June 14, 1960 W. L. McGRATH 2,940,274

PURGING ARRANGEMENTS FOR ABSORPTION REFRIGERATION SYSTEMS

Filed March 16, 1956 2 Sheets-Sheet 1

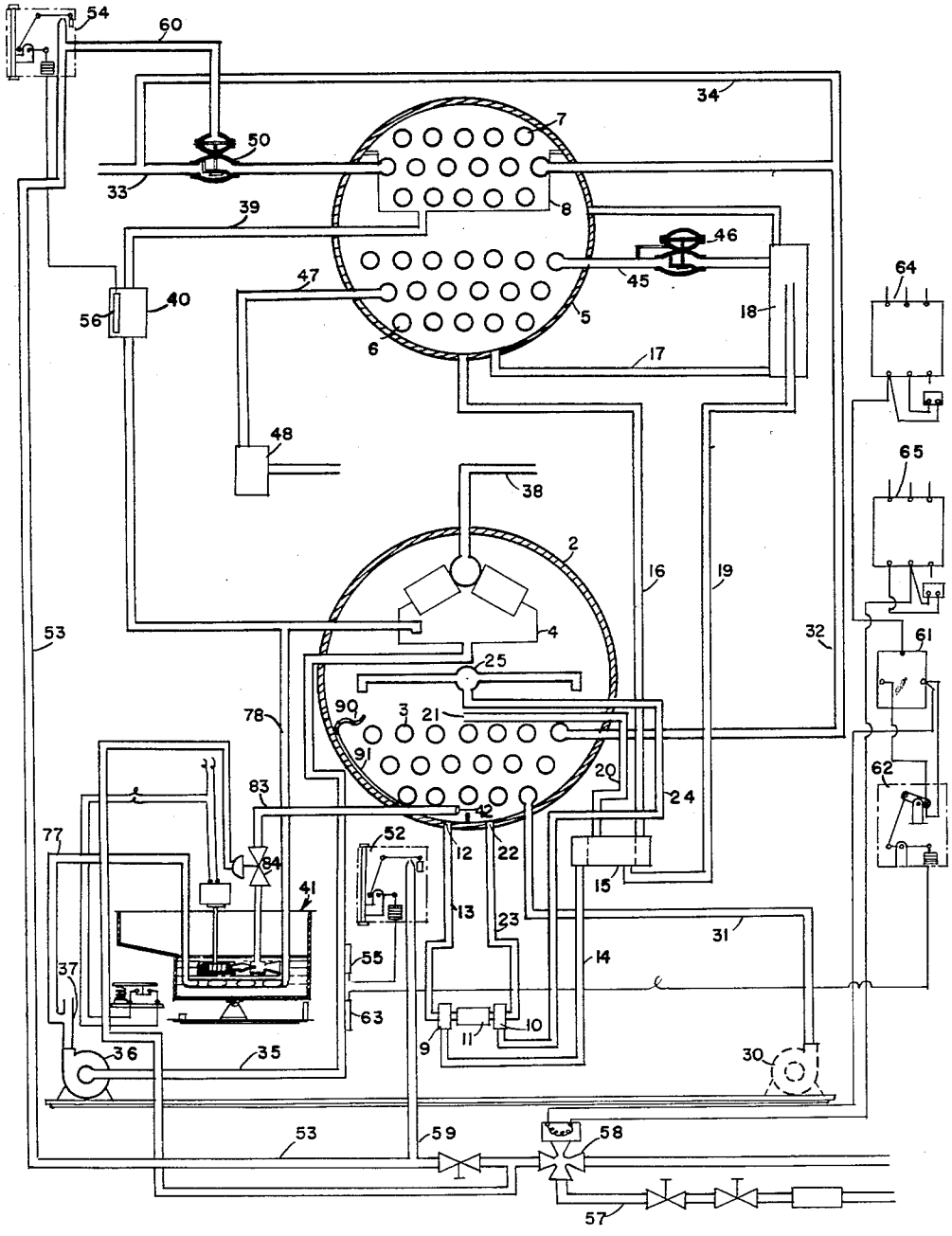


FIG. 1

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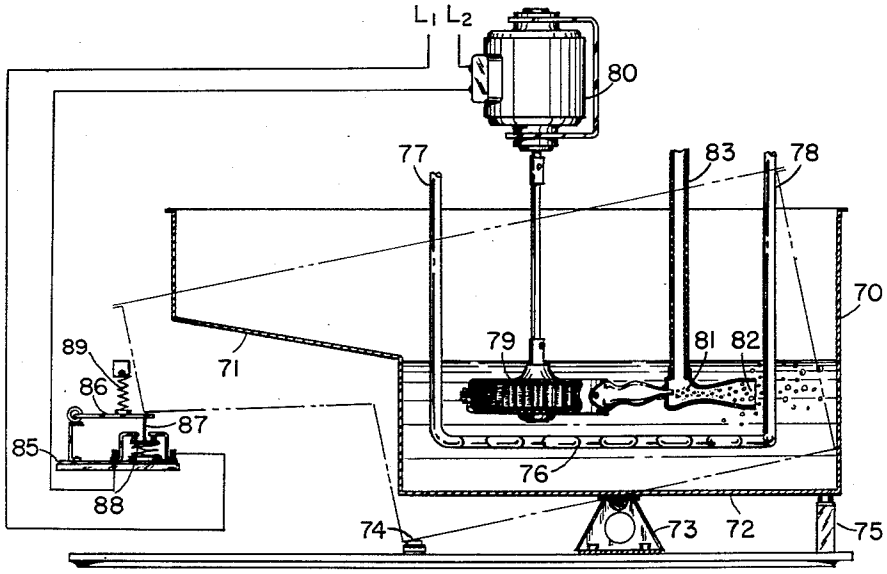


FIG. 2

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2,940,274

PURGING ARRANGEMENTS FOR ABSORPTION REFRIGERATION SYSTEMS

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10 Claims. (Cl. 62—85)

This invention relates to a purging arrangement for an absorption refrigeration system, and more particularly, to a purging arrangement for withdrawing non-condensible gases from the refrigeration system without substantial loss of refrigerant or absorbent in the system.

In Berestneff, Patent No. 2,520,027, granted August 22, 1950, there is disclosed a purge mechanism for an absorption refrigeration system which includes a steam ejector and a water ejector disposed in series to withdraw air or other non-condensible gases from the absorber and condenser of the absorption refrigeration system. This mechanism is satisfactory in use but is somewhat expensive in initial cost and operating costs and requires considerable maintenance in use. The mechanism operates continuously so that over a period of time small quantities of refrigerant and absorbent are withdrawn from the system and discharged to waste with the non-condensible gases, steam condensate and water employed to actuate the water ejector.

The chief object of the present invention is to provide a purging arrangement for an absorption refrigeration system which obviates the disadvantages inherent in prior arrangements.

An object of the invention is to provide a purging arrangement for absorption refrigeration systems which returns refrigerant withdrawn from the refrigeration system to the system, thus eliminating the necessity of additional refrigerant and/or absorbent being added to the system during long continuous periods of operation.

A further object is to provide a purging arrangement for an absorption refrigeration system employing an absorbent solution substantially the same as the absorbent solution employed in the refrigeration system which is capable of withdrawing non-condensible gases and reclaiming and returning the refrigerant to the refrigeration system without interference with the operation of the refrigeration system.

A still further object is to provide a purging arrangement for an absorption refrigeration system which is effective to withdraw non-condensible gases and to return automatically excess absorbent solution to the refrigeration system, thus eliminating waste and inefficient operation of the refrigeration system. Other objects of the invention will be readily perceived from the following description.

This invention relates to a purging arrangement for an absorption refrigeration system comprising, in combination, a container, a pivot member supporting the container in a first position, said container tilting upon the pivot member to a second position when a desired level of solution in the container is attained, a pump for circulating solution in the container, an ejector connected to the pump having a nozzle opening, a line adapted to connect the ejector with the absorber of the refrigeration system whereby discharge of solution through the ejector by said pump induces non-condensible gases from the absorber and forwards the non-condensible gases to the container for discharge to ambient atmosphere, means

for controlling the operation of the pump, tilting of the container actuating said means to discontinue operation of the pump whereby atmospheric pressure forces solution in the tank through said line to the absorber until a desired level of solution in the container is attained permitting the container to return to its first position thus permitting said means to resume operation of the pump.

This invention further relates to a method of purging an absorption refrigeration system including an absorber, an evaporator, a generator and a condenser in which the steps consist in circulating solution in a container to induce non-condensible gases from the absorber and, when the volume of solution in the container increases to a desired level, tilting the container to discontinue operation of circulation means thereby discontinuing circulation of solution in the container and withdrawal of non-condensible gases from the absorber, supplying solution in the container to the absorber, and, when the volume of solution in the container has decreased to a desired level, returning the container to its first position to resume operation of the circulation means thereby again circulating solution in the container and withdrawing non-condensible gases from the absorber.

The attached drawings illustrate a preferred embodiment of the invention, in which

Figure 1 is a diagrammatic view of an absorption refrigeration system including the purging arrangement of the present invention; and

Figure 2 is a sectional view of the purging arrangement.

Referring to the attached drawings, there is illustrated in Figures 1 and 2 the purging arrangement of the present invention employed in an absorption refrigeration system of the type disclosed and claimed in the co-pending application of Louis H. Leonard, Serial No. 505,369, filed May 2, 1955, now Patent No. 2,840,997, entitled Absorption Refrigeration Systems. Referring specifically to Figure 1, the absorption refrigeration system comprises a shell 2 containing a plurality of tubes 3 which cooperate with the shell to form an absorber. Placed in shell 2 above absorber 3 is a pan-like member 4 which cooperates with shell 2 to form an evaporator.

A second shell 5, preferably, is placed above the first shell. Tubes 6 extend in the lower portion of shell 5 and cooperate with shell 5 to form a generator or boiler. A plurality of tubes 7 are placed in the upper portion of shell 5 which cooperate with a pan-like member 8 to form a condenser.

A double pump arrangement is provided to circulate solution through the system. This arrangement includes pump 9 which serves to supply weak solution from the absorber to the generator and pump 10 which serves as an absorber pump. Pumps 9 and 10 are driven by a motor 11. If desired, separate motors may be provided.

Pump 9 withdraws weak solution from absorber 3 through outlet or sump 12 and line 13. Pump 9 forwards the weak solution through line 14, heat exchanger 15 and line 16 to generator 6. Strong solution is drawn from generator 6 through line 17 to an overflow arrangement 18 which maintains a desired level of solution in generator 6 and is returned to the absorber through line 19, heat exchanger 15, line 20 and inlet 21 of absorber 3 by forces of gravity. Strong solution may be dumped in the absorber over the tubes 3 or if desired may be discharged against an interior wall of shell 2.

Pump 10 is the absorber pump and is employed to withdraw a solution of intermediate concentration from absorber 3 through outlet 22 and line 23, forwarding the recirculated solution through line 24 to the spray arrangement 25 of the absorber. Sprays 25 serve to distribute the recirculated solution over the tubes throughout the length of the absorber 3. It will be understood the strong

solution mixes to some extent with solution in the absorber and that further mixing occurs as pump **10** forwards the mixed solution so that a solution having a concentration intermediate the concentrations of the strong and weak solutions is circulated. It is important that the strong solution be discharged in the absorber at a place where interference with the purging operation cannot occur.

The strong solution is superheated with regard to pressure existing in the absorber so that it flash cools upon discharge in the absorber liberating a considerable amount of water vapor. It is important that this vapor be liberated in a manner that does not interfere with the collection of non-condensible gases at a specific location beneath the tubes.

Pump **30** supplies condensing water through line **31** to the tubes **3** of the absorber. The condensing water after passage through tubes **3** passes through line **32** to the tubes **7** of the condenser. The condensing water after passage through the tubes of the condenser is discharged to a cooling tower or drain through line **33**. If desired a by-pass line **34** is provided about tubes **7** of the condenser, extending from line **32** to line **33**.

Chilled water is withdrawn from the evaporator **4** through line **35** by pump **36** and is circulated to a place of use which may be the central station of an air conditioning system through line **37**. The chilled water is returned to the evaporator through line **38** and is flash-cooled in the evaporator the flashed vapor passing to the absorber.

Condensate leaves condenser **7** through line **39** and is returned to the evaporator, being flash-cooled in the evaporator, the flashed vapor passing to the absorber, as previously described. A tank or container **40** is placed in line **39**, for a purpose hereinafter described.

The purging arrangement **41** of the present invention is provided to remove non-condensible gases from the system. This purging arrangement will be more fully described hereinafter. A purge line **42** extends generally longitudinally of the absorber below the tube bundle, preferably, at the center of the bundle.

Steam is supplied to the tubes **6** of the generator through line **45**. A pressure regulating valve **46** may be placed in line **45** to assure desired steam pressure in the generator. Valve **46** assures that pressure of steam passing to the generator is controlled at a predetermined point. Steam condensate leaves the tubes of generator **6** through line **47**, a steam trap **48** being placed in line **47** to assure that only condensate leaves the generator.

A normally closed pneumatic valve **50** is placed in line **33** between the tubes **7** of the condenser and the connection of by-pass line **34** with line **33**. Valve **50** regulates passage of condensing water through the tubes of condenser **7**. By-pass **34** assures that flow of condensing water is maintained substantially constant while permitting variation in the flow of condensing water through the tubes of condenser **7**.

A thermostatic control **52** regulates the pressure of air passing through branch line **53** to a second thermostatic control **54**. Thermostatic control **54** in turn regulates the air pressure applied to valve **50**. Control **52** is actuated by means of a bulb **55** placed adjacent chilled water line **35**. Bulb **55** reflects the temperature of chilled water which in turn indicates the load imposed upon the system. Control **54** is actuated by bulb **56** placed in container **40** in line **39** and reflects saturation temperature corresponding to pressure in shell **5**.

Compressed air is supplied to the controls through main air line **57**. Preferably a solenoid valve **58** or relay of suitable design is placed therein as a safety control. Air pressure passes from line **57** to line **53**. Thermostat **52** is connected to line **53** by branch line **59**; thus, pressure in branch line **53** may be regulated by thermostat **52** bleeding a portion of air therein to the atmosphere in accordance with the temperature of the chilled water reflecting the load imposed upon the system. Branch line **53** is connected to valve **50** by line **60**. Thermostats **52** and **54** regulate the air pressure supplied to the diaphragm of valve **50**.

A rotary switch **61** is provided which is connected to a mercury switch **62**. Mercury switch **62** may be actuated by means of a bellows and a bulb **63** placed adjacent chilled water line **35** and reflecting the temperature of chilled water therein. Mercury switch **62** serves in effect as a safety control. An increase in temperature of chilled water above a predetermined point opens this switch thereby closing valve **58** to prevent supply of air to controls **52**, **54** and valve **50**. The starters **64** and **65** actuate the motor **11** of pumps **9**, **10** and the motor (not shown) of chilled water pump **36**. The starter for the condensing water pump **30** is not shown since such pump and motor are generally provided by the installer.

The control arrangement shown herein is disclosed in the patent to Louis H. Leonard, No. 2,722,805, issued November 8, 1955, entitled Control Arrangement for Absorption Refrigeration System, and reference is made to such patent for a full description of the control arrangement and the manner in which it operates.

The term "weak solution" is used herein to describe a solution weak in absorbing power. The term "strong solution" is used herein to define a solution strong in absorbing power.

A preferred absorbing solution is a solution of lithium bromide, in water; the preferred refrigerant is water. With such solution preferably, the solution concentration leaving the generator is 66%. A greater concentration may permit crystallization to occur, causing solidification in the heat exchanger and, perhaps, in other portions of the system.

The purging arrangement **41** is shown in Figures 1 and 2. Referring to Figures 1 and 2 there is shown a container or tank **70** adapted to contain a solution of absorbent and refrigerant similar to the absorbent and refrigerant employed in the absorption refrigeration system. Preferably, the container is thermal and sound insulated. The solution employed in the present purging arrangement comprises a solution of lithium bromide and water similar to the absorbent and refrigerant employed in the absorbent refrigeration system with which the purging arrangement is used. It will be understood, of course, other solutions of absorbent and refrigerant may be used depending upon the absorbent and refrigerant employed in the refrigeration system.

The container **70** has one side indicated at **71** extending outwardly at an angle so that the top of the container is of greater length or has a greater area than the base **72** of the container. The container is mounted on a pivot member **73**. Due to the contour of the container, as the volume of solution in the container increases to a predetermined level or volume, the container tilts or pivots on member **73**, toward the left as shown in the figures, to the position shown in dotted outline. Suitable stop members **74**, **75** are provided to restrain movement of the container beyond a desired point.

A cooling coil **76** is placed in the container and is connected to chilled water line **37** or the outlet of pump **36** by line **77**. The outlet of coil **76** may be connected to line **78** to return chilled water to the evaporator **4** after its passage in heat exchange relation with solution in container **70**. Other sources of cooling water may be employed, if desired.

A pump **79** driven by motor **80** is placed in container **70** and is connected to an ejector **81** also in the container to circulate solution in the container. Motor **80** is connected in the electrical circuit of the system. The ejector **81** has a nozzle outlet **82**. The suction side of ejector **81** is connected by line **83** to purge line **42** of the absorber. A suitable shut-off valve **84** is placed in line **83** as shown in Figure 1.

A suitable switch member **85** is placed in the electrical

circuit actuating motor 80 of pump 79. When non-condensible gases are being purged from the absorber, switch 85 is in closed position permitting energization of motor 80. An arm 86 carrying a finger 87 is provided adjacent the switch arm 88 of switch 85. A spring 89 holds the arm 86 away from switch arm 88. However, when container 70 is tilted, it contacts arm 86 moving it downward toward switch arm 88 and urging finger 87 in contact with switch arm 88 to move it from one of its contacts thus breaking the electrical circuit and deenergizing motor 80.

Considering the operation of the purging arrangement, lithium bromide solution is discharged by pump 79 through ejector 81 to induce non-condensible gases from the absorber through line 83. A properly designed ejector, of course, will pull a vacuum corresponding to the saturated vapor pressure of the liquid being discharged through it. The solution and non-condensible gases pass from outlet 82 of the ejector into the container where the solution is again circulated by pump 79. The non-condensible gases bubble off to atmosphere in the container.

Since cooling coil 76 is supplied with chilled water from the refrigeration system, it possesses a lower vapor pressure than solution circulated in the refrigeration system because it is cooler; thus, the suction pressure of ejector 81 is lower than pressure in the absorber. Since pressure at the suction of ejector 81 is lower than pressure in the absorber, non-condensible gases are withdrawn from the absorber through line 83. Solution in the container absorbs and condenses refrigerant so that the solution separates refrigerant from non-condensible gases. The non-condensible gases are extremely insoluble in lithium bromide thus permitting such separation. The non-condensible gases are released from the surface of solution in the container to the atmosphere.

During the purging process, some amount of water vapor (refrigerant) is gradually removed from the refrigeration system. The refrigerant or water vapor is absorbed and condensed by the solution in the container gradually weakening the solution, increasing its vapor pressure and also increasing the volume of solution in the container. When the volume of solution in the container increases to a predetermined level, container 70 tilts from its first or normal position to a second position, shown in dotted outline in Figure 2. Movement of container 70 to a second position brings the container in contact with arm 86 thus urging finger 87 in contact with switch arm 88 to move switch arm 88 from its contact thus deenergizing motor 80 to discontinue operation of pump 79. Under these circumstances, pressure of ambient atmosphere is sufficient to force solution in the container through line 83 and purge line 42 to the absorber.

A decrease in the volume of solution in container 70 to a predetermined level permits container 70 to resume again its first or normal position, thereby moving finger 87 away from switch arm 88 to permit the circuit to be closed to energize motor 80 thereby placing pump 79 in operation, as previously described.

As stated above, the solution including the refrigerant is returned to the absorber, mixing with solution therein and being forwarded to the generator. In the generator, refrigerant is boiled off, condensed in the condenser and returned to the evaporator.

As shown in Figure 1, preferably, a tube 90 is provided in the absorber to collect a small amount of lithium bromide solution from the absorber spray arrangement 25. This small amount of solution drains through line 91 to the purge line 42 and is withdrawn with non-condensible gases to container 70. The amount of solution provided is not critical since only a minimum amount of solution need be provided.

The present invention provides a simple inexpensive purging arrangement for use with an absorption refrigeration system. It will be understood it may be employed with any desired type of absorption refrigeration system. The refrigeration system is maintained under vacuum during shut-down since the purge valve isolates the system from the purging arrangement thus obviating non-condensible gases seeping into the system during shut-down through the purge line. In the present invention, refrigerant vapor removed from the system is reclaimed and returned to the system.

While I have described certain preferred embodiments of the present invention, it will be understood the invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

I claim:

1. In a purging arrangement for an absorption refrigeration system the combination of a container open to the atmosphere, a pivot member supporting said container in a first position, said container tilting upon said member to a second position when a desired level of solution in the container is attained, a pump for circulating solution in the container, an ejector connected to the pump having a nozzle opening, a line adapted to connect the ejector with the absorber of the system whereby discharge of solution through the ejector by said pump induces non-condensible gases from the absorber and forwards the non-condensible gases to the container for discharge to ambient atmosphere, means for controlling the operation of said pump, tilting of said container actuating said means to discontinue operation of the pump, atmospheric pressure when operation of the pump is discontinued forcing solution in the tank through said line to the absorber until a desired level of solution in the container is attained permitting the container to return to its first position thus permitting said means to resume operation of said pump.

2. In a purging arrangement for an absorption refrigeration system, the combination of a container, a pivot member supporting said container in a first position, said container tilting upon said member to a second position when a desired level of solution in the container is attained, a pump for circulating solution in the container, an ejector placed in said container connected to the pump having a nozzle opening, a line adapted to connect the ejector with the absorber of the system whereby discharge of solution through the ejector by said pump induces non-condensible gases from the absorber and forwards the non-condensible gases to the container for discharge to ambient atmosphere, means for controlling the operation of said pump including a prime mover, a switch and an electrical circuit including the prime mover and the switch, said switch in normal position permitting energization of the prime mover, and means actuated by movement of the container to a second position to open said switch to discontinue operation of prime mover, at least some portion of the solution in said container being forced by atmospheric pressure to return to the absorber through said line when operation of said prime mover is discontinued.

3. A purging arrangement for an absorption refrigeration system according to claim 2 in which the control means include an arm carrying a finger, resilient means retaining said arm in normal position, tilting of the container moving the container in engagement with the arm to move the finger in contact with the switch arm to deenergize the pump.

4. A purging arrangement for an absorption refrigeration system according to claim 3 in which stop members are provided to regulate tilting movement of the container.

5. A purging arrangement for an absorption refrigeration system according to claim 1 in which stop members are provided to regulate tilting of the container.

6. In a method of purging an absorption refrigeration system including an absorber, an evaporator, a generator and a condenser, the steps which consist in circulating solution in a container to induce non-condensible gases from the absorber and when volume of solution in the container increases to a desired level, tilting the container

to discontinue operation of circulation means thereby discontinuing circulation of solution in the container and withdrawal of non-condensible gases from the absorber, supplying at least some portion of the solution in the container to the absorber when circulation of solution in the container is discontinued, and when the volume of solution in the container has decreased to a desired level returning the container to its first position to resume operation of the circulation means thereby again circulating solution in the container and withdrawing non-condensible gases from the absorber.

7. A method of purging an absorption refrigeration system according to claim 6 in which solution in the container is supplied to the absorber by means of atmospheric pressure when operation of the circulation means is discontinued.

8. In a purging system, the combination of a pivoted container sensitive to fluid level, a pump placed in the container for circulating fluid in the container, an ejector in the container connected to the pump for withdrawing non-condensible gases from an area to be purged, and means for discontinuing operation of the pump, said means being actuated by tilting of the container.

9. In a purging system, the combination of a container, a pivot member supporting the container in a first position, said container tilting upon said member to a second position when a desired level of fluid in the container is attained, a pump for circulating liquid in the container, an ejector connected to the pump, a line connecting the ejector with an area to be purged whereby discharge of liquid through the ejector by the pump induces non-condensible gases from the area and forwards the non-condensible gases to the container for discharge, means for controlling operation of the pump, tilting of the container to a second position actuating said means to discontinue operation of the pump thereby permitting fluid in the container to return to said area through said line, return of the container to its first position permitting said means to resume operation of the pump.

10. In a method of purging, the steps which consist in circulating fluid in a container to induce non-condensible gases from an area to be purged, and, when volume of fluid in the container increases to a desired level, tilting the container to discontinue operation of circulation means thereby discontinuing circulation of fluid in the container and withdrawal of non-condensible gases from the area while supplying at least some portion of the fluid to the area, and, when volume of fluid in the container has decreased to a desired level, returning the container to original position to resume purging of the area.

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