ABSTRACT: An automatic air release valve is connected to the discharge side of a self-priming centrifugal pump for venting air from the pumping system during the priming cycle. The valve automatically closes upon completion of the priming cycle to prevent liquid during the pumping cycle.
AIR RELEASE VALVE FOR SELF-PRIMING CENTRIFUGAL PUMP

BACKGROUND OF THE INVENTION

The present invention relates generally to the centrifugal pump art, and more particularly to pumping systems including a self-priming centrifugal pump and an automatic air release valve connected to the discharge side of the pump for venting air from the system during the priming cycle.

During the priming cycle of a centrifugal self-priming pump, the air or gas in the pump suction line is evacuated to provide the suction lift. In so-called force main systems in which a head of liquid is maintained in the discharge line downstream from the pump, suitable provision must be made for venting such air or gas from the pumping system.

It has been conventional to provide centrifugal pumping systems with a constantly open vent communicating with the discharge side of the pump. One typical vent structure which has been used in a flow restriction device comprising a closed cylindrical housing having a tangential inlet communicating with the pump discharge line and an axial outlet communicating with a sump or a return line or the like.

The gas or air evacuated from the pump suction lines during the priming cycle is vented through the flow restrictor to a portion of the liquid which is forced from the discharge chamber of the pump. After the pump has been fully primed pumped liquid flows through the flow restrictor during the entire time that the pump is in operation.

The flow restrictor of the prior art is constructed to minimize the flow of liquid therethrough during the pumping cycle. Nevertheless, the constant venting of a portion of the liquid being pumped through the flow restrictor is both wasteful and expensive and decreases the efficiency of the pump.

Another disadvantage of many of the prior art vent arrangements is that they are subject to malfunction under conditions which may result in clogging of the vent line. Centrifugal pumps are often used to handle liquids containing heavy concentrations of foreign materials or solids which tend to clog the vent lines and the flow restrictor itself and thereby prolong or even prevent priming. Furthermore, the closed housing of the conventional flow restrictor device described above is difficult to clean and is responsible for increased maintenance costs.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a pumping system including a centrifugal self-priming pump and an air release valve associated with the discharge side of the pump which is open during the priming cycle to vent the air or gas evacuated from the pump suction lines and which automatically closes when the pump is fully primed to prevent the venting of liquid during the pumping cycle.

Another object of the present invention is to provide a pumping system including a centrifugal self-priming pump and an air release valve associated with the discharge side of the pump which is responsive to the conditions of fluid flow therethrough, whereby the valve remains open during the priming cycle to vent air or gas evacuated from the pump suction lines and which automatically closes when the pump has been fully primed to prevent the venting of liquid throughout the pumping cycle.

A further object of the present invention is to provide a pumping system including, in combination with a centrifugal self-priming pump, an automatic air release valve which can be adjusted to operate at the condition point of the system, whereby the valve remains open during priming to permit the venting of air or gas evacuated from the pump suction lines and which automatically closes when the pump is operating at rated capacity and head to prevent the venting of liquid.

Still another object of the present invention is to provide in combination with a centrifugal self-priming pump a fluid responsive, automatic air release valve which can be easily cleaned and maintained to prevent clogging.

Another object of the present invention is to provide a pumping system including a centrifugal self-priming pump, an automatic air release valve which is operable to vent the air or gas evacuated from the pump suction lines during priming and to automatically close when the pump is operating at rated capacity and head, and check valve means associated with the air release valve for preventing reverse flow of air through the release valve into the discharge side of the pump.

A further object of the present invention is to provide a flow control valve which operates in response to conditions of fluid flow, whereby the valve is normally open to permit the flow of air or gas therethrough and automatically closes to block full liquid flow.

Another object of the present invention is to provide a flow control valve having a normally open valving member which permits the venting of air or gas through the valve and which can be adjusted to automatically close in response to any predetermined condition of liquid flow.

In the preferred embodiment of the invention, the air release valve comprises a housing which defines a vortex chamber and which has a tangential inlet and a relatively larger, axial outlet. A valving member is mounted in the housing and is biased by a spring assembly to a normally open position permitting the flow of gas or a mixture of gas and liquid through the valve. The valve member is automatically movable from its open position to a closed position in response to liquid flow. At a predetermined condition of liquid flow through the housing to its outlet, the liquid will cause the valving member to move against the action of the spring assembly to the closed position, thereby preventing any further discharge of fluid from the outlet. The spring assembly is preferably adjustable to vary the biasing force exerted on the valving member, whereby the valve will close in response to any desired condition of liquid flow through the housing.

The air release valve is installed so that the inlet of the valve housing communicates with the discharge line of a centrifugal self-priming pump, and the setting of the spring loaded valving member is adjusted so that the valve member closes at the particular condition point of the pumping system, that is, the point at which the pump commences to pump liquid at the rated capacity and head. Thus installed and adjusted, the air or gas evacuated from the pump suction lines during priming is vented to atmosphere through the normally open valve. As soon as the pump has been fully primed, the valve automatically closes to block the flow of liquid therethrough and thereby prevents the inefficient, costly and wasteful recirculation or venting of liquid during the pumping cycle.

When the pumping cycle has been completed and the pump shut off, the valve automatically opens. If for any reason the suction lift is lost before the next pumping cycle, the valve will remain open upon reactivation of the pump until a full prime has been attained, whereupon the valve again automatically closes. If pump suction is not lost, the valve will close immediately when the pump is started. The valve thus operates automatically and unattended once it has been adjusted to the condition point of the particular pumping system. The operation of the valve is shock-free and results in increased pumping efficiency and reduced maintenance and operating costs.

The invention further contemplates the provision of check valve means in association with the air release valve for preventing reverse flow of air through the air release valve into the pump when the pump is shut off. Such check valve means prevents loss of the suction lift in the event that the valves in the suction lines are either damaged or prevented from fully closing.

Another feature of the invention resides in a construction of the air release valve which permits it to be quickly cleaned in order to prevent clogging. The housing of the valve includes a removable cover assembly which can be removed without affecting the adjusted setting of the valving member so that any foreign materials or solids can be removed from the housing.
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Still other objects, features and advantages of the invention will be had by reference to the following detailed description and the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration of a pumping system embodying the present invention;

FIG. 2 is a cross-sectional view of the air release valve embodied in the system illustrated in FIG. 1 having portions shown in elevation and on a scale larger than the scale of FIG. 1;

FIG. 3 is a cross-sectional view taken on the line 3-3 of FIG. 2;

FIG. 4 is a cross-sectional, fragmentary view of a modified air release valve including check valve structure;

FIG. 5 is a cross-sectional view taken on the line 5-5 of FIG. 4;

FIG. 6 is a cross-sectional view of a portion of the valve of FIG. 4;

FIG. 7 is a view similar to FIG. 4 illustrating another modified air release valve construction including check valve structure;

FIG. 8 is a view taken on the line 8-8 of FIG. 7;

FIG. 9 is an elevational view with portions broken away of still another modified valve construction;

FIG. 10 is a view taken on the line 10-10 of FIG. 9;

FIG. 11 is a view of a portion of still another modified valve according to this invention; and

FIG. 12 is an elevational view of still another modified valve according to this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and to FIG. 1 in particular, there is shown a conventional centrifugal self-priming pump which includes a casing having a rear wall 11, a front wall 12, and a partition wall 13. The walls of the casing cooperate to define a suction chamber 14 and a discharge chamber 15. An impeller 16 is disposed within the pump casing and is supported on a shaft 17 which extends rearwardly through the rear casing wall 11 and is connected to a suitable motor 18.

An inlet pipe fitting 25 is connected to the front wall 12 of the casing and opens into the suction chamber 14 through a hole in the front wall which is equipped with a suction check valve 26. An outlet pipe fitting 27 also is connected to the casing and opens into discharge chamber 15.

The pump 10 is illustrated as being embodied in a so-called force main system in which a static condition of liquid is maintained at all times in the discharge line of the pump. The system includes an inlet pipe 35 which is connected to the inlet fitting 25 and extends downwardly into a suitable reservoir or tank 36 containing the liquid to be pumped. A discharge pipe 37 is connected to the discharge fitting 27 and extends upwardly from the pump 10. The discharge line 37 is equipped with a check valve 38 downstream from the pump 10 which serves to maintain a static head of liquid in the discharge pipe above the valve 38 when the pump 10 is not operating at rated capacity and head.

When the pump 10 has been fully primed and is operating in its pumping cycle at rated capacity and head, a column of liquid is maintained in the suction inlet pipe 35 and a vacuum exists in the suction chamber 14 above the level of liquid therein. The impeller 16 operates to pump the liquid from the suction chamber 14 into the discharge chamber 15 and out of the pump 10 through the discharge line 37 and then through the check valve 38.

During the priming cycle of the pump 10, which will occur upon initial operation of the pump and when, for some reason, the suction head is lost between pumping cycles, air or gas will be contained in the inlet pipe 35 and in the chamber 14 of the pump. When the pump 10 is ready for priming, a quantity of liquid is contained in the suction and discharge chambers somewhat as indicated in FIG. 1. The pump motor 18 is energized to start rotation of the impeller 16 to move a quantity of the liquid and air in the suction chamber 14 into the discharge chamber 15, thus creating a partial vacuum on the suction side of the pump. Atmospheric pressure exerted on the liquid to be pumped forces the liquid up the inlet pipe 35 to a height depending upon the volume of liquid pumped out of the suction chamber and the internal dimension of the pipe 35. In some applications, the liquid may rise 4 to 5 feet up the pipe 35 each time the liquid is pumped out of the suction chamber. Continued actuation of the impeller 16 continues to move quantities of liquid and air from the suction chamber into the discharge chamber, thus causing the height of the liquid in the pipe 35 to progressively increase. The priming cycle is completed when a vacuum has been established in the suction chamber 14 and the pump is operating at its rated capacity and head.

It will be apparent from the foregoing description that it is necessary to vent the air or gas which is pumped by the impeller 16 into the discharge chamber during the priming cycle so that the pressure in the discharge chamber remains relatively low. Such air or gas cannot be forced through the main discharge line 37 past the valve 38 because of the relatively larger static pressure of the liquid which is maintained in the discharge line downstream from the valve. In order to vent the air or gas which is evacuated from the suction inlet pipe 35 and the chamber 14 during the priming cycle, the invention provides a new air release valve assembly 45 which is connected to the discharge pipe 37 between the discharge side of the pump 10 and the valve 38. As generally explained above, the new air release valve 45 is open during the priming cycle to vent the air or gas evacuated from the suction inlet line and automatically closes at the end of the priming cycle to prevent the venting of liquid through the valve 45 during the pumping cycle.

Referring now to FIGS. 2 and 3, the new air release valve assembly 45 is shown to comprise a valve body housing 46 including a cuplike base member 47 and a cover 48 removably attached to the base member. The base member 47 carries studs 49 which are threaded into the rim 50 of the base member at spaced locations around its circumference and which project upwardly through openings in the cover 48 near its periphery. Wing nuts 51 or the like are threaded on the upper ends of the studs 49 to hold the cover 48 in place. The wing nuts 51 permit the cover 48 to be quickly removed from the base member 47 so that the valve housing 46 can be easily cleaned whenever necessary. A suitable O-ring seal 52 is provided between the cover 48 and the rim 50 of the base member 47 to prevent leakage of fluid between these parts.

The interior of the housing 46 formed by the members 47, 48 defines a generally cylindrical vortex chamber 54. At least one inlet port 55 is formed through the sidewall or rim 50 of the base member 47 to direct fluid tangentially into the vortex chamber 54. As is most clearly shown in FIG. 3, the inlet port 55 is formed through an external corner structure 56 which is part of the base member sidewall.

An inlet line 57 is connected to the discharge line 37 and communicates with the inlet port 55. In the preferred construction of the invention, a second tangential inlet port 60 is formed through the corner structure 56 into communication with the vortex chamber 54 at right angles to the inlet 55. The two ports 55, and 60 only one of which is used, permit either right- or left-hand installation of the valve 45. The inlet port which is not in use, for example, the port 60, is normally closed by a suitable threaded plug 61 and may serve as a drain when the plug is removed. The valve body housing 46 is also provided with an outlet port 62 which extends axially from the vortex chamber 54 through a centrally located, outwardly extending boss 63 of the base member 47. The outlet port 62 may be connected to an outlet or discharge line 64 by a transparent nipple 65 which is threaded into the boss 63. As more fully explained below, observation of liquid flow through the transparent nipple 65 facilitates proper adjustment of the valve 45.
A valve seat ring 66 having a frustoconical seating surface 67 is mounted in a recess formed in the bottom of the base member 47 around the mouth of the outlet port 62. As shown, an O-ring 68 is carried in a peripheral groove formed in the sidewall of the seat ring 66 and is disposed in seating engagement with the sidewall of the recess in which the seat ring is mounted. In the preferred construction of the valve 45, a resilient backup ring 69 is disposed between the seat ring 66 and the bottom of the recess in which the seat ring is mounted. The backup ring 69 permits limited floating movement of the seat ring 66 to assure complete closing of the outlet port 62 as described presently.

A valve member 75 is carried by the housing cover 48 for movement axially of the housing into and away from engagement with the valve seat ring 66 for opening and closing the outlet port 62. The valve member 75 has a stem portion 76 and a head 77. The head 77 is formed to have a generally hemispherical or domelike upper portion 78 and a generally frustoconical lower portion 79 which converges from the upper portion 78 to the bottom of the head, as viewed in FIG. 2. The frustoconical portion 79 is engageable with the seating surface 67 of the seat ring 66 to close the outlet port 62.

In the illustrated embodiment of the invention, the stem 76 of the valve member 75 extends through a central, axially outwardly projecting hub portion 80 of the housing cover 48. A bushing 81 is threaded into the inner end of the hub portion 80 around the stem 76 and serves to support the valve member 75 for its sliding movement between its open and closed positions. The valve member 75 is urged to a normally open position by a spring 82 which is connected to the end of the stem 76 and to the end of an adjustment screw 83. The spring 82 and the adjustment screw 83 are disposed within a sleeve 84 which has one end threaded into the hub 80 and its opposite end closed by a cap 85. The adjustment screw 83 extends outwardly through a threaded opening in the cap 85, and a locknut 86 and a suitable sealing washer 87 are carried on the adjustment screw for engagement with the outer surface of the cap 85.

The outwardly projecting end of the adjustment screw 83 is shown as having a slot 88 suitable for receiving a screwdriver of the like whereby the adjustment screw 83 can be rotated to advance it in and out of the sleeve 84. Selective adjustment of the stem serves to vary the tension of the spring 82, thereby changing the biasing force urging the valve member 75 to its normally open position.

The operation of the valve 45 is dependent upon the creation of a pressure differential across the housing with the inlet pressure being greater than the outlet pressure. To this end, the outlet port 62 of the housing 64 is made larger than the inlet port. In the preferred construction of the valve, the outlet port 62 has a diameter which is preferably 25 percent larger than that of the inlet port. In order to prevent debris, such as rags and other solids, from clogging the inlet port of the valve, it has been found desirable to form the inlet port with a 1-inch diameter. Thus, in a valve construction having a 1-inch inlet port, the outlet port should preferably be 1/4 inches in diameter.

When fluid is introduced into the valve 45 through one of the inlet ports 55 or 60, a vortex flow is created within the chamber 54 so that the fluid swirls inwardly of the housing across the inner surface of the cover 48. This vortex flow of fluid is such that the pressure at the upper hemispherical portion of the valve head 77 is greater than the pressure on the frustoconical lower portion 79. As the flow rate increases, the pressure differential across the head 77 also increases to gradually pull the valve member 75 into engagement with the seat ring 66 against the biasing force of the spring 82 thereby closing the outlet port 62. By adjusting the tension of the spring 82, the valve member 75 can be made to close upon any desired condition of liquid flow through the housing 46.

The operation of the valve 45 in the illustrated pumping system will be largely apparent from the foregoing description. Assuming that the pump 10 is unprimed, the valve 45 will remain in its normally open position when the pump motor is turned on to initiate the priming cycle described above so that the air and fluid evacuated from the pump suction lines and discharged from the pumping chamber 15 can flow through the open valve 45 and the connected outlet line 64. As the flow of liquid through the valve 45 increases during the priming cycle, the valve member 75 will be pulled toward the seat ring 62 against the biasing force of the spring 82. When the priming cycle has been completed and the pump 10 is operating at rated capacity and head, the liquid flowing through the valve will pull the valve member 75 to its fully closed position, thereby preventing any further discharge of liquid through the valve during the pumping cycle. When the pump motor is shut off at the end of the pumping cycle the valve 45 will automatically open, but will close immediately when the pump is restarted if the pump suction has not been lost. If for some reason the pump suction is lost before restarting the pump, the valve will remain open to allow the pump to recylce and will close when full prime has again been attained.

An important feature of the invention resides in the construction which permits the valve 45 to be adjusted to operate at the condition point of any pumping system, which condition point varies from system to system depending upon such factors as the pressure drop in the pipes or lines, the output capacity of the system, etc. The spring-loaded valve member 75 may be adjusted to close at the condition point of the system in which it is installed by loosening the locknut 86 and turning the adjustment screw 83. Inward adjustment of the screw 83 decreases the tension of the spring 82 so that the valve member 75 can close quickly under conditions of low head. Outward adjustment of the screw 83 increases the spring tension and the closing time of the valve member, as is required under conditions of the high head.

The spring-loaded valve member 75 is preferably adjusted after the pump has been operated to complete its first priming cycle. Such adjustment is facilitated by the transparent nipple 65 connected to the outlet of the valve 45. The priming cycle is completed when full liquid flow is observed through the nipple, and at that time the tension of the spring 82 is properly adjusted so that the valve member closes and remains closed during the pumping cycle. When adjusted, the valve 45 will operate automatically during subsequent cycles of the pump and no further attention is required.

Reference is now made to FIGS. 4—12 which illustrate different check valve arrangements which may be associated with the air release valve 45 for the purpose of preventing a reverse flow of air through the valve 45 into the pumping chamber 15 when the pump is not in operation. As previously described, the valve 45 opens automatically at the conclusion of each pumping cycle. Any reverse flow of air through the valve when the pump has been stopped could result in a loss of pump suction if the suction valve 26 is not completely closed. The check valve arrangements of FIGS. 4—12 ensure against loss of pump suction by blocking reverse flow of air through the valve 45 when it is open.

Referring particularly to FIGS. 4—6 there is shown a check valve construction 115 which is disposed in the vortex chamber of the pump 45 and adapted to block the inlet port 55 when the pressure in the vortex chamber 54 approaches the pressure in the inlet line 57. The check valve assembly 115 includes a rectangular padlike check valve member 116 of resilient rubberlike of liquid tight which extends across ports 55, 60 so that, when the check valve member 116 is in the position illustrated in FIG. 4, air flow from the vortex chamber through the inlet 57 is prevented. The check valve member 116 is urged to its closed position by a spring construction including spring strips 120, 121 which are formed of suitable corrosion resistant material, such as stainless steel, and connected to the member 116 by rivets 122. The check valve member 116 and
the spring strips 120, 121 are supported in the chamber 54 by a pintle 125, the ends of which are received in cylindrical cavities 126, 127 formed in the cover and base of the valve 45 respectively. The spring strip 121 is bent to form a loop 130 medially of its ends through which the pintle 125 extends.

FIG. 6 illustrates the check valve construction 115 in a relaxed condition. It is apparent that when the check valve construction is mounted in the chamber the spring strips 121, 122 are deflected from their relaxed conditions and urge the check valve member 116 firmly against the sidewall of the chamber. Accordingly the check member prevents flow from the vortex chamber through the inlet line 57 when the fluid pressure force in the vortex chamber and the force of the springs 120, 121 are greater than the pressure force exerted on the valve member by the fluid pressure in the inlet port 55.

The check valve construction 115 permits tangential flows of gas and the liquid into the vortex chamber 54 regardless of whether the flow is introduced through the inlet port 55 or the inlet port 60. When flow is directed into the chamber 54 through the inlet port 55, the end 131 of the check valve member 116 is deflected toward the center of the chamber. The opposite end 132 of the check valve member is maintained in the closed position. If the flow is directed into the chamber through the inlet port 60 the end 132 is deflected into the end vortex chamber 54 while the end 131 remains stationary.

FIGS. 7 and 8 illustrate a modified check valve assembly 135 disposed in the vortex chamber 54. The check valve assembly 135 includes a flapperlike valve member 136 in the form of a rectangular strip of rubberlike material positioned across the inlet ports 55, 60 and supported in position by a clamp 137. The clamp 137 is connected to the sidewall of the vortex chamber by screws 142 extending into tapped holes 145a in the sidewall which cause the clamp to tightly grip the valve member 136.

The inherent resilience of the valve member 136 normally maintains it closed across the inlet ports 55, 60 (see FIG. 7). The end 143 of the valve member is deflected into the vortex chamber 54 only in response to fluid flow into the chamber through the inlet port 55.

In applications in which fluid is introduced through the port 60 the check valve assembly 135 is turned end for end in the chamber and the screws 142 are threaded into holes 145b so that fluid flow from the inlet port 60 is directed tangentially into the vortex chamber past the free end of the valve member.

FIGS. 9 and 10 illustrate a gas venting assembly valve 45 utilizing a “duck bill” type check valve 150 for preventing reverse air flow through the valve 45. The check valve 150 is formed of a rubberlike material and includes a pair of lips 151, 152 and an integral annular flange 153. The check valve 150 is held in position by engagement of the flange 153 below the seat ring 66 so that the lips 151, 152 can close the outlet port 62. The flow of liquid through the valve 45 forces the lips 151, 152 apart permitting relatively unimpeded flow of the fluid to the discharge pipe 64. When the pressure in the discharge pipe is equal to or greater than the pressure in the chamber, the lips 151, 152 move together to close the outlet port 62 and prevent air flow from the pipe 64 into the chamber 54.

FIG. 11 illustrates a modified check valve 150 which is substantially the same as the check valve 150 of FIGS. 9 and 10 except that four lips 160—163 are provided. The modified valve 150 is disposed in the air release valve 45 in the same manner as the valve 150, and, since it operates substantially in the same manner as the check valve 150, further, description is believed unnecessary.

FIG. 12 illustrates a further modified air release valve 45 including swing-type check valves 170, 171 in the inlet and outlet lines 57, 64 respectively. Each valve assembly includes a housing 173 which supports a swing-type valve member 174 rotatable about a hinged support 175 in the housing. The valve member 174 moves about a pivot axis 176 to permit flow from the pipe 57 through the valve 45 to the outlet pipe 64. The valve member closes to prevent flow in the opposite direction and in the illustrated construction is moved to the closed position by gravity. Although two check valves 170 are illustrated in FIG. 12, in practice only one of these check valves is necessary to prevent the reverse flow of air through the valve 45.

It can now be seen that the objects heretofore enumerated and others have been accomplished and that a new air release valve combined with a pump has been provided which vents gas from the pump discharge during priming and automatically closes to prevent pumped liquid from venting when the pump operates at rated head and capacity.

We claim:

1. In combination, a pump having an inlet opening and an outlet opening said outlet opening communicating with a discharge line, and an air release valve assembly for venting said discharge line only during priming of said pump, said valve assembly comprising:

a. a valve inlet means connected to said discharge line;

b. a valve outlet means having a larger flow area than the flow area of said valve inlet means; and

c. a chamber having an inlet port defined by said valve inlet means opening into said chamber and an outlet port defined by said valve outlet means, said chamber defining a larger flow area than the flow area of said valve inlet means;

d. valving means in said chamber comprising:

1. a valve seat surrounding said chamber outlet port;

2. a valve member movably supported in said chamber; and

3. biasing means urging said valve member toward a predetermined position spaced from said seat;

e. said valving means having an open condition wherein said valve member is in said predetermined position and spaced substantially away from said valve seat enabling unrestricted fluid flow between said valve member and said valve seat;

f. said valve inlet means directing pump effluent into said chamber along a flow path for impingement on said valve member;

g. said pump effluent creating a pressure force on said valve member for opposing and overcoming said biasing means at pump effluent mass flow rates above a predetermined flow rate whereby said valve member seats on said valve seat to terminate flow through said outlet means.

2. The combination as claimed in claim 1 wherein said biasing means is adjustable for selectively varying the force exerted on said valve member;

3. In combination, pump means operable through a priming cycle and a pumping cycle, said pump means including an inlet opening and an outlet opening; discharge valve means connected to said outlet opening for permitting fluid flow therethrough during said pumping cycle and for blocking fluid flow therethrough during said priming cycle; and air release valve means connected between said pump outlet opening and said discharge valve means for permitting fluid flow therethrough during said priming cycle and blocking fluid flow therethrough during said pumping cycle, said air release valve means including a valve housing defining a vortex chamber having a cylindrical chamber wall portion, means defining a valve inlet opening for directing pump effluent into said chamber substantially tangentially along said wall portion to create vortical flow in said chamber, an axial valve outlet opening from said chamber, a valve seat surrounding said valve outlet opening, and a valving member supported by said housing for movement toward and away from said valve seat, said valving member being biased away from said seat and including a surface portion impinged upon by vortical flow of pump effluent in said chamber, mass flow rates of pump effluent greater than a predetermined flow rate impinging on said surface portion to overcome the bias on said valving member and move said valving member into engagement with said valve seat to terminate flow through said outlet opening.
4. The combination as claimed in claim 3 wherein said valving member includes a head portion disposed in said housing, and further including means reacting on said valving member for biasing said valving member toward said open position.

5. The combination as claimed in claim 4 wherein said biasing means includes bias adjusting structure to permit said valving member to be moved to said closed position at various desired pump effluent flow rates and whereby said valve means can be adjusted to close when said pump is primed.

6. The combination as claimed in claim 3 and further including a check valve structure preventing fluid flow through said air release valve means to said pump outlet opening when said pump is not operating.

7. The combination as claimed in claim 6 wherein said check valve structure includes a member extending across said valve inlet opening preventing flow from said chamber through said valve inlet opening and movable to enable fluid flow into said chamber through said valve inlet opening.

8. The combination as claimed in claim 6 wherein said check valve structure includes a member which closes said valve outlet opening to fluid flow through said valve outlet opening into said chamber.

9. A fluid operated valve comprising a housing defining a circular vortex chamber having a tangential inlet port and an axial outlet port, a valving member supported for movement in said housing between a first position communicating said inlet and outlet ports for enabling fluid flow through said chamber and a second position preventing fluid communication between said ports, said valving member including at least a surface disposed for contact with fluid in said chamber, and biasing means for urging said valving member to one of said positions, vortical fluid flow in said chamber so that a vortex is produced in said chamber, a valving member in said housing movable between an open position permitting fluid flow between said ports and a closed position blocking fluid flow between said ports, said valving member including a head portion disposed in said housing so that liquid flowing from said inlet port at flow rates above a predetermined level impinges on said valving member and is effective to force said valving member toward said closed position, and means for biasing said valving member toward said open position.

10. In combination, centrifugal pump means operable through a priming cycle and a pumping cycle, said pump means including an inlet opening and an outlet opening; discharge valve means connected to said outlet opening for permitting fluid flow therethrough during said pumping cycle and for blocking reverse fluid flow therethrough during said priming cycle; and air release valve means connected between said pump outlet opening and said discharge valve means for permitting fluid flow therethrough during said priming cycle and blocking fluid flow therethrough during said pumping cycle, said air release valve means including a housing defining a vortex chamber, said housing having an inlet port opening tangentially into said chamber and an outlet port disposed transversely to said inlet port along the axis of said chamber so that a vortex is produced in said chamber, a valving member in said housing movable between an open position permitting fluid flow between said ports and a closed position blocking fluid flow between said ports, said valving member including a head portion disposed in said housing so that liquid flowing from said inlet port at flow rates above a predetermined level impinges on said valving member and is effective to force said valving member toward said closed position, and means for biasing said valving member toward said open position.

11. A fluid operated valve comprising a housing defining a vortex chamber having an inlet port and an outlet port, said vortex chamber being generally cylindrical, said inlet port directing fluid flow tangentially into said chamber and said inlet port being disposed along an axis of said chamber, a valving member in said housing supported for movement along said axis between a first position communicating said inlet and outlet ports for fluid flow and a second position preventing fluid communication between said ports, said valving member including at least a surface disposed for contact with fluid in said chamber, biasing means for urging said valving member to one of said positions, vortical fluid flow in said chamber of a given flow rate acting upon said at least one surface to overcome said biasing means and move said valving member to the other of said positions.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,575,521 Dated April 20, 1971

Inventor(s) Robert J. Porter and Stanley B. McFarlin

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 7, line 25, delete "end" (first occurrence)

Column 7, line 67, delete the comma (,) after "further".

Column 8, line 15, (Claim 1, line 2)
insert a comma (,) before "said".

Column 9, line 41, (Claim 10, line 5)
delete "communication" insert -- permit

Signed and sealed this 7th day of September 1971.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Pa