AUTOMATIC REFILL DEVICE HAVING FLUIDICALLY OPERATED CONTROL

ABSTRACT: A refill mechanism, for example, a water closet tank refill apparatus, having a valve which maintains itself in the "on" position once the fluid flow starts and switches to the "off" position in response to the attainment of a predetermined liquid level.
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BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a fluid refill mechanism and more particularly to a refill mechanism which incorporates a fluidic switching mechanism.

2. Description of the Prior Art

The need for an inexpensive, efficient, reliable refill mechanism, for a variety of applications has long existed. A typical situation is found in the case of water closet tank refill devices. These devices are characteristically noisy, are excessively subjected to wear and do not stay in the full open position during the entire filling operation, but rather begin a slow close procedure well before the tank is completely filled. Furthermore, these valves require the use of a large float and lever arm mechanism and are relatively expensive.

A further problem is that leakage of any sort from the tank causes the water control valve to open, thus replenishing the water lost due to leakage. A permanent “on” situation could thus be produced, resulting in flooding or the like.

SUMMARY OF THE INVENTION

It has now been found that a refill mechanism can be designed which can maintain itself in the refill position, that is, in the completely open position during the entire cycle, and then, through the use of a fluidic switching mechanism, automatically stop the refill cycle.

The mechanism includes a primary fluid inlet, a control inlet with valve means, a control chamber, a single outlet with valve means and a valve actuating rod or plunger.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects, features and advantages of the present invention will be further understood as the description of the invention proceeds, particularly when taken together with the accompanying drawings wherein like reference numerals indicate similar parts throughout the several drawings and wherein:

FIG. 1 is a schematic representation of a valve mechanism in accordance with the present invention, said mechanism being in the “off” position;
FIG. 2 is a cross section of the valve of FIG. 1, taken along lines 2-2;
FIGS. 3 and 4 are schematic representations of the mechanism of FIG. 1, in the “start” position;
FIG. 5 is a schematic representation of the valve structure of FIG. 1 in the “stop” position;
FIG. 6 is a schematic representation of another embodiment of a valve in accordance with the present invention;
FIG. 7 is a schematic representation of another embodiment of a valve;
and
FIG. 8 is a schematic representation of a further embodiment of a valve structure.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The filling mechanism is normally at rest in the “off” position as shown in FIG. 1.

Conduit 10 is at all times in communication with the refill liquid. In the case of a water closet refill system, water at a pressure in the range from 5 to 120 pounds per square inch would be supplied to conduit 10. The fluid pressure acts on ball 12, keeping the ball firmly seated on valve seat 14, thus sealing the vent opening 16. Similarly, the ball 18 is firmly seated against the valve seat 20, sealing the passage to refill conduit 22.

As shown in FIG. 3 in order to start the refill operation, the plunger 24 is depressed against the force of spring 26, causing the ball 18 to move toward the opposite end of the valve chamber 50 as indicated by arrow 30. The movement of the ball 18 opens the passage to the refill conduit 22 thus permitting fluid to flow around the ball 18, through the refill conduit 22 and into the receptacle being filled. Air is aspirated through the control conduit 46 as a result of the low pressure created by fluid entrainment in the jet issuing from the inlet nozzle 30. The jet then attaches to the upper wall 32 of the control or interaction chamber 34 and continues to do so, until the port 16 is closed or blocked. The jet attachment to the wall 32, appears to be due to the low pressure created by fluid entrainment in the jet near the upper wall and the near ambient pressure in the lower part 36 of the control chamber provided by the inflow of air through the control port 16.

The switching action can also be accomplished by injecting or aspirating a fluid at an appropriate control point, as well known in the art.

As shown in FIG. 2, the valve chamber 50 is larger in cross section than the chamber 34. Thus the ball 18 is confined within the valve chamber which for convenience is shown to be circular in cross section.

The theory and phenomena involved in the present invention are not set forth by way of limitation or as an indication of an absolute mode of operation, but rather, are set forth for the purpose of attempting to clarify the invention in the most feasible manner.

It is evident, as shown in FIG. 4, that a fluid-flow pattern becomes established after the ball is moved slightly away from the valve seat 20, such that a positive force acts to move the ball 18 in the direction away from the valve seat 20, as indicated by the arrow 41. It would appear that a pressure differential and/or a flow pattern exists between the region of the valve chamber 50 which is adjacent the refill conduit 22 and the region which is adjacent the wall 42 of the chamber 34 which causes the ball 18 to rapidly move along the valve chamber 50.

With the cessation of air flow into the control chamber as shown in FIG. 5, the jet indicated by arrows 36 will attach to the lower wall 42 of the control chamber 34 and enter the end 54, of the chamber 50 moving ball 18 to its seat 20, thus stopping flow through discharge port 40. Line pressure will then exert a force through control port 46 which will seat ball 12 thus stopping all flow of water and air through the duct 16.

The chamber 48 can be positioned so that the vent opening 16 is at a height which would suit the application. It is evident that either the conduit 46 can be of the required length or a conduit can be provided in communication with and extending from the vent opening 16.

Flow through the device can be started manually, or through hydraulic or mechanical linkage to a machine or appliance, or it can be started electrically by use of a solenoid.

The vent chamber 48 can be connected to the control chamber 34 by any convenient type of conduit, either flexible or rigid, as required in the particular application, or can be fixed in position and have a flexible or rigid conduit extend the required distance.

For example, the system can be used to regulate the filling of a bath tub to a predetermined height. The vent chamber could in such a case be connected to the control chamber by a telescoping linkage or a flexible conduit. In the latter case, the chamber 48 or flexible length of conduit could be fixed in the desired position by means of a conventional suction cup. In either case, if the chamber 48 accidentally moves out of the desired position, since its motion will always be downward, the flow will merely stop prematurely.

The duct 16 can be sealed by means of a conventional stem or check valve in lieu of the ball valve. Similarly, the cylindrical valve chamber could employ, in lieu of ball 18, an elongated rod having a hemispherical end portion which would seat alternately in a valve seat 20, or other shaped valve bodies in combination with cooperatively shaped valve seats.

The refill control device can be simply extrusion molded in two mirror image halves. The valve seats 14 and 20 can be formed at the time of the molding or can be inserts which are set in place before the two halves are sealed to each other. In the case of insert type valve seats, circumferential grooves can be employed for receiving the seats and holding them in place.
It should be understood that the term cylindrical as employed herein is intended to refer primarily to right circular cylinders, but also includes cylinders having noncircular cross sections.

The chamber 48 can be of any desired cross section. It is essential however that there be a clearance between ball 12 and the inside surface of walls of the chamber such that the ball can move freely, and so that air can flow around the ball when it is in a position off the seat 14.

The fluid emitting from the nozzle 11, should flow in a direction approximately normal to the exit walls 13 and 15 prior to deflection toward either wall 42 or wall 32. The venting action causes the fluid to attach to the wall 32 as it is well known in the art of the venting art, allowing the fluid to attach to, or flow along the more proximate wall 42.

As shown in FIG. 6, the valve structure can be designed so that a single valve unit, consisting of a movable member 60 and a seat 62 is positioned between the supply conduit 63 and the primary fluid inlet 11.

The movable valve member 60 is fixed to the ball 70 by any conventional linkage, such as a rod 72. Thus, as previously described movement of the actuator 24 causes a flow to start by moving the valve member 60, off the seat 62. The resultant flow patterns forces the ball 70 toward the end 74 of the chamber 76 thus forcing the valve member 60 out of the path of the flowing fluid.

As previously described, sealing of the vent port 66 causes a change in fluid flow which results in the ball 70 being forced toward the refill conduit 68 end of the chamber 76. The valve 60 is simultaneously forced into a sealing engagement with the valve seat 62, and held in place by the line pressure.

FIG. 7 shows a variation of the type of valve structure of FIG. 6. A diaphragm member 90 is interposed between the valve member 60 and the disc or cup member 71 in order to supply additional force, if required in order to prevent the line pressure against the valve member 60 from prematurely seating the valve member, thus terminating the refill cycle.

In the instant design, closing of the vent port 60 causes the disc 71 to seat against the valve seat 78 thus terminating the fluid pressure in the chamber 82 of the diaphragm member.

The line pressure acting against the valve member 60 in combination with the previously described tendency of disc 71 to be forced against or towards valve seat 78 will provide the necessary closing action. It is not critical for the disc 71 to provide a total fluidtight seal since this function is provided by valve member 60. The disc 71 need only restrict the flow sufficiently to provide a substantial if not total loss of pressure in diaphragm chamber 82. The disc member 71, can be in any convenient form, for example, it can also be in the form of a ball.

The fluidic valve of the instant invention can be employed as a water closet tank refill control mechanism. While such mechanisms typically are provided with antisiphon or backspitting devices, the structure of the present invention can be provided with what is inherently an antisiphon arrangement.

The conduit 16 which extends from the control conduit 46 and responds to the water level in order to shut off the valve mechanism, can be made to extend below the height of the main water outlet conduit 22. In a situation in which the water adjacent to the control conduit is somewhat above the height of the inlet to the conduit and a negative pressure exists at the primary fluid inlet 10 to the valve, fluid would tend to be drawn upwardly into the valve via the control conduit 46. However, according to the combination action would simultaneously draw air into the valve structure through the relatively large conduit 22 which normally serves as a primary fluid outlet. A release of fluid pressure on the chamber 34 side of the ball 18, 70 would automatically cause the ball to move from its seated position in which it is in sealing engagement with the valve seat, to the position away from the seat. Because of the relative dimensions of the control conduit 16 and the fluid outlet 22 a vacuum or a negative pressure at the primary fluid inlet 10 would selectively or preferentially draw air inwardly through the primary fluid outlet rather than water inwardly through the control conduit 16.

In a further application the fluidic valve and outlet conduit can be employed in a two-way system. In this application the primary fluid outlet 22 would extend below the level of the control conduit 16 and typically to a position approximately to the bottom of the receptacle to be filled with fluid. The conduit 22 could then be used to withdraw fluid from the receptacle by means of either a pumping action applied at the position upstream of the primary fluid inlet 10 or by merely having the conduit connected to the primary fluid inlet 10 extend to a position below the level of the fluid in the receptacle. In such a case, the fluid would tend to flow backward, that is upstream through the fluidic valve. The ball 18 which is acting in a sense as a check valve type of ball, would simply be moved away from its sealing position by virtue of the relative fluid pressures and would not prohibit the upstream flow of fluid.

As shown in FIG. 8, the fluidic mechanism of the instant invention can be automated so that it will not only stop the flow of fluid through the valve automatically when the height in the receptacle being filled reaches a predetermined height but also will automatically commence the flow of fluid. The plunger or actuator member 90 can be linked to a float 96 which preferably has a density somewhat less than or about equal to that of the fluid in the receptacle and positioned at a level at which refilling is to be commenced. When the float is above the water level, its effective weight would increase and cause the linkage mechanism 94 to rotate about the pivot support 92. The downward force thus exerted on the plunger 90, causes the ball 18 to unscale and starts the flow of fluid through the fluidic valve.

As previously described when the height of the fluid reaches the desired, predetermined level the fluid flow would be automatically terminated. Thus the valve mechanism of the instant invention can be a self-starting as well as a self-stopping type of mechanism.

The structure of FIG. 8 can be used as a direct substitute for conventional toilet tank refill mechanisms of the float-type. In such an application, the weight 96 can simply be a hollow cup or container filled with water. By virtue of the mechanical advantage which is achieved by having the distance between the pivot support 92 and the end of the arm 94 much longer than the distance between the pivot support 92 and the plunger rod 90, only a small volume of water would be required to cause a sufficient unseating of the ball 18 to start the fluid flow through the fluidic valve.

Although the invention has been described in its preferred forms with a certain degree of particularity, it is understood that the present disclosure of the preferred forms has been made only by way of example, and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention.

What is claimed is:
1. A valve mechanism comprising in combination a control chamber having:
   a. an outlet to exit a primary fluid from said control chamber;
   b. a primary fluid inlet to feed the primary fluid to said control chamber;
   c. a control port;
   d. a first wall;
   e. a second wall, said first wall and said second wall being opposing walls of said control chamber and extending continuously from said inlet to a valve housing, said opposing walls diverging from each other proximate said inlet and converging proximate a valve housing;
   f. said valve housing interposed between said inlet and said outlet to selectively stop the fluid of said primary fluid through said inlet and said outlet and having:
   aa. a first end, said first end being proximate a first wall of said control chamber,
bb. a second end proximate a second wall of said control chamber.

c. valve means for selectively passing the flow of the primary fluid through said control chamber outlet and said primary inlet, said valve means being movable between said first end and said second end, and serving to close said control chamber outlet to stop the flow of fluid through said inlet and said outlet when positioned at said second end.

2. The structure of claim 1, wherein said control fluid port is positioned in said first wall of said control chamber.

3. The structure of claim 1, wherein said control fluid port is positioned proximate said primary fluid inlet.

4. The structure of claim 1, wherein said valve means further comprises a ball valve having a seat at said control chamber outlet.

5. The structure of claim 4, wherein said valve housing is a substantially cylindrical bore, said ball being dimensional and positioned for movement within said cylindrical bore.

6. The structure of claim 1, further comprising a control valve chamber, housing a second valve means, said chamber having an inlet passage at one end and an outlet passage at the other end, and a valve seat at said inlet end, said outlet passage being in communication with said control fluid port.

7. The structure of claim 6, further comprising a flexible conduit extending from said control valve chamber inlet passage.

8. The structure of claim 1, further comprising a primary fluid valve means for controlling the flow to said primary fluid inlet, said primary fluid valve means being movable in response to movement of said valve means.

9. The apparatus of claim 8, wherein said valve means further comprises a ball valve having a seat at said outlet port.

10. The method of controlling fluid flow comprising:
   a. passing a primary fluid through a nozzle;
   b. aspirating a control fluid adjacent said nozzle;
   c. passing said primary fluid along a first flow path to a primary fluid outlet port;
   d. terminating the aspirating of a control fluid and thereby causing at least a portion of said primary fluid to divert to a second fluid flow path toward said primary fluid outlet port, wherein the flow of primary fluid along said first flow path creates pressure balances which maintain a valve member away from said primary fluid outlet port and the fluid flow along said second fluid flow path causes said valve member to move from an open position away from said primary fluid outlet port to a position closing said primary fluid outlet port, and wherein a portion of the primary fluid flowing along said first fluid flow path flows away from said primary fluid outlet thereby drawing said valve member away from said outlet port.

11. A valve mechanism comprising in combination: a control chamber having,
   a. a primary inlet to feed a primary fluid to said control chamber;
   b. a control inlet;
   c. an outlet port to exit the primary fluid from said control chamber;
   d. a first wall in said chamber;
   e. a second wall in said chamber diverging from said first wall in the downstream direction;
   f. valve means interposed between said primary inlet and said outlet port to selectively stop the flow of said primary fluid through the primary inlet and the outlet port, said valve means having:
      aa. a first end, said first wall of said control chamber terminating at said first end,
      bb. a second end, said second end being said outlet port, and being proximate the downstream end of said second wall,
      cc. control chamber outlet port valve means for selectively passing the flow of the primary fluid through said outlet port and through said primary inlet, said valve means being movable between said first end and said outlet port to selectively stop the flow of fluid through said primary inlet and said outlet port.

12. The structure of claim 11, further comprising a primary fluid valve means for controlling the flow to said primary fluid inlet, said primary fluid valve means being movable in response to movement of said valve means.

13. The structure of claim 11, wherein said valve means has first valve means which extends from said first end to said second end and said valve means first wall in combination with said control chamber first wall and second wall and control chamber third and fourth walls constituting substantially the entire peripheral walls of said control chamber, said control chamber third and fourth walls being substantially parallel walls which extend from said primary inlet to said outlet port and from said control chamber first wall and said valve means first wall to said control chamber second wall.

14. The structure of claim 11, wherein said valve means is enclosed within said control chamber the walls of said valve means being walls of said control chamber, said valve means being open to primary fluid flow from said valve means first end to said valve means second end.

15. The structure of claim 11, wherein at the upstream end, said first wall diverges from said second wall in the downstream direction, and that the downstream end, said first wall curves towards said first wall, whereby fluid travelling along either said first wall or said second wall is directed toward said outlet.

16. The structure of claim 11, wherein said control chamber said second wall curves continuously toward said outlet port and at the upstream end of said control chamber said first wall being a continuous wall which at the upstream end diverges from said second wall, then reverses its curvature and at its downstream end curves toward said second wall and in the direction of said outlet port.

17. The structure of claim 11, wherein said control chamber first wall and second wall constitute the flow directing opposing walls of said control chamber and diverge at their upstream end and converge at their downstream end.

18. The apparatus of claim 11, further comprising means for guiding and restricting the movement of said valve means between said first end and said second end.

19. The apparatus of claim 18 wherein said control chamber further comprises third and fourth walls, said third and fourth walls being parallel, and said means for guiding and restricting the movement of said valve means is a substantially cylindrical bore having its axis substantially parallel to the planes of said third and fourth walls, and a ball is positioned in said bore and dimensioned for movement within said cylindrical bore, the diameter of said ball being greater than the distance between said third and fourth walls at their intersection with said cylindrical bore.

20. The structure of claim 11, further comprising a control valve chamber, housing a second valve means, said chamber having an inlet passage at one end and an outlet passage at the other end, and a valve seat at said inlet end, said outlet passage being in communication with said control fluid port.

21. The structure of claim 20, further comprising a flexible conduit extending from said control valve chamber inlet passage.

22. The structure of claim 11 wherein said control fluid port is positioned in said first wall of said control chamber.

23. The structure of claim 22, wherein said control fluid port is proximate said primary fluid inlet.