Nov. 29, 1938. L. A. PHILIPP 2,138,612

REFRIGERATING APPARATUS

Filed July 2, 1937 2 Sheets-Sheet 1

Fig. 1.

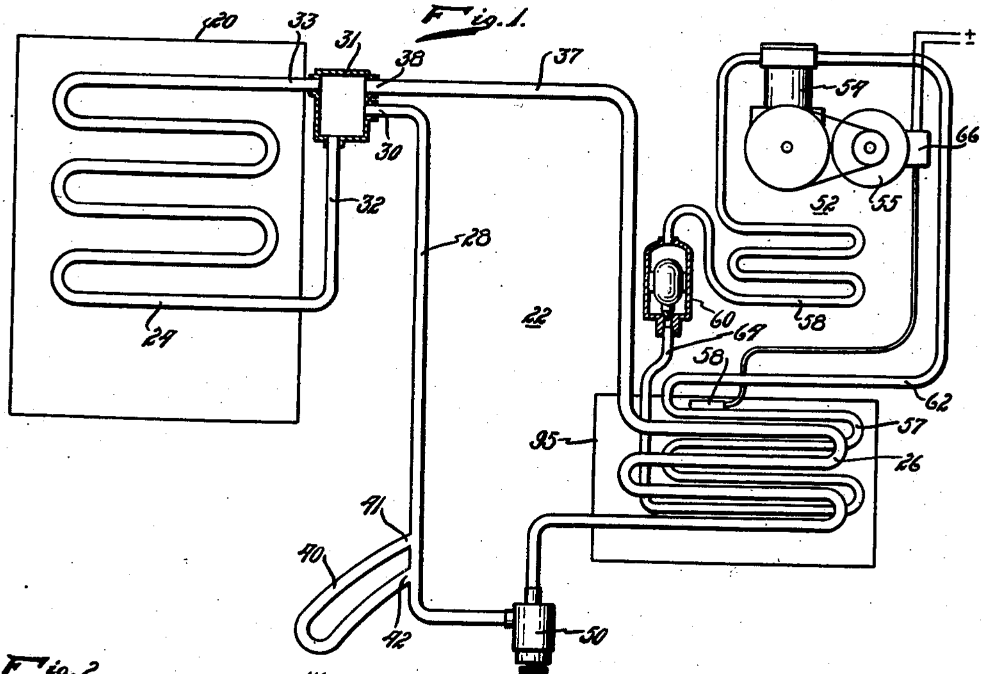


Fig. 2.

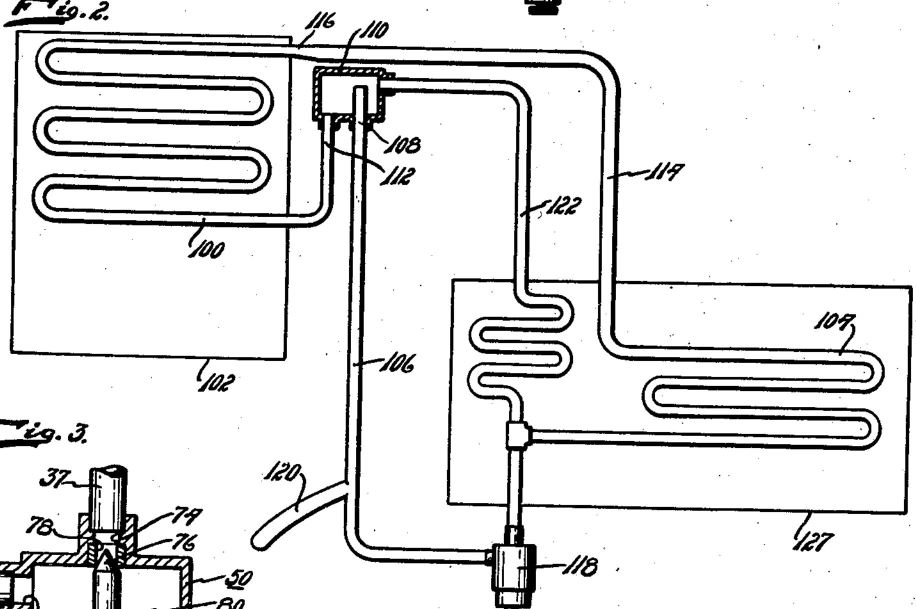
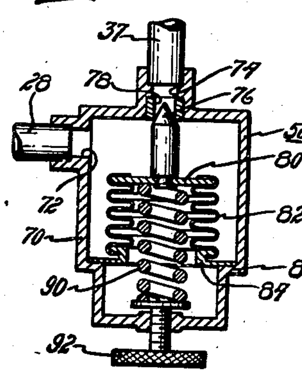


Fig. 3.



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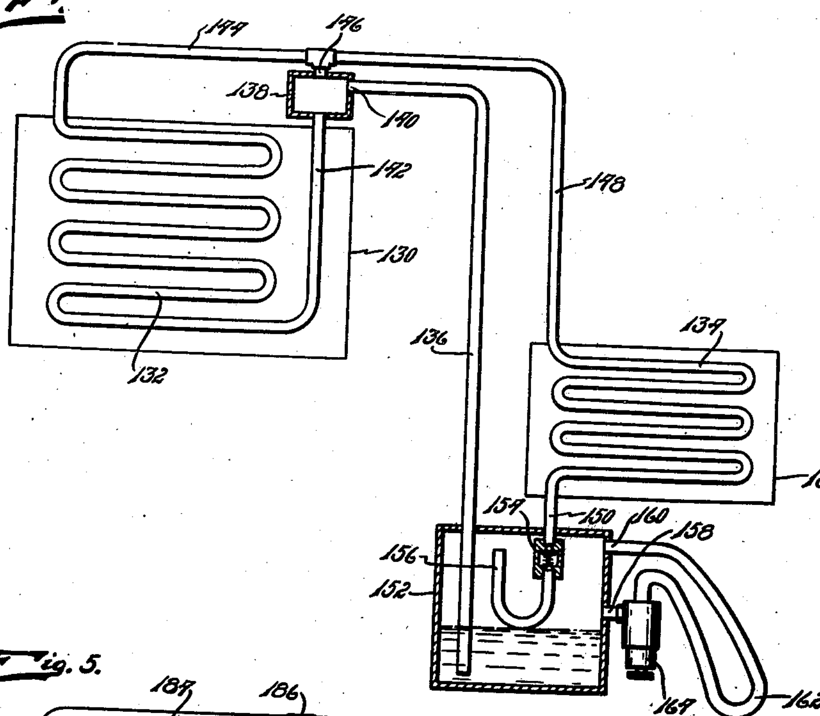
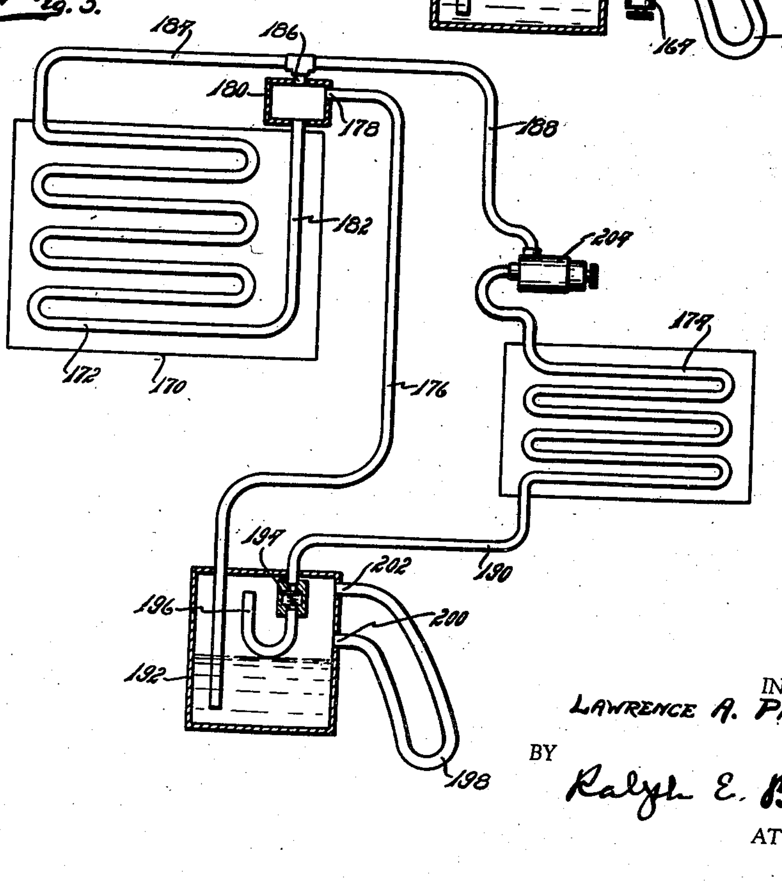


Fig. 5.



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UNITED STATES PATENT OFFICE

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REFRIGERATING APPARATUS

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Application July 2, 1937, Serial No. 151,571

1 Claim. (Cl. 62—125)

This invention relates to refrigeration and more particularly to an improved method of and apparatus for refrigeration.

One of the objects of my invention is to provide an improved arrangement for conducting liquid refrigerant to a refrigerant evaporating zone located above the condensing zone and to provide an improved arrangement for controlling the flow of liquid refrigerant to the evaporating zone.

Another object of my invention is to provide an improved method of refrigeration which consists in elevating liquid refrigerant to an evaporating zone which is located at a point above the condensing zone by utilizing the application of heat for conducting the liquid refrigerant and controlling the flow of liquid refrigerant to the point of heat application in accordance with changes in pressures existing in the evaporating zone.

Another object of my invention is to maintain a substantially constant temperature differential between primary and secondary refrigerating systems by controlling the pumping of liquid refrigerant to the evaporating zone of the secondary system in accordance with the changes in the environment air temperatures adjacent the refrigerant pumping device and by controlling the flow of liquid refrigerant to the refrigerant pumping device in accordance with changes in pressures within the secondary refrigerating system.

Other objects and advantages of the present invention will become apparent upon perusal of the following description, reference being had to the accompanying drawings in which are illustrated preferred forms of my invention.

In the drawings:—

Fig. 1 is a diagrammatic view of a refrigerating system including primary and secondary refrigerating systems embodying features of my invention;

Fig. 2 is a diagrammatic view of a modified form of secondary system;

Fig. 3 is a view in cross-section of a pressure responsive valve embodying features of my invention;

Fig. 4 is a diagrammatic view of another modified form of secondary refrigerating systems; and

Fig. 5 is a diagrammatic view of a still further modified form of secondary system.

In some instances in the use of primary and secondary refrigerating systems it has been found desirable to position the refrigerant evaporator of the secondary refrigerating system entirely above the condensing element of the secondary system. One example of this use is found in the refrigeration of motor vehicles, such as trucks, wherein the refrigerant evaporating element is positioned adjacent the uppermost part of the compartment wherein foods are stored for delivery and the condenser is located in the lower portion of the vehicle body and cooled by ice or blocks of CO_2. By this arrangement the ice or blocks of CO_2 constitute the primary refrigerating system and may be readily placed in contact with the condenser of the secondary system without elevating such primary system to undue height to which the secondary refrigerant evaporator is located. In some installations it is found desirable to associate with the secondary condenser a refrigerating system which is automatic and is of the so-called compression type. In either case wherein the secondary condenser is located below the secondary evaporator some provisions must be made for pumping or otherwise conducting liquid refrigerant from the secondary condenser to the secondary evaporator. In many instances it has been found desirable to maintain the temperature of the secondary system evaporator considerably above the lowest temperatures prevailing in the primary system.

In accordance with my invention I provide an improved arrangement for conducting liquid refrigerant to a refrigerant evaporating element of a secondary refrigerating system, which element is located above the condensing element of the system, and also provide an improved arrangement for positively controlling the temperatures existing in the secondary system.

Referring to the drawings and particularly Fig. 1, the numeral **20** designates in general a compartment which is provided for the storage of foods and the like and may be the compartment of any suitable refrigerating apparatus such as meat boxes, household refrigerators, or cooling compartments of motor vehicles and the like. The compartment **20** is maintained at a substantially constant temperature by means of a secondary refrigerating system **22** which includes a heat absorber or refrigerant evaporating element **24** disposed within the enclosure **20** and a heat dissipator or condenser **26** for dissipating the heat absorbed in the element **24**. Liquid refrigerant is delivered from the condenser **26** to the evaporator **24** by a liquid supply conduit **28**. The conduit **28** has an outlet **30** associated with a vessel **31** which is connected in open communication with inlet **32** and outlet **33** of the evaporator **24**. Gaseous refrigerant is conducted from the evaporator **24** to the condenser **26** through a vapor return line 37 which has an inlet end 38 connected to the upper part of vessel 31. Gaseous refrigerant passing through conduit 37 into the condenser 26 is liquefied in the condenser whence it passes to the evaporator 24 by means of a vapor lift pump or trap 40 which is connected in the liquid supply line between the condenser 26 and the evaporator 24. This vapor lift pump or trap is formed in the general shape of a U having both ends 41 and 42 connected to the supply conduit 28. By this arrangement liquid refrigerant leaving the condenser 26 will first pass into the leg 42 of trap 40 and by the application of heat to the trap 40 vaporization will take place to such an extent that it will lift liquid refrigerant upwardly through the conduit 28 into the vessel 31 whence it passes into the inlet 32 of the evaporator 24. The trap 40 may be placed in any suitable position desired where it will be subject to changes in the temperatures of the environment air or, if desired, any generated heat. However, it has been found that in systems of this type the condenser and evaporator may be completely insulated within certain compartments of a refrigerator and the trap 40 exposed to the environment air surrounding the refrigerator where it will receive sufficient heat to cause liquid refrigerant to be elevated to the evaporator 24.

In order to control the flow of liquid refrigerant to the evaporator 24 I have provided an automatic pressure responsive valve 50 which, as shown in Fig. 1, is connected between the condenser 26 and the trap 40. This valve is set so as to be responsive to changes of pressures within the system so as to allow the flow of liquid refrigerant from the condenser 26 to the trap 40 when the pressure within the evaporator 24 reaches a predetermined high value. When this occurs the temperature of the evaporator 24 is such that there is a need for refrigeration by that evaporator and accordingly the valve permits the flow of liquid refrigerant to the trap 40 to thus cause the flow of liquid refrigerant to the evaporator 24 in response to that refrigeration requirement.

Any suitable means may be provided for cooling the condenser 26 and as herein disclosed, I have provided an automatic refrigerating system of the compression type for automatically maintaining substantially constant temperatures within the condenser 26 so as to provide for maintaining a substantially constant temperature differential between the primary refrigerating system and the evaporator of the secondary refrigerating system. This is accomplished by automatically controlling the temperature of the evaporator of the primary system and by the use of the automatic pressure responsive valve 50 in the secondary system. The primary system 52 comprises in general a compressor 54, motor 55, evaporator 57, condenser 58 and float valve mechanism 60. Compressor 54 withdraws gaseous refrigerant from the evaporator 57 through vapor return conduit 62, compresses the gaseous refrigerant and delivers same to condenser 58 wherein it is liquefied and from which it is delivered to the float valve mechanism 60. The float valve mechanism 60 controls the flow of liquid refrigerant to evaporator 57 through conduit 64. The compressor 54 is operatively connected with motor 55 for actuating motor 54. Preferably the primary system 52 is intermittently operated under the control of a thermostat 66 which includes thermo-bulb 68 connected to evaporator 57, so as to be responsive to changes in temperature within that evaporator for opening and closing the motor circuit upon predetermined increase or decrease in temperatures within the evaporator 57 as is well understood. Other primary systems may be used if desired such, for example, as a block of CO_2 or the like.

While the primary system 52 may be operated at any desired temperature either above or below freezing, the secondary system may be adjusted readily for operating at any desired temperature above the temperature of the evaporator 57 of the primary system. This is accomplished by use of the adjustable valve 50.

In accordance with my invention I provide the valve 50 for controlling the flow of liquid refrigerant in the secondary system and in so doing provide for maintaining a predetermined temperature differential between the primary and secondary refrigerating systems. The refrigerants used in the primary and secondary systems may be the same or different refrigerants as desired and may be any of the refrigerants now well known in the art.

Referring now to Fig. 3, the valve 50 comprises in general a casing 70 having ports 72 and 74 to which conduits 28 and 37 are connected respectively. Within the casing 70 is disposed valve proper 76 which cooperates with valve seat 78 for controlling the flow of refrigerant between conduits 37 and 28. The valve proper 76 is carried by an annular disc 80 to which is sealed bellows 82. The opposite end of bellows 82 is sealed to an annular disc 84 which rests upon a shoulder 85 formed in the casing 70. Upon an increase of pressure within the casing 70 the bellows 82 tends to collapse and in so doing moves the valve 76 away from its seat 78. At this time communication is established between conduits 37 and 28. The bellows tends to collapse in opposition to compression spring 90 which continuously tends to urge the valve 76 towards seat 78. The effectiveness of the spring 90 may be controlled by adjustment screw 92. Preferably the annular disc 84 is sealed to the shoulder 85 so as to prevent leakage of refrigerant out of the casing and about the screw 92. By this arrangement it will be noted that when the pressure within the evaporator 24 reaches a predetermined value the pressure within the liquid supply conduit 28 will be equivalent to the pressure within evaporator 24 and this pressure will be the same within the casing 70 to exert itself upon the bellows 82 to collapse said bellows. When this takes place the valve 76 is in open position and allows liquid refrigerant to flow from the condenser 26 into trap 40 where the refrigerant is subjected to heat so as to provide a vapor lift pump for conducting said liquid refrigerant into the evaporator 24. Any setting of the valve 50 for different temperatures in the secondary system may be had as desired.

When my invention is employed, for example, in household refrigerators, the primary refrigerant evaporator 57 may be completely insulated from environment air surrounding the refrigerator and may be of the same construction as is now generally employed in household refrigerators for the freezing of ice cubes and the like. These structures are well known and illustration and further description thereof is deemed unnecessary. Thus a refrigerator may be provided for the freezing of ice cubes by utilizing the primary evaporator for that purpose. At the same time the evaporator 24 may be disposed within a food storage compartment which may be the compartment 20 and utilized for proper preservation of food stuffs and the like. The evaporator 24 may be designed of sufficient size so as to properly cool the food stuffs without the collection of frost on its external surface, the temperature of that evaporator being controlled by the valve 50, which, as previously stated, prevents the flow of liquid refrigerant to the evaporator 24 until the evaporator 24 reaches a predetermined high temperature. If, however, it is desired to design the evaporator 24 of a smaller size and maintain proper preservation of food stuffs in the compartment 20, the same may be operated in such a manner that frost collects on its outer surface when the primary refrigerating system is in operation and the frost is allowed to melt off during periods when the primary refrigerating system is inoperative. If, however, it is desired to continuously operate evaporator 24 so that its temperature is constantly below freezing, the valve 50 may be set to accomplish this result. In this instance, however, the evaporator need not be as large as evaporators which either do not collect frost or collect frost part of the time and allow the same to melt off during other periods of operation.

It will readily be apparent that the refrigerating system disclosed in Fig. 1 may be suitable for use for other purposes than household refrigerators, and as disclosed, it will be readily apparent that adjustment may be readily accomplished for obtaining any temperatures desired.

When the system disclosed in Fig. 1 is used for household refrigerators, it may be in some instances desirable to place the trap 40 in heat exchange relation to the motor compressor unit of the primary system 52 so that when there is a demand for refrigeration by the thermostat 66 the heat given off by the motor compressor unit 55 and 54 will quickly cause the trap 40 to respond to pass liquid refrigerant to the evaporator 24 as at this time the evaporator 24 will be demanding refrigeration because it is primarily that demand for refrigeration that results in operation of the primary system 52. In some instances where trap 40 is positioned in heat exchange relation with the motor 55 and compressor 54 it may be found desirable to have the thermostat 66 responsive to the temperatures of the evaporator 24, and this may be accomplished by merely placing the thermo-bulb 68 in heat exchange relation with the evaporator 24. As this modification is readily understood by the foregoing description, it is believed that further description and disclosure in the drawing is unnecessary for a proper understanding of such modification.

From the foregoing it will readily be apparent that I have provided a new and improved refrigerating system of the type including primary and secondary refrigerating systems wherein desired temperatures may be maintained in the secondary system in a new and improved manner and the evaporator of the secondary system may be located above the condenser of that system without in any manner impairing the efficiency or operation of the secondary system and that the liquid refrigerant in the secondary system is elevated by utilizing environment temperature inside or about the refrigerating apparatus. It will also be apparent, however, that artificially generated heat may be used for applying heat to trap 40 and that under either conditions of operation the valve 50 serves to maintain a predetermined temperature differential between the primary and secondary systems. As shown in Fig. 1, the condenser 26 and evaporator 57 are positioned in a compartment 95 which may be of such size and construction as to provide a storage space for food articles for storing same at low temperatures either above or below freezing as desired and which temperatures may be controlled by the setting of thermostat 66. Evaporator 57 may be attached to condenser 26.

In Fig. 2 there is shown a modified form of refrigerating system embodying features of my invention. In this figure in the drawings the numeral 100 designates a heat absorber or refrigerant evaporating element corresponding to the refrigerant evaporator 24 in Fig. 1. The evaporating element 100 is disposed within a compartment 102 which corresponds to the inclosure 20 of Fig. 1. Associated with the evaporating element 100 is a condenser 104 which corresponds to condenser 26. A supply conduit 106 like conduit 28 conducts liquid refrigerant from the condenser and terminates at 108 in a vessel 110 which corresponds to vessel 31 of Fig. 1. Vessel 110, however, is in open communication with the inlet end 112 only of the refrigerant evaporator 100. A return conduit 114 corresponding to the conduit 37 of Fig. 1 connects the outlet end 116 of the evaporator directly to the condenser 104. A pressure responsive valve 118 and a single-tube 120, corresponding to valve 50 and trap 40 respectively of Fig. 1, are disposed in the supply conduit 106 for regulating the flow of refrigerant to the evaporator 100. A conduit 122 conducts vapor from vessel 110 to a condenser 124 which may be cooled by the same means utilized to cool condenser 104. Preferably, a heat absorbing element similar to evaporator 57 of the primary system 52 of Fig. 1 is used to maintain condensers 104 and 124 at a substantially constant temperature. The refrigerant condensed in condenser 122 is conducted by a conduit 126 to the supply conduit 106 where it merges with refrigerant from the condenser 104. The operation of system shown in Fig. 2 is similar to the operation of system shown in Fig. 1, however conduit 122 conducts vapor directly from vessel 110 to auxiliary condenser 124. The main portion of the evaporated refrigerant in the system is produced in evaporator 100 and is conducted to condenser 104 through conduit 114. The two condensers 104 and 124 are housed in compartment 127 which corresponds to compartment 95. The primary system may be associated with these two condensers in a manner described in connection with Fig. 1.

Another modified form of a refrigerating system embodying features of my invention is shown in Fig. 4. Numeral 130 designates an inclosure or compartment corresponding to compartment 20 of Fig. 1. In this compartment is disposed a refrigerant evaporator 132 which corresponds to evaporator 24. Associated with evaporator 132 is a condenser 134 which corresponds to condenser 26 of Fig. 1 which may likewise be maintained at a constant temperature by means of a primary system such as that shown in Fig. 1. A supply conduit 136 corresponding to conduit 28 opens into a vessel 138 similar to vessel 31 at 140. This vessel 138 is in open communication with the entrance 142 to the evaporator 132. It also communicates with the end of the evaporator through conduits 144 and 146. Return conduit 148 which corresponds to conduit 37 conducts refrigerant vapor from the evaporator and vessel

[redacted]