through the pressure pipe 21 to the nozzle of the jet pump is always substantially air free so that that unit is maintained at its maximum efficiency.

If, as is usual in the case of a dry spell the flow of water into the well is merely less than the full capacity of the system, the system will reach a condition of equilibrium in which the valve 64 is in a throttling position, throttled so as to cut down the flow of water to the pneumatic tank to equal the flow of water into the well. The system will supply to the pneumatic tank all the water flowing into the well without any attention on the part of the owner.

The above described conditions of operation may exist when very large quantities of air enter the system. When air in smaller quantities enters the system, the system will discharge that air to atmosphere without air accumulating in the air separating chamber in sufficient quantities to cause the float 62 to drop. This results from the fact that air is discharged from the air separating chamber whenever a pressure above atmosphere exists therein. In any event, when the system stops under the control of the usual pressure switch with which such systems are provided, the pressures on opposite sides of the centrifugal pump equalize and all air present is discharged from the air separating chamber. In other words, any air in the air separating chamber is discharged therefrom each time the system cycles and the float drops only under abnormal conditions of operation. As previously mentioned the valve during closing throttles the discharge. If desired, this throttling action may be eliminated by a snap action valve. If desired, for example, the float may be arranged to open and close contacts which energize a solenoid. The solenoid in turn controls the valve 64. By this means a snap action of the valve 64 may be secured to avoid the throttling effect above mentioned.

In the drawings I have shown a pressure control valve 76 in the line between the discharge of the centrifugal pump and the valve 64. This valve is adapted to be set for maintaining a predetermined pressure of water on the nozzle 22 of the jet pump 12. It may be of the same construction as that shown in the Mann patent above mentioned, the valve being indicated in that patent generally by the numeral 79. The valve 76, as the corresponding valve of the Mann patent, opens at a predetermined pressure and remains open as long as the pressure in the system is above the set point regardless of whether the pump is running or not.

In Figs. 6 and 7, I have illustrated the application of my invention to a shallow well system. The function and operation of the centrifugal pump 11, the jet pump 12, the pneumatic tank

13, the air separating chamber 33, the air relief valve 38 and the valve 64 and its controlling float 62 are essentially the same as in the deep well system above described. However, in the shallow well system no foot valve is required. A single pipe 71 extends into the well through which water is drawn from the well. The jet pump 12 is located preferably above the centrifugal pump and water flows from the diffuser of the jet pump through pipe 72 into the air separating chamber. The nozzle of the jet pump receives part of the water discharged by the centrifugal pump through a pipe 73.

Preferably between the valve 64 and the pneumatic tank 13 a check valve is provided so that when the system reaches the shut off pressure and the motor is stopped by the usual pressure switch, water from the pneumatic tank cannot back flow through the system to cause a drop in pressure in the pneumatic tank to atmospheric pressure.

The system is provided with a syphon breaker to prevent the draining of the water from the air separating chamber and the centrifugal pump casing when the pump is stopped. The syphon breaker may comprise a pipe 75 extending into the pipe 73 which is in the form of an inverted U. The other end of the U is formed with a valve seat upon which a ball valve 77 seats to normally close the inlet to the pipe 75 when the system is operating under pressure. When the system reaches shut-off pressure, the water tends to drop down the suction pipe creating a subatmospheric pressure which opens the ball valve, breaks the syphon and prevents the air separating chamber and the centrifugal pump from being drained.

It will be noted that suction pipe 71 together with the air separating chamber and the pipe 72 form a U loop on what may be termed a knee bend extending well above the level of the centrifugal pump. The syphon breaker and knee bend protect the centrifugal pump and the air trap from being drained of water. In the shallow well system I have also shown a pressure control valve 76 which, although not essential in a shallow well system, is advantageous under some conditions.

The operation is essentially the same as in the deep well system except that the necessity of employing a check valve in the line between the centrifugal pump and the pneumatic tank prevents the discharge of air from the air separating chamber each time the pump cycles. If a check valve is used in the suction pipe the operation is identical.

While I have described my method of operating a jet centrifugal system and have described an apparatus for carrying out that method, it will be obvious that various changes may be made therein particularly in the form and relation of parts without departing from the spirit of my invention as set forth in the appended claims.

I claim:

1. A water system connected to a source of water supply comprising, in combination, a centrifugal pump, a jet pump and a pneumatic tank, said system having connections arranged so that water under pressure is supplied from the centrifugal pump to the jet continuously when the system is in normal operation, water is drawn from the source of supply into the suction of the jet pump, the combined stream of water flows from the discharge of the jet pump to the

suction of the centrifugal pump and the water discharged by the centrifugal pump passes to the pneumatic tank except for such water as is continuously recirculated to the jet of the jet pump, an air trap between the discharge of the jet pump and the suction of the centrifugal pump adapted normally to contain a substantial volume of water and in which air and water separation may occur so that the water supplied to the centrifugal pump is substantially air free, means for automatically releasing air from said air trap to atmosphere comprising a float valve having a seat against which it is normally pressed, a valve in the connection to the pneumatic tank from the discharge of the centrifugal pump, and mechanical means in the air trap connected to said second valve for closing said second valve when the water in the air trap falls to a predetermined level.

2. A water system connected to a source of water supply comprising, in combination, a centrifugal pump, a jet pump and a pneumatic tank, said system having connections arranged so that water under pressure is supplied from the centrifugal pump to the jet continuously when the system is in normal operation, water is drawn from the source of supply into the suction of the jet pump, the combined stream of water flows from the discharge of the jet pump to the suction of the centrifugal pump and the water discharged by the centrifugal pump passes to the pneumatic tank except for such water as is continuously recirculated to the jet of the jet pump, an air trap between the discharge of the jet pump and the suction of the centrifugal pump adapted normally to contain a substantial volume of water and in which air and water separation may occur so that the water supplied to the centrifugal pump is substantially air free, means for automatically releasing air from said air trap to atmosphere comprising a float valve having a seat against which it is normally pressed, a valve in the connection to the pneumatic tank from the discharge of the centrifugal pump, a float in said air trap the position of which is determined by the water level in the air trap, and a connection between said float and said second valve for progressively closing the second valve as the water in the air trap drops.

3. A system as set forth in claim 2 wherein the water level in the air trap when said valve is closed is above the level of the centrifugal pump and a syphon breaker is provided in the connection from the centrifugal pump to the jet which opens when the pump stops to prevent draining of water from the air trap and the centrifugal pump.

4. In combination, a power driven water pump, a jet pump connected to a source of water supply, a connection from the discharge of said power driven pump to the jet of said jet pump, an air trap for accumulating a substantial volume of water, a connection from the discharge of said jet pump to said air trap, an air outlet valve for said air trap, a connection from said air trap to the intake of said power driven pump for supplying said pump intake with substantially air free water, a second connection from the discharge of said power driven pump for delivering water therefrom, means including a valve in said second connection for preventing delivery of water therethrough whenever a predetermined volume of air has accumulated in said air trap until at least some of the accumulated air in said air trap has been discharged through the afore-

said air outlet valve, a pneumatic tank connected to said second connection, and a pressure control valve in said second connection for maintaining at least a minimum pressure on the jet of said jet pump.

5. In combination, a power driven water pump, a jet pump connected to a source of water supply, a connection from the discharge of said power driven pump to the jet of said jet pump, an air trap for accumulating a substantial volume of water, a connection from the discharge of said jet pump to said air trap, an air outlet valve for said air trap, a connection from said air trap to the intake of said power driven pump for supplying said pump intake with substantially air free water, a second connection from the discharge of said power driven pump for delivering water therefrom, a valve in said second water delivery connection for preventing delivery of water therethrough, means in said air trap connected to said valve for closing said valve when a predetermined volume of air has accumulated in said air trap, a pneumatic tank, and means between the discharge of the centrifugal pump and said pneumatic tank for maintaining at least a minimum pressure on the jet of said jet pump.

6. A water system connected to a source of water supply comprising, in combination, a centrifugal pump, a jet pump and a discharge for use, said system having connections arranged so that water under pressure is supplied from the centrifugal pump to the jet continuously when the system is in normal operation, water is drawn from the source of supply into the suction of the jet pump, the combined stream of water flows from the discharge of the jet pump to the suction of the centrifugal pump and the water discharged by the centrifugal pump passes to the discharge for use except for such water as is continuously recirculated to the jet of the jet pump, an air trap between the discharge of the jet pump and the suction of the centrifugal pump adapted normally to contain a substantial volume of water and in which air and water separation may occur so that the water supplied to the centrifugal pump is substantially air free, an air outlet from said air trap, a float valve normally closing said outlet, a valve in the discharge for use, and means in the air trap for closing said valve in the discharge for use when the water in the air trap falls to a predetermined level.

7. A domestic water system connected to a source of water supply comprising, in combination, an intermittently operated centrifugal pump, a jet pump and a pneumatic tank, said system having connections arranged so that water under pressure is supplied from the centrifugal pump to the jet pump when the system is in normal operation, water is drawn from the source of supply into the suction of the jet pump, the combined stream flows from the discharge of the jet pump to the suction of the centrifugal pump and the water discharged by the centrifugal pump passes to the pneumatic tank except for such water as is continuously recirculated to the jet pump, an air trap having a major portion thereof above the centrifugal pump and located between the discharge of the jet pump and the suction of the centrifugal pump and adapted normally to contain a substantial volume of water and in which air and water separation may occur so that the water supply to the centrifugal pump is substantially air free, an air release valve at the top of said trap, means for main-

taining said release valve closed except when air is present in said air trap in an appreciable quantity whereby the system operates normally as a closed system and release of air occurs only at intervals when air enters the system with the water from the source of supply or through leaks in said connections, a normally open valve in the connection between the centrifugal pump and the pneumatic tank and means in said air trap for closing said normally open valve when air enters the system and a subatmospheric pressure exists in said air trap, said means closing said normally open valve before the water level in the air trap falls below said centrifugal pump.

8. A domestic water system connected to a source of water supply comprising, in combination, an intermittently operated centrifugal pump, a jet pump and a discharge for use, said system having connections arranged so that water under pressure is supplied from the centrifugal pump to the jet pump when the system is in normal operation, water is drawn from the source of supply into the suction of the jet pump, the combined stream flows from the discharge of the jet pump to the suction of the centrifugal pump and the water discharged by the centrifugal pump passes to the discharge for use except for such water as is continuously recirculated to the jet pump, an air trap having a major portion thereof above the centrifugal pump and located between the discharge of the jet pump and the suction of the centrifugal pump and adapted normally to contain a substantial volume of water and in which air and water separation may occur so that the water supplied to the centrifugal pump is substantially air free, an air release valve at the top of said trap, means for maintaining said release valve closed except when air is present in said air trap in an appreciable quantity whereby the system operates normally as a closed system and release of air occurs only when a positive pressure exists in the air trap and at intervals when air enters the system with the water from the source of supply or through leaks in said connections, a normally open valve in the discharge for use, means in said air trap for closing said normally open valve when air enters the system and a subatmospheric pressure exists in said air trap, said means closing said normally open valve before the water level in the air trap falls below said centrifugal pump, and a pressure control valve in the discharge for use, said pressure control valve being open so long as the pressure in the system is above a predetermined positive minimum so that when the pump stops the pressure in the discharge for use and the air trap will equalize and any accumulation of air in the air trap will be discharged therefrom.

9. In a water pump system the combination of a power driven water pump, a jet pump, a connection from the discharge of said power driven water pump to the jet of the said jet pump, a water supply normally exceeding the capacity of the pumping system connected to the intake of the said jet pump, said water supply having no other connection to or association with the water pumping system, a water container adapted to permit the separation of air from the water and being of sufficient capacity to contain a substantial volume of separated air and a considerable amount of substantially air free water, a connection from the discharge of the said jet pump to said water container, a one way outlet device

allowing air only to be forced out of said water

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container, a connection from said water container to the intake of said power driven water pump for supplying said pump intake with substantially air free water, a second connection from the discharge of said power driven water pump for delivering water out of the said water pumping system, a valve in said second connection, means for closing said valve whenever a predetermined volume of air has accumulated in said water container whereby the entire delivery of water from said power driven water pump passes through the jet of the jet pump to prevent delivery of water out of said system and to increase the pressure in said water container to force at least a portion of said accumulated air out of said water container through said one way outlet device, and thereafter reopen said valve to reestablish delivery of water out of said system.

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