May 2, 1939. L. A. PHILIPP 2,157,012

REFRIGERATING APPARATUS

Original Filed Dec. 29, 1932 3 Sheets-Sheet 1

Fig. 1.

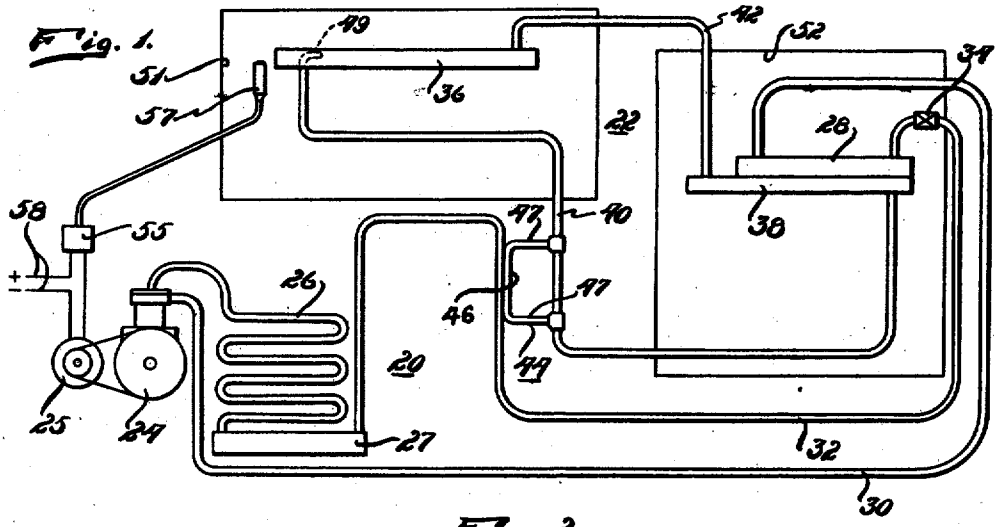

Fig. 2.

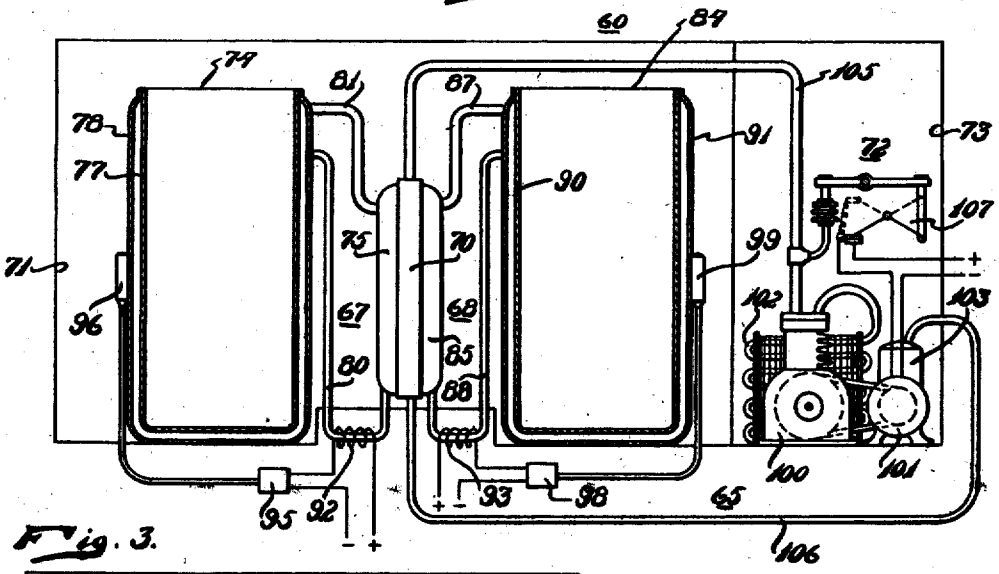

Fig. 3.

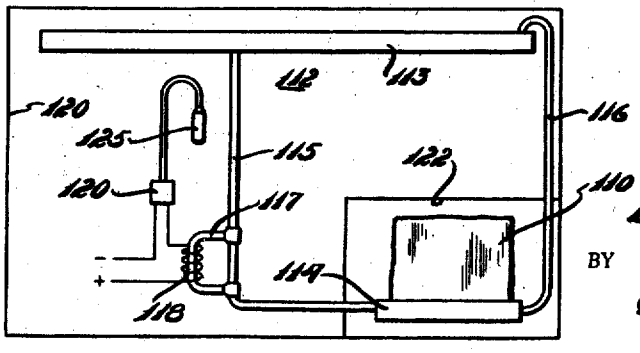

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Fig. 4

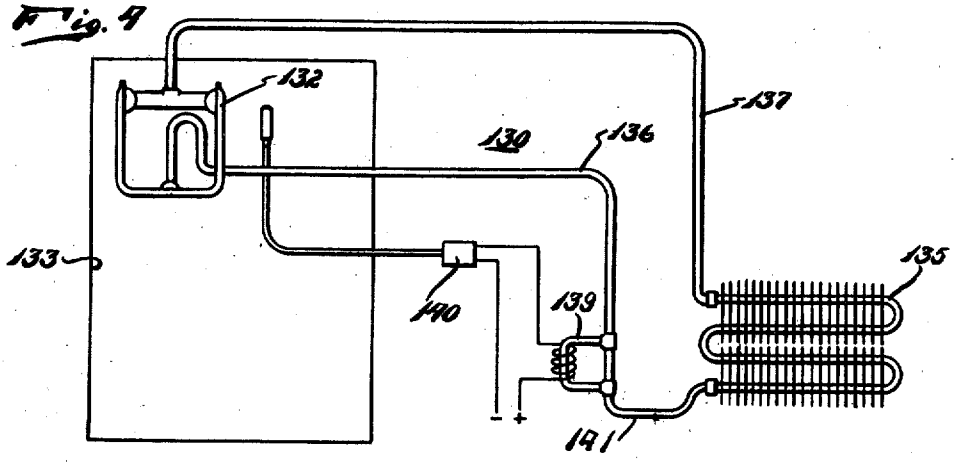

Fig. 5.

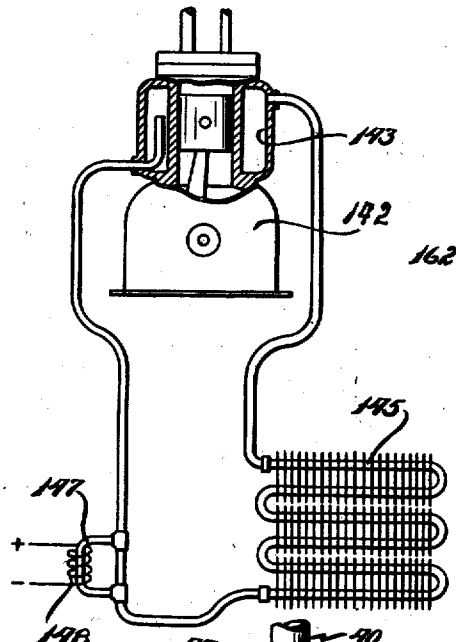

Fig. 6.

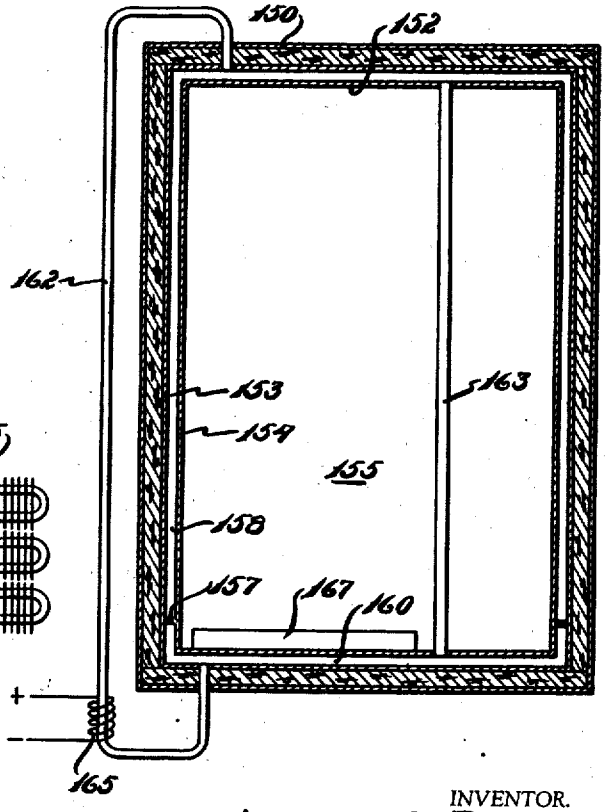

Fig. 11.

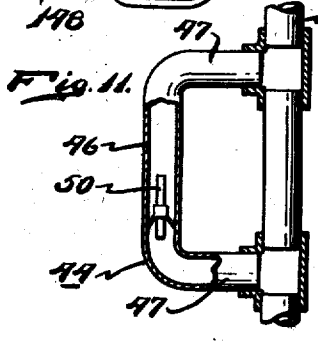

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Fig. 7.

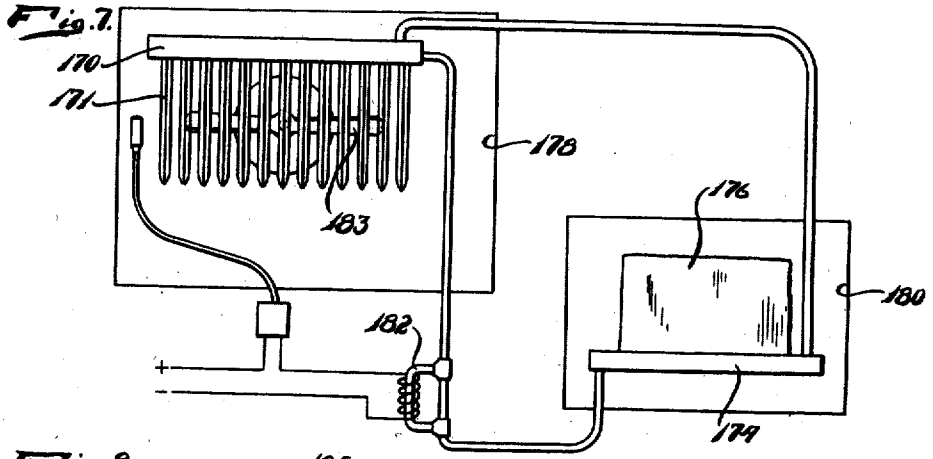


Fig. 8.

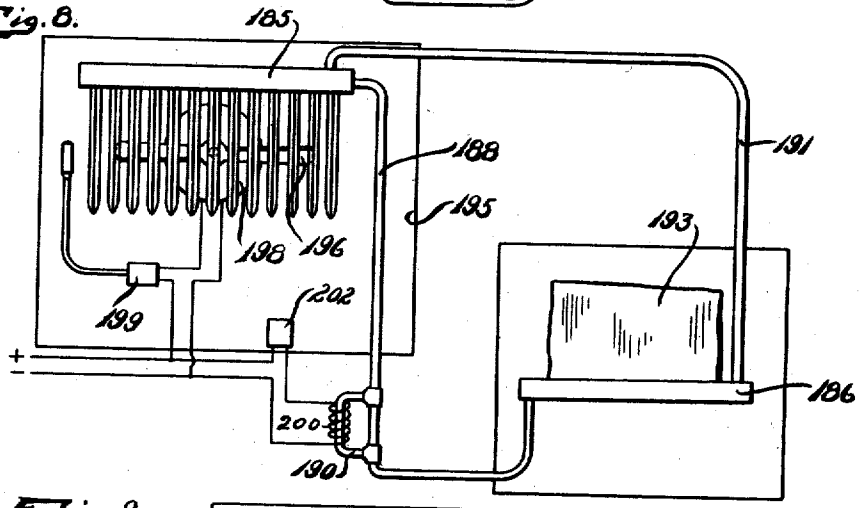


Fig. 9.

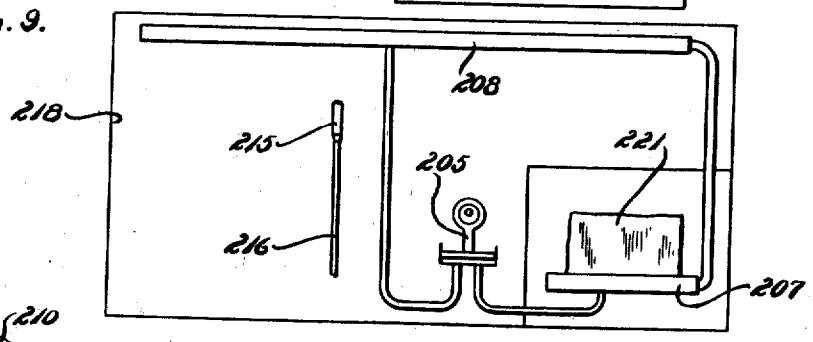
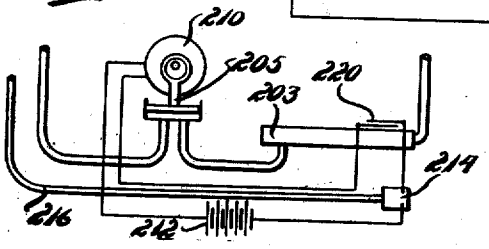


Fig. 10.



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Patented May 2, 1939 2,157,012

UNITED STATES PATENT OFFICE

2,157,012

REFRIGERATING APPARATUS

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Application December 29, 1932, Serial No. 649,341
Renewed July 2, 1936

16 Claims. (Cl. 62—125)

This invention relates to refrigerating apparatus, and more particularly to refrigerating apparatus of the type including primary and secondary refrigerating systems.

In a refrigerating apparatus of the type which includes a primary refrigerating system and a secondary refrigerating system of the closed flow type wherein the cooling element of the primary system is located in heat transfer relation with the condenser of the secondary system for condensing refrigerant in the secondary system, it has been found desirable to install the cooling element of the primary system and the condenser of the secondary system below the cooling element of the secondary system. In an apparatus of this type, some means should be provided for effecting upward flow of liquid refrigerant in the secondary system to the cooling element from the condenser.

In accordance with my invention, I provide means for delivering liquid refrigerant from the secondary condenser to the secondary cooling element located above the condenser in a closed flow secondary system.

Another object of my invention is to provide a vapor lift pump for circulating liquid refrigerant in a closed flow refrigerating system.

It is a further object to effect the flow of liquid refrigerant from the secondary condenser to the secondary cooling element in response to changes in temperature of the secondary cooling element, or in response to changes in temperature in the compartment cooled by the secondary cooling element.

Another object is to arrange for controlling the flow of liquid refrigerant in the secondary system in response to changes in humidity in the compartment which is cooled by the secondary cooling element.

Other objects and advantages will be apparent from the following description, reference being had to the accompanying drawings.

In the drawings:

Fig. 1 is a diagrammatic illustration of a refrigerating apparatus embodying features of my invention;

Figs. 2 to 9, inclusive, are diagrammatic illustrations of modified forms of refrigerating apparatus embodying features of my invention;

Fig. 10 is an enlarged, fragmentary, diagrammatic illustration of a portion of the apparatus shown in Fig. 9; and

Fig. 11 is an enlarged view in cross section of the vapor lift pump used for supplying liquid refrigerant to the cooling elements of the secondary systems.

Referring to the drawings, and particularly to Fig. 1, the numeral 20 designates in general a primary refrigerating system, and numeral 22 designates in general a secondary refrigerating system arranged in heat transfer relation with the primary system for condensing evaporated refrigerant in the secondary system.

The primary system 20 comprises, in general, a compressor 24, motor 25 for operating the compressor, condenser 26, receiver 27 and a liquid refrigerant evaporator or cooling element 28. The compressor 24 withdraws evaporated refrigerant from the cooling element through a vapor conduit 30, compresses the evaporated refrigerant and delivers it to the condenser wherein it is liquefied and from which it is delivered to the receiver. Liquid refrigerant is supplied to the cooling element through a liquid supply conduit 32 under the control of an expansion valve 34.

The secondary refrigerating system 22 is preferably of the closed flow type wherein pressures throughout the system remain substantially equal at all times, and comprises, in general, a refrigerant cooling element 36 and a refrigerant condensing element 38, which is in good thermal contact with the cooling element 28 of the primary system 20 for condensing evaporated refrigerant in the secondary system. The secondary system also includes a liquid supply conduit 40 and a vapor conduit 42 for returning vaporized refrigerant to the condenser to be condensed.

An apparatus of the type hereinbefore described is suitable for refrigerating many types of storage compartments including, for example, a storage space provided in vehicles of the type used for transporting foods and the like. In an installation of this type, it has been found desirable to position the condenser of the secondary system below the cooling element of the secondary system. Also, the cooling element and control valves therefor of the primary system may be placed below the cooling element of the secondary system. This arrangement is advantageous in the event it is desired to have ready access to the entire primary system and controls should it be desired to make repairs or to remove from and insert an entire new primary system. Thus, the cooling element of the secondary system may be located adjacent the top of the storage space in the vehicle, while all of the parts of the primary system may be located in the lower part of the vehicle where access

may be easily had thereto. With such an arrangement, however, it is necessary to provide some means for delivering liquid refrigerant from the condenser of the secondary system to the cooling element of the secondary system.

In order to provide means for delivering liquid refrigerant from the condenser 38 to the cooling element 36, I have arranged the secondary system 22 in heat transfer relation with a relatively warm part of the primary system to cause some of the liquid refrigerant in the secondary system to boil sufficiently to pick up liquid refrigerant and force slugs of the said liquid into the cooling element. The relatively warm part of the primary system employed for heating refrigerant in the secondary system, as shown in Fig. 1, constitutes the liquid supply conduit 32 which contains relatively warm, high pressure liquid refrigerant. This conduit is placed in good thermal contact with vapor leg 44 of the secondary system 22. Preferably, the supply conduit 32 and vapor leg 44 are soldered together. As shown in Fig. 11, the vapor leg includes a vertically extending portion 46 and a pair of laterally extending segmental ends 47 which are joined to the liquid conduit 40 and in open communication therewith. By this arrangement, liquid refrigerant enters the lower laterally extending end 47 of the vapor leg 44, and in the vertically extending portion 46 it is heated by the warming effect of the primary system, which causes the refrigerant to boil. This arrangement permits the evaporated refrigerant to pass out of the upper end 47 of the vapor leg and upon entering the liquid conduit 40 liquid is picked up and delivered to the cooling element 36. No evaporated refrigerant passes from the vapor leg back into the condenser due to the resistance offered by the relatively large body of liquid refrigerant therein. Thus, it will be noted that by the use of artificial heating means a vapor lift pump is provided for supplying liquid refrigerant to the secondary cooling element 36. In order to maintain a quantity of liquid in the cooling element, I have positioned the end 49 of supply conduit 40 near the upper part of the said cooling element.

In order to render the vapor lift pump or vapor leg 44 more effective, I have disposed in the portion 46 an ebullition initiator 50. Preferably, the ebullition initiator is of capillary structure, such, for example, as a piece of wood, although any suitable ebullator which has a lower inter-facial tension with liquid refrigerant than the liquid engaging surfaces of the portion 46 may be used.

As shown in Fig. 1, the cooling element 36 is disposed in a compartment 51, which may be the food storage space of the vehicle, and the cooling element 28 and condenser 38 are located in a compartment 52. Preferably, these compartments are insulated from the outside atmosphere, and, preferably, but not necessarily, from each other. Under some conditions the cooling elements 28 and 36 and the condenser 38 may be located in the same insulated compartment.

Preferably, the primary system 20 is intermittently operated. In order to control the operation of the primary system, I have provided a thermostatically controlled switch 55. To this switch is connected a fluid containing thermostatic bulb 57 which is disposed within the compartment 51 for controlling the operation of the switch 55 in response to changes in temperature within the compartment 51. The switch 55 opens and closes the circuit between the power mains 58 and motor 25 in response to changes in temperatures within the compartment 51. If desired, the thermostatic bulb 57 may be placed in contact with the cooling element 36 so that it is responsive to changes in temperature within the said cooling element.

In Fig. 2 of the drawings there is shown a refrigerating apparatus 60 which is of the type suitable for maintaining ice creams and the like in a frozen condition. The apparatus comprises, in general, a primary refrigerating system 65, and secondary refrigerating systems 67 and 68 which are adapted to be operated at different temperatures in a manner hereinafter described.

The primary refrigerant system comprises, in general, a refrigerant cooling element or evaporator 70 disposed in a compartment 71, and a refrigerant condensing element 72 which is disposed in a machine compartment 73.

The secondary refrigerating system 67 comprises, in general, a refrigerant cooling element or evaporator 74 and a refrigerant condensing element 75. The evaporator 74 is formed by an inner sheet metal shell 77 and an outer sheet metal shell 78, which is spaced from the inner shell to provide therebetween a space for liquid and gaseous refrigerant. The evaporator 74 is connected to condenser 75 by means of a liquid supply conduit 80 and a vapor return conduit 81.

The secondary refrigerating system 68 comprises, in general, a refrigerant cooling element or evaporator 84, and a refrigerant condensing element 85 connected to the evaporator 84 by vapor return conduit 87, and a liquid supply conduit 88. The evaporator 84 is formed by an inner sheet metal shell 90 and an outer sheet metal shell 91, spaced from the inner shell to provide therebetween a space for refrigerant. The inner shells 77 and 90 serve as sleeves for the reception of ice creams or the like either in cans or package form. In order to effectively condense evaporated refrigerant in the secondary systems, the condensers 75 and 85 are placed in good thermal contact with the primary cooling element 70.

As will be noted in Fig. 2, the ends of conduits 80 and 88, which are secured to evaporators 74 and 84, respectively, are located above the condensers 75 and 85. In order to provide means for delivering liquid refrigerant from the secondary condensers to the secondary evaporators, I have provided electric heating coils 92 and 93, which are associated with portions of the liquid supply conduits 80 and 88, respectively, outside of the compartment 71. The supply of electric current to the heating coil 92 is controlled by an automatic thermostatic switch 95. In the present case, I have provided a thermostatic fluid containing bulb 96, which is attached to evaporator 74 and associated with the switch 95, for actuating said switch in response to changes in temperatures within the evaporator 74. The supply of electric current to the heating coil 93 is controlled by an automatic thermostatically controlled switch 98. The switch 98 is operated in response to changes in temperatures within the evaporator 84 by means of a thermostatic fluid containing bulb 99 associated with said switch and evaporator 84. Automatic switches of this type are well known in the art and as used herein are adapted to independently connect one or the other or both of the heating coils to the power mains when there is a demand for

refrigeration in either or both of the secondary evaporators.

In order to control the temperatures within the evaporators 74 and 84 and in order to maintain different temperatures in said evaporators, I propose to adjust the automatic switches 95 and 96 so that said switches will connect the heating coils 92 and 93 to the power mains for different periods of time so that more liquid refrigerant will be supplied to one of the evaporators than to the other. By this arrangement, a temperature differential may be maintained between the two secondary refrigerant evaporators. Thus, it will be noted that the electric heating coils 92 and 93 serve to heat the liquid refrigerant in the liquid supply conduits 80 and 88, respectively, to provide a vapor lift pump for delivering liquid refrigerant to the evaporators 74 and 84. It will also be noted that when current is supplied to these coils for different periods of time different temperatures can be maintained in the different refrigerant evaporators.

Any suitable refrigerant condensing element may be used for supplying refrigeration to the cooling element 70. As shown, the condensing element 72 comprises a compressor 100, motor 101 for operating the compressor, condenser 102 and a high side float mechanism 103. The compressor withdraws evaporated refrigerant from the evaporator 70 through a vapor conduit 105, compresses the evaporated refrigerant and delivers it to the condenser wherein it is liquefied and from which it is supplied to the evaporator 70 through a liquid supply conduit 106 under the control of the float mechanism 103. Preferably, the condensing element 72 is intermittently operated. In order to control the operation of said element, I have provided an automatic switch 107 which is responsive to changes in pressures in conduit 105.

Fig. 3 discloses a modified form of apparatus in which a block of solid CO_2 110 is employed as a primary refrigerating system. A secondary refrigerating system 112 is associated with the block of CO_2 or secondary system 110. The secondary refrigerating system comprises, in general, a refrigerant cooling element 113, a refrigerant condenser 114, which supports the block of CO_2. The evaporator 113 and condenser 114 are connected by means of a liquid supply conduit 115 and a vapor return conduit 116. Liquid refrigerant is delivered to the evaporator 113 from the condenser 114 by means of a vapor leg of vapor lift pump 117. The vapor leg 117 corresponds to the vapor leg 44 shown in Figs. 1 and 11. However, the liquid refrigerant therein is heated by means of an electric heating coil 118 which is controlled by means of a thermostatically operated switch 120. An apparatus of this type is suitable for installation, for example, in vehicles used for transporting foodstuffs and the like. As shown, the evaporator 113 is located in a relatively large compartment 121 designated by the numeral 120, and the block of CO_2 and condenser 114 are located in relatively small compartment 122 below the cooling element 113. With such an arrangement, the cooling element 113 may be located near the top of the food storage space 120 of the vehicle and the compartment 122 may be located somewhere in the lower part of the vehicle so that access may readily be had thereto for inserting additional solid CO_2 as needed. Preferably, the automatic thermostatically controlled switch 120 is controlled by means of a thermostatic fluid containing bulb 125 disposed within the compartment 120 to control the operation of the switch 120 in response to changes in temperatures within the compartment 120.

In Fig. 4, there is shown a refrigerating system 130 which is of the closed flow type. The system includes a refrigerant cooling element or evaporator 132 disposed within a compartment 133, which may be the food storage compartment of a household refrigerator, and a condenser 135. The cooling element 132 and condenser 135 are connected by means of a liquid supply conduit 136 and a vapor return conduit 137. A vapor lift pump 139, which corresponds to the vapor lift pump 117, is used for delivering liquid refrigerant upwardly through the conduit 136 to the cooling element 132 in response to changes in temperature within the compartment 133 by means of a thermostatically controlled switch 140. The conduit 136 is provided with a trap 141 to prevent the return of liquid refrigerant to the condenser from the evaporator when the pump 117 is not operating. The condenser 135 is preferably air cooled and is of the type suitable to be placed outside of the building in which the refrigerator cabinet is located so that the vaporized refrigerant passing through the condenser will be condensed by the cooling effect of the temperatures prevailing outside of the building in which the refrigerator is located. If desired, however, the primary system 20 or system 75 may be used for condensing evaporated refrigerant in system 130. Also, if desired, the system 20 or system 65 may be used for condensing evaporated refrigerant in the system 130 during the warm months of the year when the temperatures outside of the building where the refrigerator is located are not low enough to condense sufficient refrigerant in system 130.

Fig. 5 discloses the use of a refrigerating system of the closed flow type for cooling parts of a refrigerant compressor 142. The compressor 142 may be the same as compressors 24 and 101 and is provided with a jacketed wall 143 which constitutes the cooling element of the refrigerating system. The system also includes a condenser 145 located below the cooling element. A vapor lift pump 147 is provided for lifting liquid refrigerant to the cooling element 143. An electric heating coil 148 forms a part of the pump 147 and is used to heat the liquid refrigerant therein. The condenser 145 may be cooled in the same manner as the condenser 135 is cooled. Thus, it will be noted that I have provided a refrigerating system for cooling parts, for instance, the cylinder wall and head of a refrigerant compressor. If desired, the compressor 142 may be used for compressing gaseous refrigerant in the primary system 20 shown in Fig. 1. When so used the heating coil 148 may be connected in series with the motor 25 so that it operates when motor 25 operates, or the compressor 142 may be used in a like manner in primary system 65 with the heating coil 148 connected in circuit with the motor 101. Also, if desired, the heating coil may be controlled by a thermostatic switch and thermostatic bulb (not shown) which is responsive to changes in temperatures of the jacketed wall 143.

Fig. 6 shows a cabinet 150 and a refrigerant evaporator 152 which is formed of two spaced apart sheet metal shells 153 and 154. These shells form the walls of a food storage compartment 155. Adjacent the lower part of and between the shells is a dam 157 which divides the space between the two shells into two chambers 158

and 160. The upper chamber 158 serves as the evaporating chamber and the lower chamber 160 serves as a condensing chamber for condensing refrigerant evaporated from the evaporating chamber. Liquid refrigerant is delivered from the condensing chamber to the evaporating chamber through a liquid supply conduit 162 and evaporated refrigerant is conducted from the vapor space in chamber 158 to the condensing chamber 160 through a vapor conduit 163. An electric heating coil 165 is provided for providing a vapor lift pump for delivering liquid refrigerant upwardly in the liquid supply conduit 162. If desired, the heating coil 165 may be connected to an automatic switch responsive to changes in temperatures within the compartment 155 in a like manner as the heating coil 118 shown in Fig. 3 is controlled. In order to condense the refrigerant in chamber 160, I have disposed a primary refrigerant evaporator 167 in thermal contact with the shell 154. This evaporator 167 may be the same as evaporator 70 shown in Fig. 2 and may be connected to the condensing element 72 shown in Fig. 2.

The apparatus shown in Fig. 7 is similar to the apparatus shown in Fig. 3 and includes a refrigerant cooling element or evaporator 170 of the type having downwardly extending refrigerant containing fins 171. The apparatus also includes a refrigerant condenser 174 which supports a block of CO_2 176 which constitutes the primary refrigerating system. The evaporator 170 is located in compartment 178 and the condenser 174 and block of CO_2 are disposed below the evaporator 170 in a compartment 180. A vapor lift pump 182 responsive to changes in temperatures in compartment 178 is provided for delivering liquid refrigerant to the evaporator. In this embodiment of the invention, I provide an electrically operated fan 183 for forcing air about compartment 178 and evaporator 170.

Fig. 8 discloses a closed flow refrigerating system which is the same as the closed flow system shown in Fig. 7. However, the manner of controlling the two systems is different. In the device shown in Fig. 8 liquid refrigerant is supplied to a refrigerant cooling element or evaporator 185 from a condenser 186 through a liquid supply conduit 188 by means of a vapor lift pump 190. Evaporated refrigerant is conducted from the evaporator 185 to condenser 186 through a vapor conduit 191. A block of solid CO_2 designated 193 is placed on the condenser 186 where it serves as a primary refrigerating system for condensing evaporated refrigerant in the secondary system. As shown, the evaporator 185 is disposed within a compartment 195. Also, within the compartment 195 is disposed a fan 196 adapted to be driven by an electric motor 198. Preferably, the motor 198 is controlled by a thermostatically controlled switch 199 which is operable in response to changes in temperature within the compartment 195. In order to control the operation of the vapor lift pump 190, I have connected an electric heating coil 200, which forms a part of the pump 190, in circuit with a humidostat 202. By this arrangement the supply of liquid refrigerant to the evaporator 185 is controlled in response to changes in humidity within the compartment 195. This is advantageous in the event it is desired to store meats and the like in the compartment 195.

Figs. 9 and 10 show an apparatus similar to the apparatus shown in Fig. 3. However, the apparatus shown in Figs. 9 and 10 employs a mechanical pump 205 for delivering liquid refrigerant from a condenser 207 upwardly to a refrigerant evaporator 208. The pump 205 is arranged to be operated by an electric motor 210. An apparatus of this type is suitable for installation in motor vehicles for cooling the food storage space thereof. When so installed the motor 210 may receive its electric current from a storage battery 212. In order to control the operation of the motor 210, I have provided a thermostatic switch 214 and thermostatic fluid containing bulb 215, which is connected to switch 214 by conduit 216. Preferably, the bulb 215 is located in the compartment 218 which is cooled by the evaporator 208 so as to control the operation of the pump 205 in response to changes in temperatures in compartment 218. In addition to the automatic control switch 214 for controlling the electric circuit to the motor 210, I have provided a switch 220 which is mounted on top of the condenser 207 so that when the block of solid CO_2, designated 221, is placed thereon the switch will be closed due to the weight of the block of CO_2. In practice, a spring (not shown) is provided for opening the switch when the block of CO_2 has melted entirely or to a predetermined degree.

In the different types of refrigerating apparatus shown in Figs. 1 to 10, inclusive, it will be apparent that either of the electrically operated primary systems 20 or 65 may be substituted for condensing evaporated refrigerant in the secondary systems in place of the blocks of solid CO_2 shown in Figs. 3, 7 and 8. Also, if desired, such substitution may be made for the block of CO_2 shown in Fig. 9 if the switch 220 is omitted.

In the closed flow refrigerating systems described hereinbefore, any suitable refrigerant may be used, such as SO_2, or, if desired, suitable low pressure refrigerants, such as methyl formate, hexane or methylene chloride, may be used. By using low pressure refrigerants which have a higher boiling point, less vapor is needed to lift the liquid refrigerant. Thus, the heating coils may be smaller if low pressure refrigerants are used instead of high pressure refrigerants. Also, the evaporators of the secondary systems may be constructed of thinner walls if low pressure refrigerants are used. In addition, I propose to use an ebullition initiator like the ebulator 50 shown in Fig. 11 in each vapor pump so as to keep the size of the electric heating coils as small as possible and to reduce operation thereof to a minimum.

Although only preferred forms of the invention have been illustrated, and those forms described in detail, it will be apparent to those skilled in the art that various modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

I claim:

1. A secondary refrigerating system of the type having substantially the same pressure throughout and in which refrigerant is evaporated and condensed simultaneously comprising in combination, an evaporator, a condenser below the evaporator, a conduit connecting the outlet of the evaporator with the inlet of the condenser, a conduit connecting the outlet of the condenser with the inlet of the evaporator, and a pump associated with the second mentioned conduit for lifting liquid refrigerant from the condenser to the evaporator.

2. A secondary refrigerating system of the

type having substantially the same pressure throughout and in which refrigerant is evaporated and condensed simultaneously comprising in combination, an evaporator, a condenser below the evaporator, a conduit connecting the outlet of the evaporator with the inlet of the condenser, a conduit connecting the outlet of the condenser with the inlet of the evaporator, and a vapor lift pump associated with the second mentioned conduit for lifting liquid refrigerant from the condenser to the evaporator.

3. A secondary refrigerating system of the type having substantially the same pressure throughout and in which refrigerant is evaporated and condensed simultaneously comprising in combination, an evaporator, a condenser below the evaporator, a conduit connecting the outlet of the evaporator with the inlet of the condenser, a conduit connecting the outlet of the condenser with the inlet of the evaporator, and means for controlling the temperature of the evaporator including a pump associated with the second mentioned conduit for lifting liquid refrigerant from the condenser to the evaporator and means responsive to the temperature of the evaporator for controlling the pump.

4. A secondary refrigerating system of the type having substantially the same pressure throughout and in which refrigerant is evaporated and condensed simultaneously comprising in combination, an evaporator, a condenser below the evaporator, a conduit connecting the outlet of the evaporator with the inlet of the condenser, a conduit connecting the outlet of the condenser with the inlet of the evaporator, and means for controlling the temperature of the evaporator including a vapor lift pump associated with the second mentioned conduit for lifting liquid refrigerant from the condenser to the evaporator and means responsive to the temperature of the evaporator for controlling the application of heat to said vapor lift pump.

5. A secondary refrigerating system of the type having substantially the same pressure throughout comprising in combination, an evaporator, a condenser, a conduit connecting the outlet of the evaporator with the inlet of the condenser for conducting gaseous refrigerant to the condenser, a conduit connecting the outlet of the condenser with the inlet of the evaporator for conducting condensed refrigerant to the evaporator, and means for controlling the temperature of the evaporator including a pump in the refrigerating circuit and means responsive to the temperature of the evaporator for controlling the pump.

6. A secondary refrigerating system of the type having substantially the same pressure throughout comprising in combination, an evaporator, a condenser, a conduit connecting the outlet of the evaporator with the inlet of the condenser for conducting gaseous refrigerant to the condenser, a conduit connecting the outlet of the condenser with the inlet of the evaporator for conducting condensed refrigerant to the evaporator, and means for controlling the temperature of the evaporator including a pump associated with the second-mentioned conduit and means responsive to the temperature of the evaporator for controlling the pump.

7. A secondary refrigerating system of the type having substantially the same pressure throughout comprising in combination, an evaporator, a condenser, a conduit connecting the outlet of the evaporator with the inlet of the condenser for conducting gaseous refrigerant to the condenser, a conduit connecting the outlet of the condenser with the inlet of the evaporator for conducting condensed refrigerant to the evaporator, and means for controlling the temperature of the evaporator including a vapor lift pump associated with the second-mentioned conduit and means responsive to the temperature of the evaporator for controlling application of heat to said vapor lift pump.

8. Refrigerating apparatus comprising in combination, a primary refrigerating system including a refrigerating portion and a portion maintained at a higher temperature than that of the refrigerating portion; and a secondary refrigerating system including a condenser in heat exchange relation with the refrigerating portion of the primary refrigerating system, an evaporator operatively connected with the condenser, said secondary refrigerating system having a portion in intimate heat exchange relation with the second-mentioned portion of the primary system for causing liquid refrigerant to flow in the secondary system.

9. Refrigerating apparatus comprising in combination, a primary refrigerating system including a refrigerating portion and a portion maintained at a higher temperature than that of the refrigerating portion; and a secondary refrigerating system including a condenser in heat exchange relation with the refrigerating portion of the primary refrigerating system, an evaporator operatively connected with the condenser, said secondary refrigerating system having a portion in intimate heat exchange relation with the second mentioned portion of the primary system for causing liquid refrigerant to flow in the secondary system; and means responsive to the temperature of the evaporator for controlling the primary system.

10. Refrigerating apparatus comprising in combination, a secondary refrigerating system including a condenser and an evaporator operatively connected with one another, a primary refrigerating system for cooling the condenser of the secondary system and including a portion having a temperature higher than the temperature of the secondary system, said portion being connected in intimate heat exchange relation with a part of the secondary circuit for causing liquid refrigerant to flow in the secondary system.

11. Refrigerating apparatus comprising in combination, a secondary refrigerating system including a condenser and an evaporator operatively connected with one another, a primary refrigerating system for cooling the condenser of the secondary system and including a portion having a temperature higher than the temperature of the secondary system, said portion being connected in intimate heat exchange relation with a part of the secondary circuit for causing liquid refrigerant to flow in the secondary system, and means responsive to the temperature of the evaporator for controlling the primary system.

12. Refrigerating apparatus comprising in combination, a secondary refrigerating system including a lower condenser and an upper evaporator, conduit means connecting said elements, a primary refrigerating system for cooling the condenser of the secondary system and including a portion having a temperature higher than the temperature of the secondary system, said portion being connected in intimate heat exchange relation with said conduit means and forming therewith a vapor lift pump for lifting liquid

refrigerant from the condenser to the evaporator.

13. Refrigerating apparatus comprising in combination, a secondary refrigerating system including a lower condenser and an upper evaporator, conduit means connecting said elements, a primary refrigerating system for cooling the condenser of the secondary system and including a portion having a temperature higher than the temperature of the secondary system, said portion being connected in intimate heat exchange relation with said conduit means and forming therewith a vapor lift pump for lifting liquid refrigerant from the condenser to the evaporator and means responsive to the temperature of the evaporator for controlling the application of heat to said lift pump.

14. Refrigerating apparatus comprising sheets of metal joined with one another providing therebetween an evaporator and a condenser for a secondary refrigerating system and providing a common refrigerating zone, and conduit means interconnecting said evaporator and condenser for conducting gaseous refrigerant from the evaporator to the condenser and for conducting liquid refrigerant from the condenser to the evaporator.

15. Refrigerating apparatus comprising an inner sheet metal shell forming a compartment for food, an outer sheet metal shell joined with the inner shell to provide between said shells an evaporator and a condenser of a secondary refrigerating system, said evaporator and condenser both cooperating to refrigerate said compartment, and conduit means interconnecting said evaporator and condenser for conducting gaseous refrigerant from the evaporator to the condenser and for conducting liquid refrigerant from the condenser to the evaporator.

16. A cooling element for a secondary refrigerating system comprising sheets of metal joined with one another and providing therebetween a condensing chamber and an evaporating chamber, the material forming said chambers also forming a common refrigerating zone.

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DISCLAIMER

2,157,012.—*Lawrence A. Philipp*, Detroit, Mich. REFRIGERATING APPARATUS. Patent dated May 2, 1939. Disclaimer filed November 6, 1939, by the patentee; the assignee, *Nash-Kelvinator Corporation*, approving,

Hereby enters this disclaimer to claims 1 and 2 in said specification.

[*Official Gazette December 5, 1939.*]

refrigerant from the condenser to the evaporator.

13. Refrigerating apparatus comprising in combination, a secondary refrigerating system including a lower condenser and an upper evaporator, conduit means connecting said elements, a primary refrigerating system for cooling the condenser of the secondary system and including a portion having a temperature higher than the temperature of the secondary system, said portion being connected in intimate heat exchange relation with said conduit means and forming therewith a vapor lift pump for lifting liquid refrigerant from the condenser to the evaporator and means responsive to the temperature of the evaporator for controlling the application of heat to said lift pump.

14. Refrigerating apparatus comprising sheets of metal joined with one another providing therebetween an evaporator and a condenser for a secondary refrigerating system and providing a common refrigerating zone, and conduit means interconnecting said evaporator and condenser for conducting gaseous refrigerant from the evaporator to the condenser and for conducting liquid refrigerant from the condenser to the evaporator.

15. Refrigerating apparatus comprising an inner sheet metal shell forming a compartment for food, an outer sheet metal shell joined with the inner shell to provide between said shells an evaporator and a condenser of a secondary refrigerating system, said evaporator and condenser both cooperating to refrigerate said compartment, and conduit means interconnecting said evaporator and condenser for conducting gaseous refrigerant from the evaporator to the condenser and for conducting liquid refrigerant from the condenser to the evaporator.

16. A cooling element for a secondary refrigerating system comprising sheets of metal joined with one another and providing therebetween a condensing chamber and an evaporating chamber, the material forming said chambers also forming a common refrigerating zone.

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