

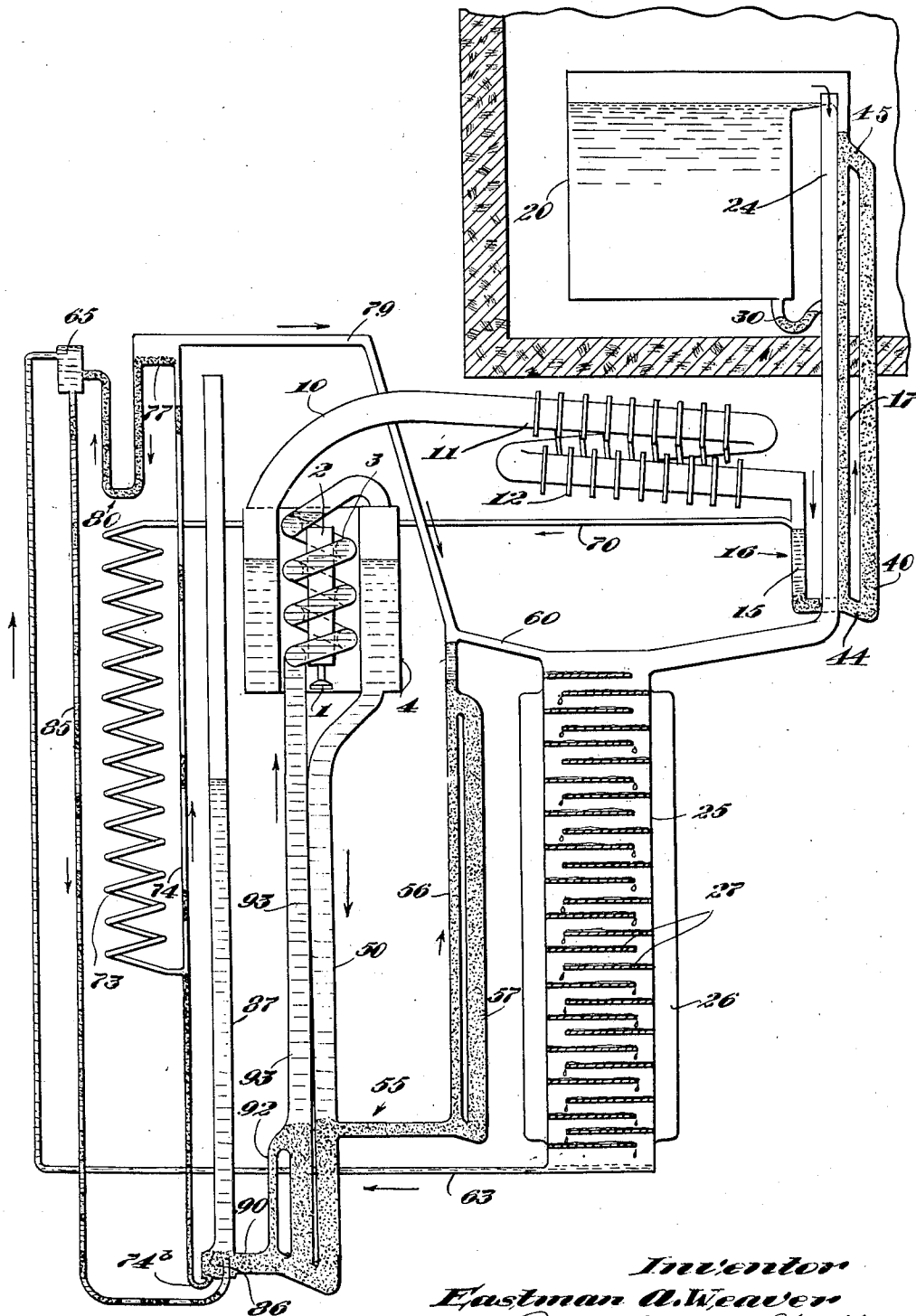
Aug. 29, 1933.

E. A. WEAVER

1,924,894

FLUID APPARATUS

Original Filed May 8, 1929



Inventor
Eastman A. Weaver
 by *Robert, Cushman & Woodberry*
Att'ys.

UNITED STATES PATENT OFFICE

1,924,894

FLUID APPARATUS

Eastman A. Weaver, Winchester, Mass., assignor,
by mesne assignments, to Stator Refrigeration,
Inc., a corporation of Delaware

Application May 8, 1929, Serial No. 361,316
Renewed September 23, 1932

22 Claims. (Cl. 62—119)

This invention relates to improvements in heat exchange systems such as refrigerating apparatus, for example of the absorption type, although certain aspects thereof are adapted to other applications, as for example to boiler feed apparatus.

The present invention permits the provision of a refrigerating system which may be free from moving parts and which is not liable to the occurrence of excessive pressures even under abnormal conditions, although permitting the boiler pressure to be high relative to the low pressures in the other portions of the apparatus, while avoiding mechanical feed pumps, valves or the like. Preferably a refrigerant having low vapor pressure at the temperature of the cooler is employed; for example, this pressure may be a small fraction of atmospheric pressure. Means are provided to permit the continued maintenance of such a low pressure within the system and to compensate for any slight leakage of non-condensable gases into the same which may occur and which might otherwise cause an undue rise in the pressures of the contained fluids. Accordingly a thermally operated pumping means is combined with the refrigerating system and comprises an auxiliary fluid circuit in portions of which an auxiliary liquid, such for example as mercury, may be utilized to pump the absorbent-refrigerant mixture back to the boiler or generator against a comparatively high pressure in the latter. Furthermore, this pumping means may be advantageously arranged to ensure the exhaustion of non-condensable gases from the system so that the occurrence of minute leaks in the same will not be objectionable and will not affect the operating efficiency thereof. Furthermore, the invention affords pressure balancing means between various parts of the refrigerant circuit which are at different pressures, such for example as the condenser and the evaporator or the boiler and absorber, such pressure balancing means preferably comprising columns of the comparatively heavy liquid, (e. g. mercury) which is utilized in the auxiliary or pumping circuit, through which the lighter refrigerant and/or absorbent may rise and with which they are substantially immiscible.

While for purposes of exemplification the various features herein shown are particularly illustrated as applied to a continuously operable refrigerating system of the absorption type, it is to be understood that certain aspects of the invention are broadly applicable to other uses such, for example, as to other forms of refrigerating systems or heat exchange systems or to boiler feed pumps of general application.

In the accompanying drawing, the figure is a diagrammatic illustration of one system embodying the principles of this invention.

Referring to the drawing, the numeral 1 designates a heating factor, such as a gas burner, which is supplied with a flue 2 about which the boiler coil 3 is arranged, the upper portion of this coil being connected with an annular separating chamber 4 disposed about the coil. Refrigerant vapor and a weak solution of refrigerant in the absorbent liquid pass into chamber 4, the vapor rising from the same into the upwardly extending rectifier duct 10 which is continued in a downwardly inclined portion 11 provided with cooling means such as fins 12 to form a refrigerant condenser. The lower portion of this condenser 11 is connected to an outlet 15 which forms one leg of a trap 16, the opposite leg 17 of which is higher than the leg 15, having its upper end connected to the cooler 20, for example, to the upper portion of the latter. The cooler, as shown, may be of the tank type having a vapor duct 24 connected to its upper portion and extending to an absorber 25. The latter may be provided with cooling fins 26 or the equivalent. Preferably pipes 17 and 24 are placed in juxtaposition to form a heat interchanger so that the temperature of the liquid rising through the former is lowered by the cold vapor from the cooler.

A trap 30 connects the lower portion of the cooler with the vapor pipe 24. Preferably this trap as well as the pipe 17 contains a comparatively heavy liquid, such as mercury, it being evident that the weight of the liquid column in pipe 17 balances the difference between the pressure in condenser 12 and in cooler 20 and that liquid refrigerant collecting at the mouth of pipe 15 tends to pass over into the other leg of the trap and to rise up to the cooler. Trap 30 is so arranged that the occurrence of an excess of liquid such as mercury in cooler 20 will cause the overflow of some liquid into vapor duct 24 and thence to the absorber.

In order to prevent sudden pressure changes within the system from causing the outflow of mercury from the pipe 17 a second pipe 40 of comparatively large diameter is joined to the upper and lower portions of the same by inclined connections 44 and 45. The latter are so arranged that globules of the lighter refrigerant will rise through the small pipe 17 to the cooler, while the large volume of the heavy liquid such as mercury in the large pipe 40 permits a slight change in the level of the contained liquid to compensate for radical changes in the condition

of the liquid column within the small pipe, as the same is affected by the amount of refrigerant rising therethrough, by sudden changes in pressure etc. It is further evident that the frictional resistance of the large pipe to changes in the position of the heavy liquid is comparatively low, thus aiding this function.

A drain 50 preferably is connected to the lower portion of separating chamber 4, this drain forming one leg of a trap 55, the opposite leg 56 of which contains mercury, it being evident that an increase in pressure above the pipe 50 will cause some of the weak solution from chamber 4 to pass over into the other leg of the trap and to rise to the top of the liquid column in pipe 56. A second pipe 57 of larger diameter is connected to the upper and lower portions of the pipe 56 to ensure the maintenance of a column of heavy liquid therein even under abnormal conditions. Pipe 56 is continued upwardly to join a downwardly inclined duct 60 through which the weak solution flows to the upper portion of absorber 25. The latter may be provided with a plurality of deflector plates or baffles 27 which cause the weak solution to follow a tortuous path and aid the absorption of vapor from the cooler 20 in the weak solution received from the pipe 60. The lower portion of the absorber is connected by a tube 63 to an entraining chamber 65. Preferably tube 63 has a restricted diameter to permit globules of stray mercury to be entrained in the same.

A shunt tube 70 preferably is connected to the duct 15 adjoining the condenser. This tube is provided with an elongate helical portion 73 of restricted diameter which affords considerable resistance to the flow of vapor therethrough. Accordingly only a relatively small portion of the refrigerant that remains in the vapor phase when reaching the upper part of tube 15 is shunted through tube 70. The lower end of the helical coil 73 is connected to a lifter tube 74 that forms part of the auxiliary heavy liquid or pumping circuit. Preferably this tube is of comparatively small diameter, i. e. of capillary dimensions, so that vapor vented into the same is effective in lifting successive slugs of mercury upwardly in tube 74 to a separating chamber 77. The upper portion of the latter is connected by a vapor return duct 79 to the pipe 60. Accordingly refrigerant is supplied at comparatively high pressure, i. e. at the pressure of the condenser, to tube 70—73 and thence to the lifter tube 74 while the vapor passes from this tube at the low pressure of the absorber. Consequently the refrigerant vapor tends to move up the lifter tube rapidly and to entrain mercury slugs, carrying the same to the chamber 77. As mercury collects in the latter it flows downwardly through one leg of a trap 80, the opposite leg of which is connected to the intermediate portion of entraining chamber 65.

A tube 85 of capillary size is adapted to receive successive slugs of mercury from this chamber and to entrain bodies of strong solution from tube 63 therebetween. Non-condensable gases also tend to be carried with the strong solution to the chamber 65 and to be entrained between the mercury slugs or globules in pipe 85. The lower end of the latter is connected to an upwardly projecting extension 86 which is adapted to vent liquid at the lower end of a standpipe 87. The latter contains a column of liquid, i. e. strong solution or such a solution and mercury, and its upper end preferably is open to the atmosphere so that non-condensable gases may

rise to the surface of the liquid column and be vented from the system.

The lower portion of the standpipe is connected by a trap 74^b to lifter pipe 74 which extends upwardly to its connection with pipe 71 and supplies mercury to be lifted by vapor from the latter. The lower end of standpipe 87 is connected to a horizontal pipe 90 which is provided with an upwardly extending branch 92 connected to pipe 93 and with a downwardly inclined continuation which joins the lower portions of pipes 50 and 93 containing mercury; the upper end of pipe 93 is connected to the boiler coil 3. Thus as the height of the column in pipe 87 increases, some of the solution will tend to pass over into duct 92 and rise through the same to pipe 93, the upper end of which is connected to the boiler coil 3. The large bodies of mercury contained in the lower portions of pipes 50 and 93 will tend to prevent any exhaustion of mercury from this portion of the system even under abnormal changes in pressure.

Obviously a system of this character may use a variety of absorbent and refrigerant fluids. The types of absorbents and refrigerants suggested in my copending application Serial No. 339,053, filed February 11, 1929, may be advantageously utilized, for example, in a system of this character. Among the refrigerants disclosed in that application are, for example, diethylamine as well as other amines such as propylamine, allylamine, and triethylamine, while the methanolamines and perhaps the more volatile ethanolamines are also suitable for this purpose, while for absorbents propionic or butyric acids as well as oleic, valerianic, caprylic, or caproic acids may be used. Due to the provision of columns of heavy liquid, such as mercury, for balancing pressure differences, a system of this character may be quite compact.

In the operation of this system it is evident that strong solution rising through pipe 93 is heated by the warm solution in pipe 50 and passes to vaporizer coil 3. A portion of the refrigerant is vaporized in the latter and passes with some of the solution to separating chamber 4 where the heat from the vaporizer causes the separation of additional refrigerant vapor from the solution. The vapor rises through pipe 10, and the major portion thereof passes into the condenser 11 where the refrigerant is liquefied. Due to the relatively high pressure in the condenser the weight of the column of heavy liquid such as mercury in pipe 17 is balanced and as the liquid collects at the lower part of the condenser the mercury at the bottom of trap 16 is sufficiently depressed to permit globules of the refrigerant to pass over into the longer leg of the trap and to rise through the same to cooler 20. As previously explained, the larger volume of mercury in the pipe 40 which is parallel to pipe 17 and is connected thereto prevents sudden changes in fluid or pressure conditions in the latter from materially affecting the amount of mercury contained therein.

The normal level of the liquid contained in cooler 20 may be substantially at the top of the vapor pipe 17 so that collection of excess liquid, which, for example, may result from the straying of absorbent to the cooler, will result in the spilling over of liquid from the latter into duct 24 and thence to absorber 25. While the upper portions of the mercury columns in pipes 17 and 40 are normally below the connection between the upper end of the former and the cooler so

that mercury is not likely to stray to the latter, the removal of mercury from the cooler is provided for by the trap 30, since stray mercury will tend to fall to the bottom of the cooler and collect in the trap causing a portion of the mercury in the opposite leg of the same to spill over into the vapor duct 24 whence it passes to the absorber 25 and to the tube 63 at the bottom of the same. Obviously the refrigerant vapor is drawn from the surface of the liquid contained in cooler 20 through duct 24 to the strong solution which flows downwardly over the deflector plates 27 in the absorber, thus the temperature of the cooler is reduced and refrigeration is provided.

A portion of the vapor rising to pipe 10 is shunted into the pipe 70, and the latter is connected to the mercury lifter tube 74, it being understood that when the system is in normal operation the mercury in the lifter tube will tend to stand above the end of pipe 71. Since the upper portion of tube 74 is connected through duct 79 to a low pressure portion of the system, i. e. the absorber, refrigerant vapor tends to flow through the tube 70 in response to the different pressure conditions at the opposite ends thereof and to flow upwardly through tube 74, entraining successive slugs of mercury and lifting the same to separating chamber 77. Even should refrigerant flowing through pipe 70 become condensed, it will be vaporized due to the low pressure in the lower end of pipe 73. As mercury piles up in the lower portion of chamber 77, successive slugs of mercury will pass out of the opposite leg of trap 80 into the entraining chamber 65. The strong solution from absorber 25 is drawn through that tube to the chamber 65 by the suction of successive slugs of mercury falling through tube 85. Stray mercury, for example from the cooler 20, which collects at the bottom of absorber 25 will form into occasional mercury slugs which will similarly be drawn through tube 63 to the entraining chamber 65.

Non-condensable gases will tend to collect either in the absorber or in the condenser. Gases occurring in the former will be drawn with the strong solution through tube 63 and be entrained between the mercury globules falling through tube 85. Non-condensable gases in the condenser will be swept toward the end thereof adjoining the mouth of the pipe 70 and pass into that tube with the refrigerant vapor, rising through the lifter tube 74 to the separating chamber 77 and thence passing through ducts 79 and 60 to the absorber from which the non-condensable gases are drawn to the entraining chamber 65 and tube 85. Since the latter is connected to the standpipe 87 and the liquid column therein is exposed to the atmosphere or any suitable gas receiving region, the non-condensable gases will rise through the liquid column in the standpipe and be exhausted from the system.

The height of the liquid column in the standpipe varies to compensate for changes in barometric pressure and in the internal pressures of the system. As the strong solution continues to collect in pipe 87 the height of the contained column will rise sufficiently to depress the mercury at the bottom of the standpipe to permit some of the solution to pass over into tube 92 through which it rises to pipe 93, thus completing the circuit. Mercury, on the other hand, tends to flow downwardly through the connection 74^b at the bottom of the standpipe and thence returns to the lifter pipe 74. The liquid column in pipe

56 balances the pressure difference between the absorber and the separating chamber 4 and is so arranged that portions of mercury which may accidentally pass into pipe 79 may collect at the top of the column and be returned to the main mercury circuit.

From the foregoing it is evident that the heavy liquid provided in the auxiliary circuit is lifted by the refrigerant, shunted through pipe 74 in order to circulate and entrain bodies of strong solution and non-condensable gases to return the strong solution to the boiler against the high pressure therein and to exhaust the gases to the atmosphere. It is further evident that the heavy liquid employed in the auxiliary pumping circuit may also form pressure-balancing columns, such for example as that provided between the cooler and condenser or between the separating chamber and the absorber, and it is further evident that an excess of mercury which passes into the main refrigerant circuit will automatically be returned to the heavy liquid circuit while the major portion of the working liquids of the refrigerating system which flow through the pumping circuit will be returned to the former. While a small portion of the working fluids may be lost from the top of the column in pipe 87 due to evaporation and to incomplete condensation of vapors out of the non-condensable gases, such a loss is so small that it may continue over a period of years without objectionably depleting the fluids within the system.

I claim:

1. Apparatus of the class described comprising a main fluid circuit having a high pressure portion and a low pressure portion, and means maintaining a difference of pressure therebetween, and means associated therewith to return fluid from the low to the high pressure portion of the system, said means comprising a fluid passage between said portions of the circuit and an auxiliary fluid circuit having a tube of capillary dimensions in common with said passage and means for supplying successive slugs of auxiliary liquid to the tube whereby fluid is entrained by the heavy liquid and pumped to the high pressure portion of the main circuit.

2. Apparatus of the class described comprising a main fluid circuit having a high pressure portion and a low pressure portion and means maintaining a difference of pressure therebetween, and means associated therewith to return fluid from the low to the high pressure portion of the system, said means comprising a fluid passage between said portions of the circuit, and an auxiliary fluid circuit having a tube of capillary dimensions in common with said passage and means for supplying successive slugs of auxiliary liquid to the tube, said passage including a connection between said tube and the high pressure portion of the circuit and means for separating the auxiliary liquid from the fluid flowing through said connection.

3. Apparatus of the class described comprising a main fluid circuit having a high pressure portion and a low pressure portion and means maintaining a difference of pressure therebetween, and means associated therewith to return fluid from the low to the high pressure portion of the system, said means comprising a fluid passage between said portions of the circuit and an auxiliary fluid circuit having a tube of capillary dimensions in common with said passage and means for circulating the auxiliary fluid through its circuit, said means including a shunt between the high and

low pressure portions of the main circuit where fluid from the main circuit entrains the auxiliary liquid thus supplying successive slugs of auxiliary liquid to the tube whereby fluid is pumped to the high pressure portion of the main circuit.

4. Apparatus of the class described comprising a main fluid circuit having a high pressure portion and a low pressure portion, and means for returning liquid from the high pressure portion to the low pressure portion, said means comprising an auxiliary liquid circuit containing a heavy, relatively non-volatile liquid, a shunt connection adapted to direct fluid from the high to the low pressure portion of the main circuit, said shunt and auxiliary circuit having a capillary tube portion in common where shunted vapor entrains the heavy auxiliary liquid, and a liquid connection between the high and low pressure portions of the main circuit, said connection also having a second capillary tube portion in common with the auxiliary circuit where liquid is entrained by said auxiliary liquid, and thus returned to the high pressure portion of the main circuit.

5. Apparatus of the class described comprising a main fluid circuit having a high pressure portion and a low pressure portion and means for returning liquid from the high pressure portion to the low pressure portion, said means comprising an auxiliary liquid circuit containing a heavy, relatively non-volatile liquid, a shunt connection adapted to direct fluid from the high to the low pressure portion of the main circuit, said shunt and auxiliary circuit having an upwardly extending capillary tube portion where shunted vapor lifts slugs of the heavy liquid, and a liquid connection between the high and low pressure portions of the main circuit including a downwardly extending capillary tube portion in common with the auxiliary circuit where liquid is entrained between falling slugs of said auxiliary liquid, and thus returned to the high pressure portion of the main circuit.

6. Apparatus of the class described comprising a main fluid circuit having a high pressure portion and a low pressure portion and means for returning liquid from the high pressure portion to the low pressure portion, said means comprising an auxiliary liquid circuit containing a heavy, relatively non-volatile liquid, a shunt connection adapted to direct fluid from the high to the low pressure portion of the main circuit, said shunt and auxiliary circuit having an upwardly extending capillary tube portion where shunted vapor lifts slugs of the heavy liquid, and a liquid connection between the high and low pressure portions of the main circuit comprising a downwardly extending capillary tube portion in common with the auxiliary circuit where liquid is entrained between falling slugs of said auxiliary liquid and thus returned to the high pressure portion of the main circuit, and means to supply non-condensable gases from said main circuit to said capillary tube portion, and means for venting said gases from the same to the air while permitting the continued circulation of the liquids.

7. Apparatus of the class described comprising a main fluid circuit having a high pressure portion and a low pressure portion and means for returning liquid from the high pressure portion to the low pressure portion, said means comprising an auxiliary liquid circuit containing a heavy, relatively non-volatile liquid, a shunt connection adapted to direct fluid from the high to

the low pressure portion of the main circuit, said shunt and auxiliary circuit having an upwardly extending capillary tube portion where shunted vapor lifts slugs of the heavy liquid and a liquid connection between the high and low pressure portions of the main circuit comprising a downwardly extending capillary tube portion in common with the auxiliary circuit where liquid is entrained between falling slugs of said auxiliary liquid, and thus returned to the high pressure portion of the main circuit, and means to supply non-condensable gases from said main circuit to said capillary tube portion, and means for venting said gases from the same to the air while permitting the continued circulation of the liquids, said means including a liquid column with its lower end connected to said second tube and its upper end exposed to a region of gas exhaustion.

8. Apparatus of the class described comprising a main fluid circuit having a high pressure portion and a low pressure portion and means for returning liquid from the high pressure portion to the low pressure portion, said means comprising an auxiliary liquid circuit containing a heavy, relatively non-volatile liquid, a shunt connection adapted to direct fluid from the high to the low pressure portion of the main circuit, said shunt and auxiliary circuit having a capillary tube portion in common where shunted vapor entrains the heavy auxiliary liquid, and a liquid connection between the high and low pressure portions of the main circuit, said connection also having a second capillary tube portion in common with the auxiliary circuit where liquid is entrained by said auxiliary liquid and thus returned to the high pressure portion of the main circuit, and pressure balancing means within the main circuit comprising a column of the heavy auxiliary liquid through which the circulating liquid may rise.

9. Apparatus of the class described comprising a main fluid circuit having a high pressure portion and a low pressure portion and means for returning liquid from the high pressure portion to the low pressure portion, said means comprising an auxiliary liquid circuit containing a heavy, relatively non-volatile liquid, a shunt connection adapted to direct fluid from the high to the low pressure portion of the main circuit, said shunt and auxiliary circuit having a capillary tube portion in common where shunted vapor entrains the heavy auxiliary liquid, and a liquid connection between the high and low pressure portions of the main circuit, said connection also having a second capillary tube portion in common with the auxiliary circuit where liquid is entrained by said auxiliary liquid, and thus returned to the high pressure portion of the main circuit, and means for automatically returning to the auxiliary circuit auxiliary liquid that strays to the main circuit.

10. Apparatus of the class described comprising a main fluid circuit having a high pressure portion and a low pressure portion and means for returning liquid from the high pressure portion to the low pressure portion, said means comprising an auxiliary liquid circuit containing a heavy, relatively non-volatile liquid, a shunt connection adapted to direct fluid from the high to the low pressure portion of the main circuit, said shunt and auxiliary circuit having a capillary tube portion in common where shunted vapor entrains the heavy auxiliary liquid, and a liquid connection between the high and low pressure portions of the main circuit, said connection also having

a second capillary tube portion in common with the auxiliary circuit where liquid is entrained by said auxiliary liquid and thus returned to the high pressure portion of the main circuit, and pressure balancing means within the main circuit comprising a column of the heavy auxiliary liquid through which the circulating liquid may rise, and means for returning to the auxiliary circuit an excess of the auxiliary liquid that strays to the main circuit.

11. Absorption refrigerating apparatus comprising an absorber-generator-condenser-evaporator circuit, and suitable absorbent and refrigerant fluids in said apparatus, and pressure balancing means in the circuit comprising columns of a heavy liquid immiscible with the absorbent and refrigerant and through which the absorbent and refrigerant may pass.

12. Absorption refrigerating apparatus comprising an absorber-generator-condenser-evaporator circuit, and suitable absorbent and refrigerant fluids in said apparatus, pressure balancing means in the circuit including a column of liquid heavier than the refrigerant and immiscible therewith between the condenser and evaporator through which the refrigerant may rise to the latter.

13. Absorption refrigerating apparatus comprising an absorber-generator-condenser-evaporator circuit, and suitable absorbent and refrigerant fluids in said apparatus, pressure balancing means in the circuit, including a column of liquid heavier than the absorbent and immiscible with the refrigerant and absorbent, through which the weak solution may rise to the absorber.

14. Absorption refrigerating apparatus comprising an absorber-generator-condenser-evaporator circuit, and suitable absorbent and refrigerant fluids in said apparatus, pressure balancing means in the circuit including a column of liquid heavier than the refrigerant between the condenser and evaporator through which the refrigerant may rise to the latter, said column being connected to the cooler adjoining the normal surface of the liquid contained therein, and a vapor pipe extending downwardly from the upper portion of the cooler in heat transfer relation to said column.

15. Absorption refrigerating apparatus comprising an absorber-generator-condenser-evaporator circuit, and suitable absorbent and refrigerant fluids in said apparatus, pressure balancing means in the circuit including a column of liquid heavier than the refrigerant between the condenser and evaporator through which the refrigerant may rise to the latter, said column being connected to the cooler adjoining the normal surface of the liquid contained therein, and a vapor pipe extending downwardly from the upper portion of the cooler in heat transfer relation to said column; and a trap containing heavy liquid and connecting the lower portion of the cooler to a vapor duct between the latter and the absorber.

16. Apparatus of the class described comprising an absorber-generator-condenser-evaporator circuit through which refrigerant is circulated, and means containing mercury and associated therewith for pumping strong liquid from the absorber to the generator while concomitantly exhausting non-condensable gases from the main circuit, said means including a tube of capillary dimensions forming a part of the strong liquid duct between the absorber and generator in which falling slugs of mercury entrain the strong liquid, and means associated with the system automati-

cally to return to the pumping means stray mercury that passes into the refrigerant circuit.

17. Apparatus of the class described comprising an absorber-generator-condenser-evaporator circuit through which refrigerant is circulated, and means containing mercury and associated therewith for pumping strong liquid from the absorber to the generator while concomitantly exhausting non-condensable gases from the main circuit, said means including a tube of capillary dimensions forming a part of the strong liquid duct between the absorber and generator in which falling slugs of mercury entrain the strong liquid, a column of the mercury balancing the difference between the pressure of the condenser and cooler and permitting the flow of liquid refrigerant from the former to the latter, said system being arranged automatically to maintain the mercury column and to return an excess of mercury from the main circuit to the pumping means.

18. In apparatus of the class described, a fluid circuit having high and low pressure portions, means to circulate fluid therethrough, and pressure balancing means between the portions of the circuit comprising a column of heavy liquid immiscible with the circulating fluid, said column being disposed in one leg of a trap through which bodies of the circulating fluid may rise, and a column of the heavy liquid parallel to the first column and having a larger cross-sectional area, said columns having their upper and lower parts connected, so that variation in the amount of circulating fluid in the first column does not materially affect the amount of the heavy liquid in this portion of the system.

19. In apparatus of the class described, a fluid circuit having high and low pressure portions, means to circulate fluid therethrough, and pressure balancing means between the portions of the circuit comprising a column of heavy liquid immiscible with the circulating fluid, said column being disposed in one leg of a trap through which bodies of the circulating fluid may rise, and a column of the heavy liquid parallel to the first column and having a larger cross-sectional area, and connections inclined downwardly from said first to said second column whereby the lighter circulating fluid rises through the first column, so that variation in the amount of circulating fluid in the first column does not materially affect the amount of the heavy liquid in this portion of the system.

20. In combination a low pressure refrigerating system including a suitable fluid circuit, a factor for imparting energy to the system to circulate fluid therethrough and means comprising a fluid shunt connected to said circuit so that fluid flows therethrough in parallel to the fluid flow in the circuit as a result of the energy received from said factor, a heavy liquid circuit having a tube portion of small diameter in common with said shunt, where globules of the heavy liquid are lifted by the fluid flowing through the shunt, another portion of said heavy liquid circuit comprising a tube of small diameter having its upper end arranged to receive heavy liquid globules and gas bodies pocketed therebetween and its lower end arranged to effect the separation of the gas and heavy liquid, and means to return to the refrigerating system circuit condensable fluid that strays therefrom to the region of gas entrainment.

21. A refrigerating system comprising a refrigerant circuit, a low pressure portion of the circuit including a cooler, a high pressure portion

of the circuit including a condenser and pressure-balancing means between said portions of the circuit, means for removing non-condensable gases from said circuit, said means comprising a
5 fluid passage connected to the high and low pressure portions of the circuit to shunt a portion of the refrigerant from the same, a heavy liquid circuit, said fluid passage and circuit having a portion
10 in common where the shunted refrigerant lifts the heavy liquid, another portion of said circuit comprising a tube of small diameter having its upper end arranged to receive heavy liquid globules and gas bodies pocketed there-
15 between and its lower end arranged to effect the separation of the gas and heavy liquid, and means

connected to said tube to return stray refrigerant to the refrigerant circuit.

22. The art of low pressure refrigeration comprising circulating a refrigerant of low vapor pressure from a region of high pressure where it is condensed to a region of low pressure where it is vaporized to produce a low temperature shunting a portion of the refrigerant from said circuit
80 to lift a heavy liquid, entraining non-condensable gases from the circuit between globules of the heavy liquid, exhausting the gas to the atmosphere while returning the heavy liquid to the point of entrainment, and returning to the re-
85 frigerant circuit refrigerant that strays into the heavy liquid. 90

EASTMAN A. WEAVER.

20

95

25

100

30

105

35

110

40

115

45

120

50

125

55

130

60

135

140

70

145

150