# United States Patent

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[54] **FLUID SYSTEM FOR FILLING AND EMPTYING AN ENCLOSURE**
**21 Claims, 5 Drawing Figs.**


[52] **U.S. Cl.** ..... **137/81.5,** 128/145.8, 137/63R
[51] **Int. Cl.** ..... **F15c 1/12**
[50] **Field of Search** ..... 137/81.5, 63R; 128/145.8



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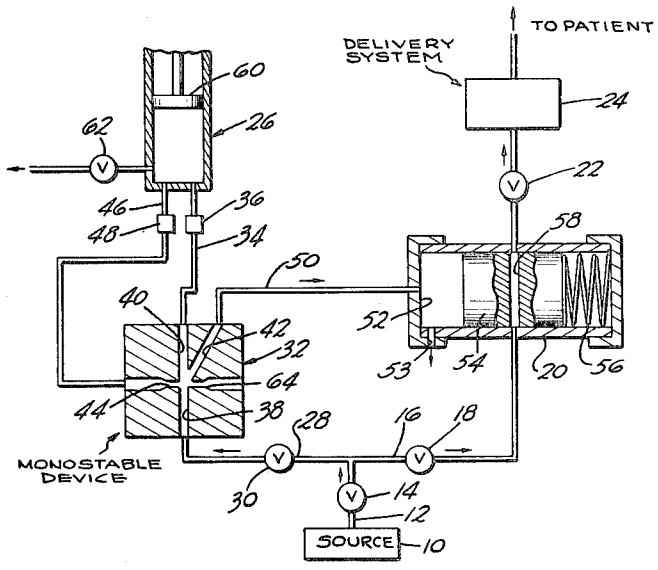
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**ABSTRACT:** Apparatus for alternately filling and emptying an enclosure such as the lungs of human beings or animals, or which can be used to pump fluids, both liquid and gas. The apparatus includes a supply circuit, and a control circuit for controlling flow through the supply circuit, whereby (1) the cycle time, (2) the portion of time for each phase of the cycle and (3) the flow rate during the filling phase are readily established. Fluidic switches are used in the control circuit for automatically regulating the operation of the supply circuit, and in certain modifications of the apparatus, the fluidic switches may be actuated in part in response to pressure conditions in the enclosure.

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FIG. 1

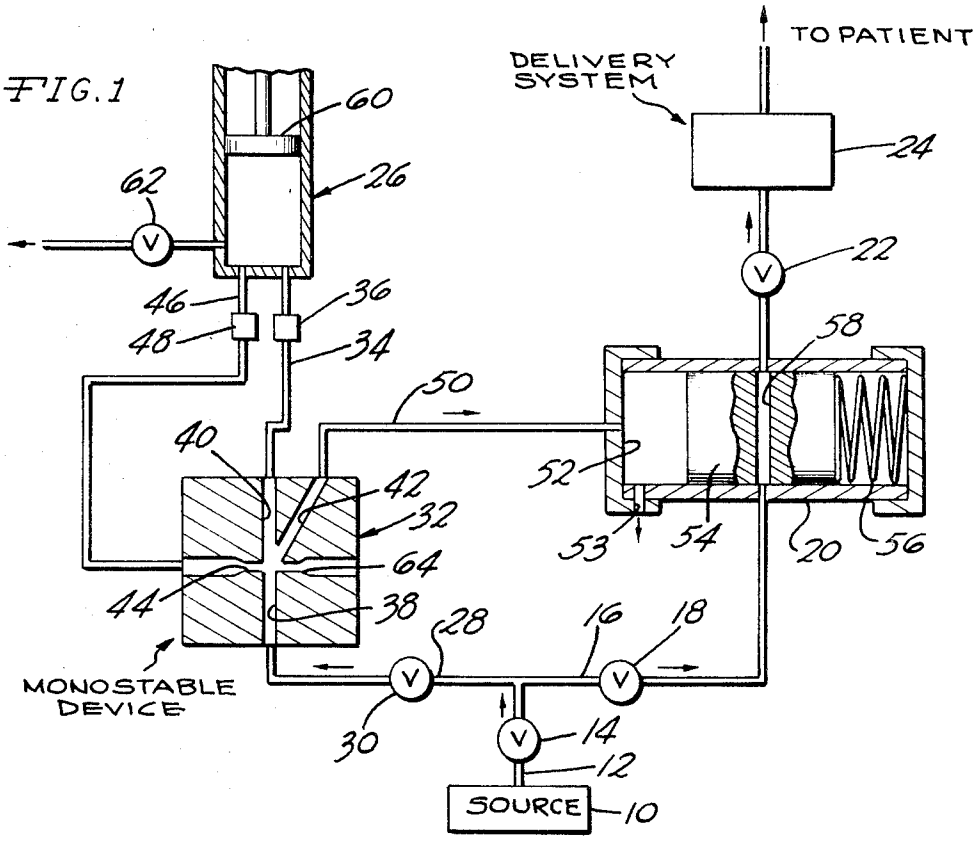
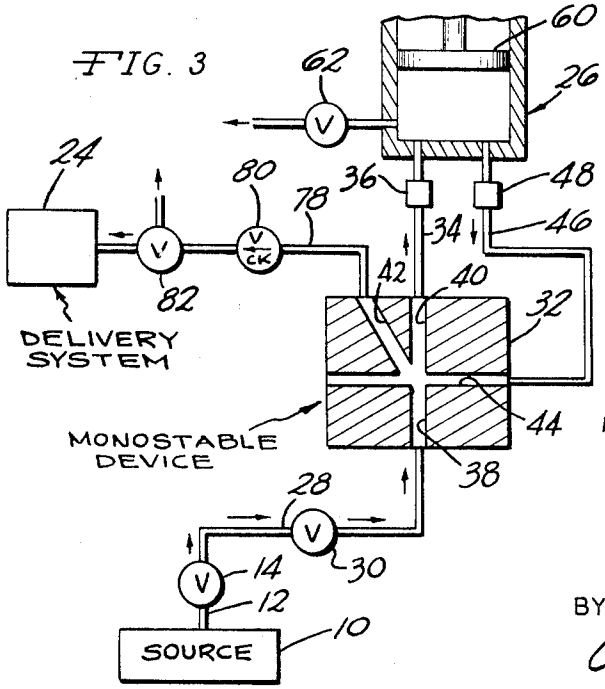



FIG. 3



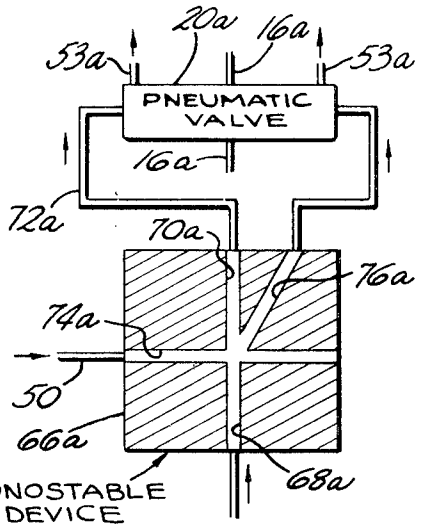
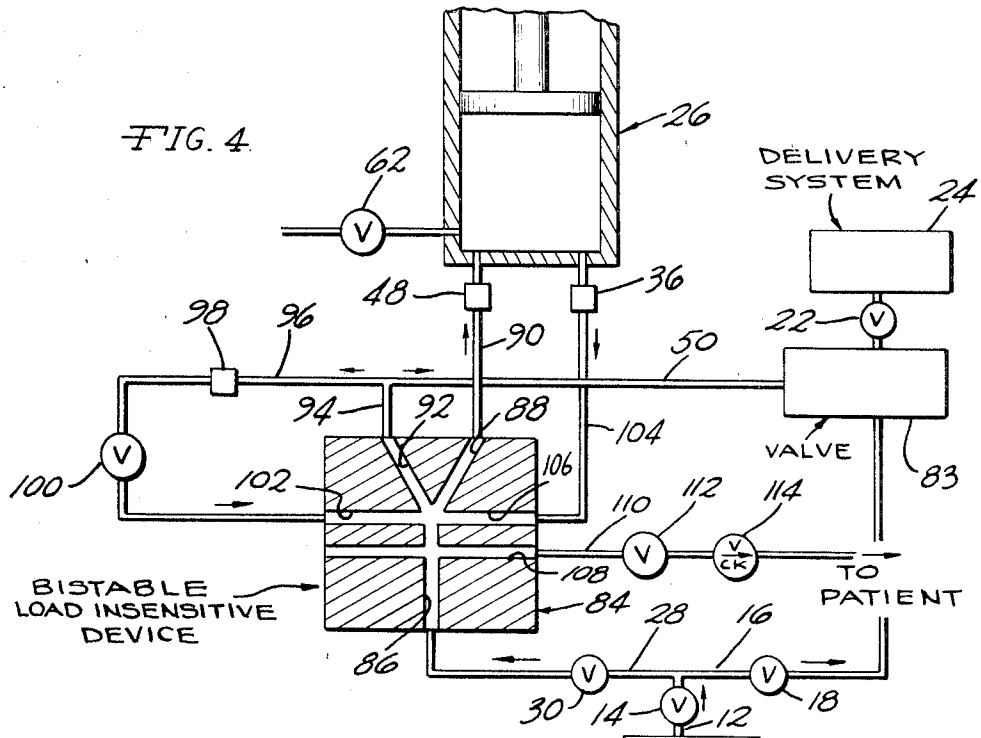




FIG. 2

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FIG. 4



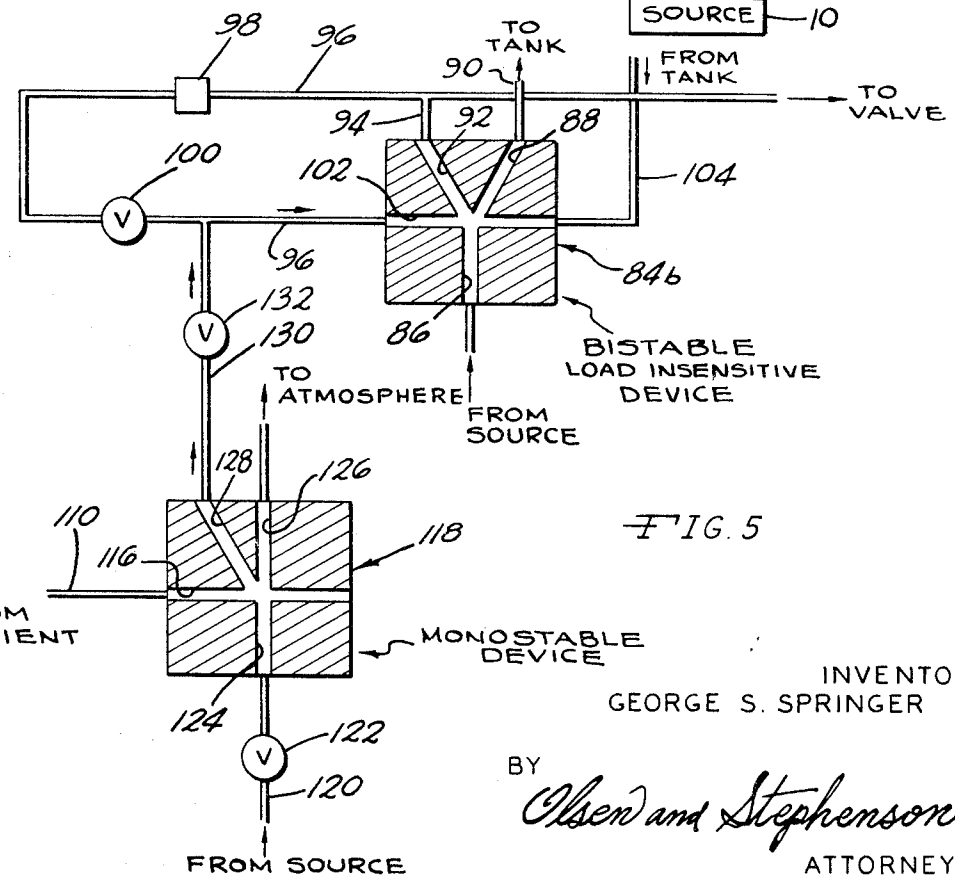




FIG. 5

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U.S. PATENT 3,522,816

# FLUID SYSTEM FOR FILLING AND EMPTYING AN ENCLOSURE

## BACKGROUND OF THE INVENTION

The present invention relates to respirators and other systems wherein an enclosure, such as a human lung, is filled with and emptied of pressurized fluid, and in which these results are realized essentially in the absence of moving parts.

It is known to provide respirator apparatus which can function essentially without moving parts by the employment of fluidic devices, but such prior art apparatus fails to supply fully all of the basic requirements for such apparatus. The basic requirements of any device, such as a respirator, that works in a cycle, that is, which alternates between two separate modes of operation, are (1) the cycle time must be adjustable within a wide range; (2) the flow rate through the device during the filling phase must be adjustable through a wide range; and (3) the proportion of time of the two phases within any given cycle must be adjustable. For instance, in the case of a respirator, the times for inspiration and expiration are unequal and it is necessary that the apparatus be adjustable to accommodate the needs of the patient. It is desirable that the device be adjustable with respect to all three of the items set forth above, independently of each other. In addition, it is also desirable that the apparatus be of a simple construction which can be produced at low cost, which is easy to operate, which is reliable and which is easy to clean.

As indicated above, the prior art apparatus fails to fully meet these basic requirements. Normally when systems of this character are provided which employ fluidic devices, the patient is required to regulate the cycling time. Also, during exhalation, the device is open to the atmosphere so that there is considerable loss of the supply fluid to the respirator. In addition the prior art devices have a lower limit for the flow rate, below which the apparatus will not function properly.

## SUMMARY OF THE INVENTION

The present invention has overcome the problems of the prior art and has provided apparatus which will meet all of the basic requirements set forth above.

According to one form of the present invention, apparatus is provided for filling an enclosure intermittently with a fluid in cycles of uniform duration including a first phase for delivering fluid to the enclosure and a second phase for interrupting delivery of fluid to the enclosure. The apparatus comprises a source of fluid under pressure, delivery means for delivering fluid to the enclosure, a tank of fixed volume, first passage means extending from the source to the delivery means in a normally closed state, second passage means extending from the source to the tank in a normally open state, a fluidic switch operably associated with the first and second passage means responsive to pressure in the tank of a pre-established magnitude to start said first phase by interrupting normal flow of fluid through said second passage means and to effect flow of fluid through said first passage means, and thereafter, in response to pressure in said tank of a lesser magnitude to start said second phase by interrupting flow of fluid through said first passage means and effecting resumption of flow of fluid through said second passage means.

In carrying out this operation a normally closed valve is positioned in the first passage from the source to the enclosure, and this valve is responsive to fluid under pressure to be opened to permit flow from the source to the enclosure. The fluidic switch is in communication with the normally closed valve to open the same when the fluidic switch responds to the pre-established pressure in the tank to interrupt flow of fluid through said second passage.

In this form of the invention the cycle time can readily be changed over a wide range by changing the effective volume of the tank. Also, the proportion time of the two phases of each cycle can be adjusted by means of a control valve associated with the tank for selectively establishing the rate at



which the pressure in the tank is reduced from the pre-established magnitude to the lesser magnitude. Still further, the flow rate through the system during the filling phase of the cycle can readily be adjusted by means of a pressure regulating valve member located in the supply line to the delivery system.

The invention is not limited to this first form of the invention, but various other arrangements can be provided embodying the same essential elements of the first form of the invention. Thus, suitable modifications can be provided so that the apparatus can be automatically operated, or so that it can be operated in part in response to pressure signals received from the patient during use of the equipment.

It is an object of the present invention to provide apparatus for filling an enclosure intermittently with fluids in cycles of selected duration wherein the proportion of the filling and emptying phases can be readily set, and wherein the filling rate to the enclosure can be established over a wide range.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

## BRIEF DESCRIPTION OF THE DRAWING

**FIGURE** 1 is a schematic diagram of one embodiment of applicant's invention;

**FIGURE** 2 illustrates a modified form of the valve element that may be used with the embodiment of the invention shown in **FIGURE** 1;

**FIGURE** 3 is a second embodiment of the invention similar to that of **FIGURE** 1, but wherein a normally closed valve element in the supply circuit has been eliminated;

**FIGURE** 4 illustrates another embodiment of the invention wherein the apparatus is operable either automatically or in response to the patient; and

**FIGURE** 5 is still another embodiment, similar to that of **FIGURE** 4, showing a modified arrangement whereby the patient can control the apparatus.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

Referring now to **FIGURE** 1, the first form of the invention will be described. As is there shown fluid such as compressed air, oxygen, or a mixture of these two or any other gas can be supplied form source **10** via conduit **12**, valve **14**, conduit **16**, reducing valve **18**, normally closed valve **20**, regulating valve **22**, distributing system or means **24** for delivering the fluid to the patient or enclosure. In this instance the delivery means **24** serves to establish communication between the respiration apparatus and the patient's respiratory system. Such means may comprise any of the many known devices adapted for this purpose, including face masks and mouthpieces. The circuit described from the source **10** to the delivery means **24** thus comprises a first passage means which is in a normally closed state by virtue of the normally closed position of the valve **20**.

The source **10** also supplies fluid to a control circuit which is referred to as a second passage means which extends from the source **10** to the tank **26** via the conduit **12**, valve **14**, conduit **28**, reducing valve **30**, fluidic device **32**, conduit **34**, restriction **36** and the tank **26**.

The fluidic device **32** is monostable in nature of the boundary layer lock-on type sometimes referred to as an or nor gate. The device is constructed so that flow of fluid through the passage **28** to the passage **34** will flow through the input duct

38 and the stable output duct 40. However, the flow of fluid will be switched from the stable output duct 40 to the unstable output duct 42 if fluid under pressure is introduced through the control duct 44. Control fluid for this purpose will be supplied from the tank 26 via the conduit 46 and restricter 48 when the pressure in the tank 26 has reached a pre-established magnitude. When the control fluid from the source 10 is switched to the unstable output duct 42, flow will occur through the conduit 50 to the chamber 52 in the valve 20 from which it can flow to atmosphere through bleed port 53. The pressure in chamber 52 will be raised to move the valve element 54 against the biasing action of the spring 56 to open the valve passage 58 in the valve 20, thereby opening the normally closed first passage means from the source 10 to the delivery means 24.

Referring again to the tank 26, it will be observed that an adjustable piston 60 is provided for changing the effective volume of the tank 26. Also associated with the tank 26 is a pressure regulating valve 62, such as a needle valve or the like, for regulating the rate of pressure drop that can occur within the tank 26 from its pre-established magnitude, to a magnitude of a selected lesser value.

In the normal operation of the apparatus illustrated in FIGURE 1, the fluid will initally be delivered from the source 10 via the second passage means to the tank 26 and when the pressure reaches a pre-established magnitude a flow of fluid through conduit 46 to the control duct 44 will occur switching the flow of fluid from the stable output duct 40 to the unstable output duct 42 to the valve 20. This will have the effect of opening the valve 20 starting the first phase of the cycle for delivering fluid to the delivery means 24 from the source 10. During this first phase of the cycle, the fluid flow through the second passage means to the tank 26 has been interrupted and since there is flow out of tank 26 via conduit 46 and regulating valve 62, the pressure in the tank will drop to a pressure of a lesser magnitude and at such magnitude, the atmospheric pressure at the duct 64 will switch the flow from the unstable output duct 42 back to the stable output duct 40, and the second phase of the cycle will commence, because switching of the fluid away from the unstable output duct 42 will result in the valve 20 returning to its closed state thereby interrupting flow of fluid to the delivery means 24. The flow through the second passage means to tank 26 will now continue until such time as the pressure within the tank has reached the pre-established magnitude when the fluid leaking therefrom through passage 46 will again affect a switching of flow by the fluidic switch 32 from the normally stable output duct 40 to the unstable output duct 42 causing the cycle to repeat.

In this described embodiment of the invention, the time required for a complete cycle depends upon the size of the tank 26. A larger tank takes longer to fill and longer to empty, thereby providing slower cycling. A smaller tank fills and empties faster providing faster cycling. The tank volume can be varied in a number of ways, such as by the piston 60 illustrated in the drawings. It is to be observed, however, that during operation of the apparatus the volume of the tank 26 is maintained constant. The volume is changed only for the purpose of changing the cycle time. Restrictions 36 and 48 are not absolutely essential, but when slow cycling is needed, restrictions 36 and 48 serve to reduce the effective size of the tank, by slowing down the flow. The time required to fill an empty tank 26 can be further adjusted by means of control valve 62. When valve 62 is open, tank 26 will fill slower and empty faster. Thus, valve 62 can be used to adjust the proportion of the filling and emptying phases within a given cycle.

Conduit 16 is provided with regulating valve 22 by which the rate of flow of the fluid in the first phase of the cycle can be regulated.

As previously indicated, the delivery system or means 24 can include face masks, mouthpieces, or it may provide a tent, pump, or the like. This delivery system may also be equipped with suitable safety devices, such as pressure regulating means, and in this system medication, water vapor, etc. may also be mixed with the flow of fluid.

It will be noted that in this apparatus, only a small amount of fluid is lost to the atmosphere at valve 62 or at the bleed port 53. Also, essentially no moving parts are involved and the apparatus embodies all of the basic requirements previously discussed.

In the described embodiment of the invention, the only moving part in the system during operation is the valve element 54 of the valve 20. As disclosed, the valve 20 is spring actuated to a closed position, but if desired, a pneumatically operated valve may be used interchangeably with valve 20 in any of the forms of the invention utilizing valve 20. For a brief description of a pneumatic valve arrangement of this type, attention is directed to FIGURE 12. In this arrangement of the invention, a valve 20a is positioned to maintain the conduit 16 in a normally closed state. The pneumatic valve 20a has chambers, not shown, at opposite ends from which bleed ports 53a permit the leakage of fluid. A fluidic switch 66a has its inlet duct 68a in direct communication with the source of supply 10 and has its stable output duct 70a in communication with one end of the pneumatic valve 20a via conduit 72a for maintaining the pneumatic valve 20a in a normally closed state. The control duct 74a is in direct communication with the fluidic switch 32, FIGURE 1, by means of the conduit 50. When fluid flows through the conduit 50, it will cause the fluidic switch 66a to switch the flow of fluid to the unstable output duct 76a and to the chamber, not shown, at the other end of the pneumatic valve 20a, thereby moving the valve element therein, not shown, to an open state. In other respects, this modified valve structure is the same as that shown in FIGURE 1, and the complete system will operate in essentially the same manner, except that the valve 20a will be entirely pneumatically operated rather than spring operated as is the case with respect to normally closed valve 20 of the FIGURE 1 embodiment.

It is not necessary that there be a valve such as valves 20 or 20a in the system. Thus, if desired, this valve can be eliminated so that there are no moving parts during operation of the system. For a description of a form of the invention of this character, attention is directed to FIGURE 3. In this embodiment of the invention, the like parts will be identified by like reference numbers as were used with respect to the embodiment of the invention illustrated in FIGURE 1. Thus, the second passage means comprises the source 10, conduit 12, valve 14, conduit 28, valve 30, fluidic switch 32, conduit 34, flow restricter 36, and tank 26. A return flow from the tank 26 is via the conduit 46, flow restricter 48, into the control duct 44. The fluidic switch 32 includes the stable output duct 40 which forms a part of the second passage means and includes the unstable output duct 42 which is now a part of the first passage means. Thus, the first passage means now includes the source 10, conduit 12, valve 14, conduit 28, valve 30, input duct 38, unstable output duct 42, conduit 78, check valve 80, proportioning valve 82 and delivery system or means 24.

As in the previous embodiment, changing the volume of tank 26 serves to establish the duration of the cycles, adjusting of the valve 62 determines the ratio of the two phases of the cycle, and adjusting the valve 82 determines the rate of flow of the fluid to the patient during the filling phase of each cycle.

The apparatus described with respect to FIGURE 1, 2 and 3 are controlled by the operator, that is, the operator sets the timing and the proportion of the open and close phases as well as the pressure to the patient. The operation that is carried out with respect to these embodiments of the invention cannot be triggered by the patient. In some instances, it is desirable that the patient be able to trigger the operation of the flow circuits, and attention is next directed to FIGURE 4 wherein an embodiment is disclosed which can be automatically operated or which can be operated in response to the patient. In this embodiment of the invention, parts which are common to the embodiment shown in FIGURE 1 will be referred to by the same reference numbers. As shown now in FIGURE 4, a source

10 is provided for delivery of fluid to the delivery system or means 24. A first passage means is provided which is the same as that shown in FIGURE 1, in that it includes a conduit 12, valve 14, conduit 16, valve 18, normally closed valve 20, pressure regulating valve 22 and delivery means 24.

The second passage means from source 10 includes conduit 12, valve 14, conduit 28, valve 30, fluidic switch device 84 having inlet duct 86 and stable output duct 88 and conduit 90 to the tank 26. In this embodiment of the invention, the fluidic switch 84 is bistable and of the boundary layer lock-on type which may be referred to as a preferenced four input bistable device. This device is so constructed that at the start, the flow will be through the input duct 86 and out the stable output duct 92 to conduit 94 for flow through conduit 50 to the valve 20 and through conduit 96, restricter 98 and valve 100 to the control duct 102 for switching the flow of fluid from the stable output duct 92 to the stable output duct 88, so that flow to the tank 26 can occur.

When flow is through the input duct 86 and output duct 92 of the bistable device 84, the fluid which flows through conduits 94 and 50 will close the normally open valve 83, thereby preventing flow of fluid through the first passage means, and when the flow is switched to the output duct 88 and to the tank 26, the fluid will commence flowing in the first passage means to the delivery means and at the same time will flow to the tank 26 via the second passage means until a pre-established pressure has been reached in the tank 26 at which time the flow of fluid therefrom through the conduit 104 to the control duct 106 will cause the switching of the flow from the stable output duct 88 to the stable output duct 92. This will have the effect of switching the flow back from the output duct 92 so that the valve 83 will again be closed interrupting the first phase of the cycle and starting the second phase, which will last until the leakage of pressure from the tank 26 has been sufficient to allow the fluid flowing into the bistable device 84 via the control duct 102 to overcome the pressure from the fluid flowing from duct 104 and control duct 106 thereby effecting the switching back from the output duct 92 to the output duct 88 and the re-cycle will again repeat itself.

The operation above described is another form of the present invention in which the system is completely automatic in its operation. When it is desired to permit the patient to trigger the operation of the circuits, valves 62 and 100 are closed and an auxiliary passageway comprising control duct 108, conduit 110, valve 112, check valve 114 is provided. The conduit 110 can extend through the delivery means 24 or directly to the patient.

In this arrangement, the apparatus is so constructed that at the start, the flow will be through input duct 86, stable output duct 92, conduit 94, conduit 50 to close valve 83. By virtue of the fact that valve 100 is closed, there will be no flow through input control duct 102. The flow will remain directed through input duct 86 and output duct 92 until a small negative pressure is applied through conduit 110. When the patient starts to breathe, the small negative pressure thus created will produce a pressure drop along the line 110 and control duct 108 forcing the flow from input duct 86 and output duct 92 to input duct 86 and output duct 88. At this point, the flow in line 50 stops, and the valve 83 opens. The flow through the second passage means then fills tank 26 until a pre-established pressure is obtained. When such a pre-established pressure is obtained, the flow commences through the conduit 104 and control duct 106 switching the flow from output duct 88 to output duct 92, thereby supplying pressure via conduit 50 to close valve 83 again. The cycle is repeated when negative pressure is again applied via conduit 110 and control duct 108.

Again, in this embodiment, the volume of tank 26 and restrictions 36 and 48 determine the time for which valve 83 is open. The check valve 114 prevents flow from the patient back into the system.

The embodiment of the invention shown in FIGURE 5 is a variation of the system shown in FIGURE 4. This embodiment of the invention provides a modified arrangement of the auxiliary circuit extending from the patient to the bistable switching device 84b for triggering the operation of the circuit. In this form of the invention, the auxiliary circuit from the patient includes the conduit 110 which is in communication with a control duct 116 which forms a part of the monostable switch device 118. The latter is directly in communication with the source 10 by means of the conduit 120 and valve 122. The conduit 120 leads to the input duct 124, and in normal operation the flow will be directly through the switch device 118 via the stable output duct 126 to atmosphere. The monostable switch device 118 has an unstable output duct 128 which is in communication with the conduit 96 via the conduit 130 and the valve 132. In some instances it may be desired to arrange valve 100 so that when open it discharges to atmosphere. When so arranged, the flow of fluid through ducts 86 and 92 will create a negative pressure in duct 133 which will cause switching of the flow of fluid to ducts 86 and 88.

When this embodiment of the invention is to be controlled by the patient, the valves 122 and 132 are open and valve 100 is closed. Then the control flow is through conduits 120, valve 122, input duct 124 and stable output duct 126 to atmosphere. When the patient starts to breathe and thereby starts to apply a small negative pressure through conduit 110, the flow is switched from stable output duct 126 to unstable output duct 128, and from there to conduit 130, valve 132, conduit 96 and control duct 102 to switch the flow from output duct 92 to output duct 88. From this point, the cycle operates in an identical manner as described previously in connection with FIGURE 4. As soon as the pressure increases in conduit 110, the flow will again be through ducts 124 and 126 with the consequent changing to the phase wherein no fluid is delivered to the patient, and the cycle starts anew when a negative pressure is applied through conduit 110.

I claim:

1. Apparatus for filling an enclosure intermittently with a fluid in cycles of uniform duration including a first phase for delivering fluid to said enclosure and a second phase for interrupting delivery of fluid to said enclosure, comprising a source of fluid under pressure, delivery means for delivering fluid to said enclosure, a tank, first passage means extending form said source to said delivery means, second passage means extending from said source to said tank, each of said passage means being in either a closed state or an open state, a fluidic switch operatively associates with said first and second passage means responsive to pressure in said tank of a pre-established magnitude to start one of said phases by interrupting flow of fluid through said second passage means and effecting a change in the state of said first passage means and thereafter in response to a second pressure condition to start the other phase by resuming the flow of fluid through said second passage means and effecting a change in the state of said first passage means.

2. Apparatus as defined by Claim 1, wherein said tank includes means for selectively changing its effective volume so as to change the duration of each of said cycles.

3. Apparatus as defined in Claim 1, wherein said tank includes pressure regulating means associated therewith for selectively establishing the duration of time for change of pressure in said tank from a pressure of one magnitude to said pre-established magnitude so as to change the duration of one of said phases.

4. Apparatus as defined by Claim 1, wherein said first passage means includes a pressure regulating means for setting the pressure of the fluid flowing to said enclosure.

5. Apparatus as defined by Claim 1, wherein said first passage means is in a normally closed state and said second passage means is in a normally open state, and said fluidic switch is responsive to pressure in said tank of a pre-established magnitude to start said first phase by interrupting flow of fluid through said second passage means and effecting flow of fluid through said first passage means and thereafter in response to pressure in said tank of lesser magnitude to start said second phase by interrupting flow of fluid through said

first passage means and effecting resumption of fluid through said second passage means.

6. Apparatus as defined by Claim 5, wherein said tank includes means for selectively changing its effective volume so s to change the duration of said cycles.

7. Apparatus as defined by Claim 5, wherein said tank includes pressure regulating means for selectively establishing the duration of time for change of pressure in said tank between said pre-established magnitude and said lesser magnitude so as to change the relative durations of said first and second phases.

8. Apparatus as defined by Claim 5, wherein said first passage means includes an unstable output duct of said fluidic switch and said second passage means includes a stable output duct of said fluidic switch.

9. Apparatus as defined by Claim 5, wherein said first passage means includes a normally closed valve in communication with said fluidic switch, said fluidic switch being operable in response to pressure in said tank of said pre-established magnitude to supply fluid to said normally closed valve for opening the same.

10. Apparatus as defined by Claim 9, wherein said normally closed valve is spring biased to its closed position and is responsive to fluid from said fluidic switch to move to an open position.

11. Apparatus as defined by Claim 9, wherein a second fluidic switch is in communication with the first-named switch and said normally closed valve, said second fluidic switch being operable to direct fluid to said valve to maintain the same open during said first phase and to direct fluid to said valve to maintain the same closed during said second phase.

12. Apparatus as defined by Claim 1, wherein said first passage means is normally open and includes a normally open valve, said fluidic switch is a bistable device in which the input duct and one stable output duct are a segment of said second passage means, the input duct and the other stable output duct being in communication with said valve to bias the same to a closed state, said fluidic switch being responsive to closing of said valve to switch flow from said other stable output duct to said one output duct and thereby to changing said first passageway to an open state by effecting opening of said valve, said fluidic switch being responsive to pressure of said pre-established magnitude in said tank to switch flow from said one output duct back to said other output duct.

13. Apparatus as defined by Claim 12, wherein said tank includes means for selectively changing its effective volume so as to change the duration of said cycles.

14. Apparatus as defined by Claim 12, wherein said tank includes pressure regulating means for selectively establishing the duration of time for change of pressure in said tank between said pre-established magnitude and said lesser magnitude so as to change the relative durations of said first and second phases.

15. Apparatus as defined by Claim 12, wherein means are associated with said fluidic switch to render it non-responsive to closing of said valve, and an auxiliary passage means extends from said fluidic switch to said enclosure, said fluidic switch being responsive to a pressure condition in said auxiliary passage means to switch flow from said other stable output duct to said one output duct.

16. Apparatus as defined by Claim 15, wherein said auxiliary passage means includes a second fluidic switch responsive to a negative pressure in said enclosure to direct fluid under pressure to the first-named switch for effecting the switching of said flow from said other stable output duct to said one output duct.

17. Apparatus as defined by Claim 1, wherein said first passage means is normally open and includes a normally open valve, said fluidic switch is a bistable device in which the input duct and one stable output duct are a segment of said second passage means, the input duct and the other stable output duct being in communication with said valve to bias the same to a closed state, and an auxiliary passage means extends from said fluidic switch to said enclosure, said fluidic switch being responsive to a pressure condition in said auxiliary passage means to switch flow from said other stable output to said one output duct and thereby to effect opening of said valve, said fluidic switch being responsive to pressure of a pre-established magnitude in said tank to switch flow from said one output duct back to said other output duct.

18. Apparatus as defined by claim 17, wherein said auxiliary passage means includes a second fluidic switch responsive to a negative pressure in said enclosure to direct fluid under pressure to the first-named switch for effecting the switching of said flow from said other stable output duct to said one output duct.

19. Apparatus for filling an enclosure intermittently with a fluid in cycles of uniform duration including a first phase for delivering fluid to said enclosure and a second phase for interrupting delivery of fluid to said enclosure, comprising a source of fluid under pressure, delivery means for delivering fluid to said enclosure, a tank, first passage means extending from said source to said delivery means in a normally out-of-communication state, second passage means extending from said source to said tank in a normally in-communication state, a fluidic switch operatively associated with said first and second passage means responsive to pressure in said tank of a pre-established magnitude to start said first phase by interrupting normal flow of fluid through said second passage means and effecting flow of fluid through said first passage means and thereafter in response to pressure in said tank of a lesser magnitude to start said second phase by interrupting flow of fluid through said first passage means and effecting resumption of flow of fluid through said second passage means.

20. Apparatus as defined by claim 19, wherein said first passage means includes a normally-closed valve for maintaining said delivery means out of communication with said source, said valve being responsive to fluid under pressure to open said valve, and said fluidic switch is in communication with said normally-closed valve to open the same when the fluidic switch responds to said pre-established pressure to interrupt flow of fluid through said second passage.

21. Apparatus as defined by claim 19, wherein said fluid switch is a monostable device, and said second passage means includes the source input channel and the stable output channel, and said first passage means includes the source input channel and the other output channel.