Oct. 25, 1938. L. B. M. BUCHANAN 2,133,949

REFRIGERATION APPARATUS

Filed March 30, 1935 2 Sheets-Sheet 1

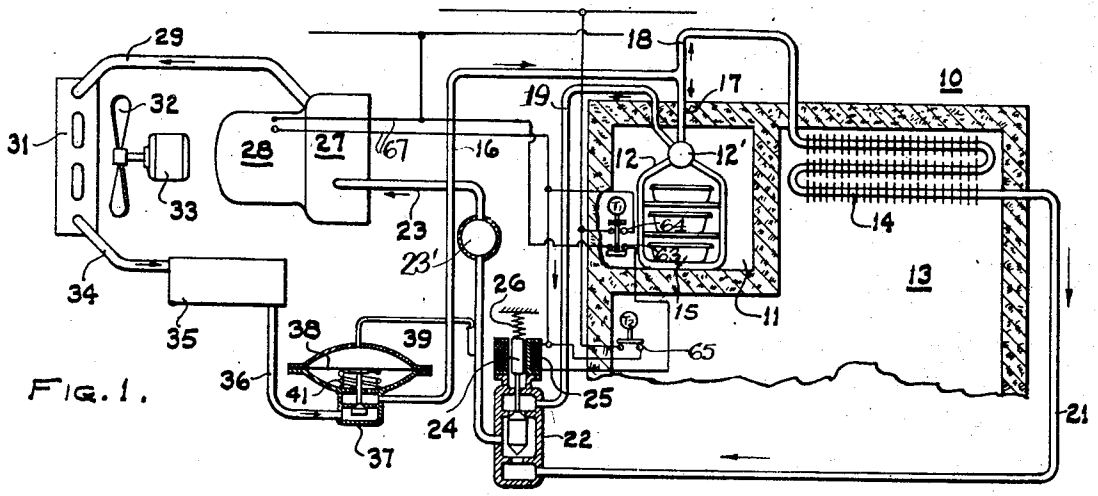


FIG. 1.

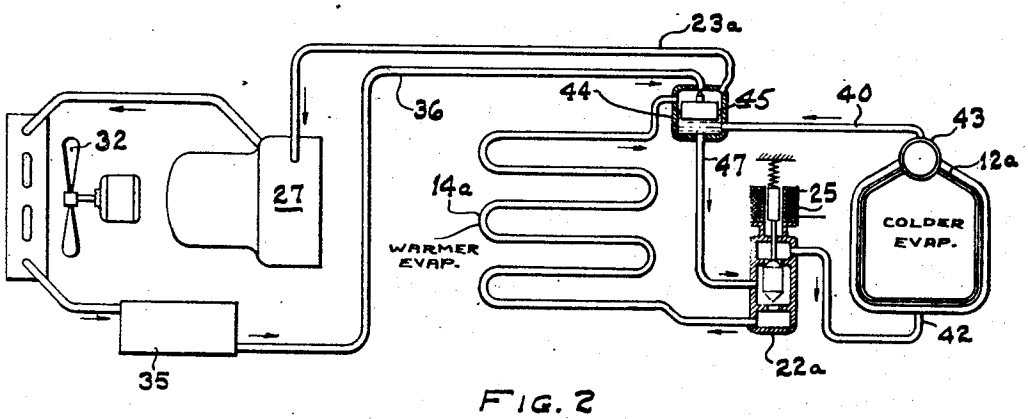


FIG. 2

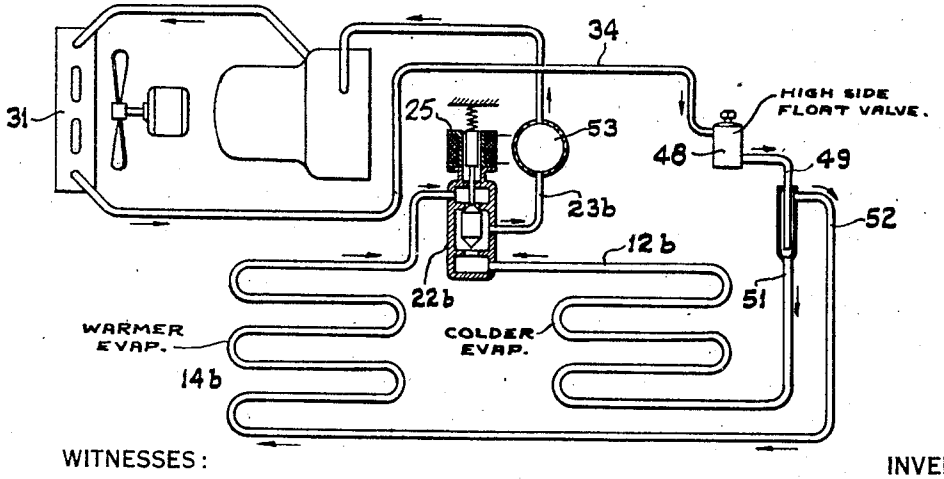


FIG. 3.

WITNESSES:
R. J. Eisinger
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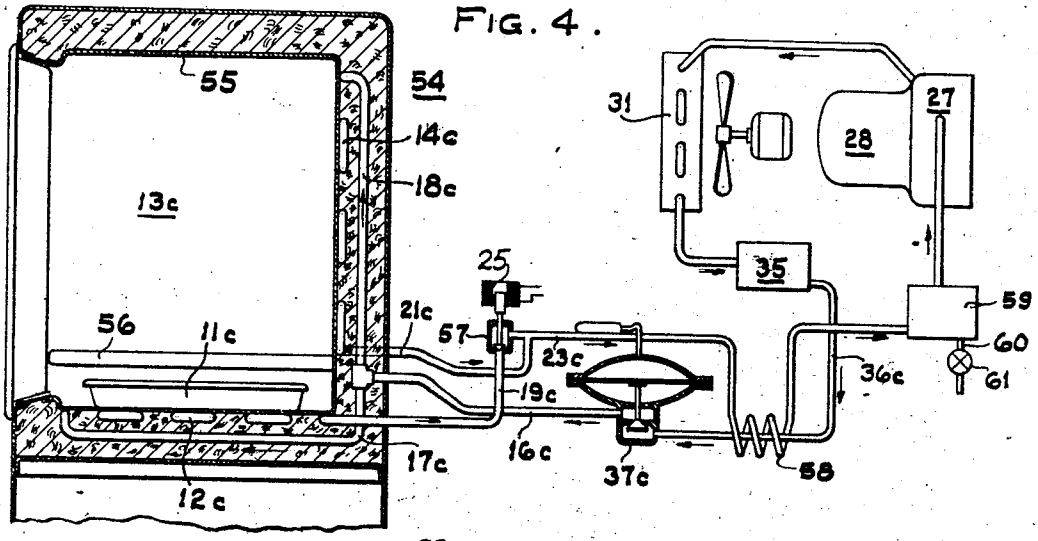
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REFRIGERATION APPARATUS

Filed March 30, 1935 2 Sheets-Sheet 2

FIG. 4.



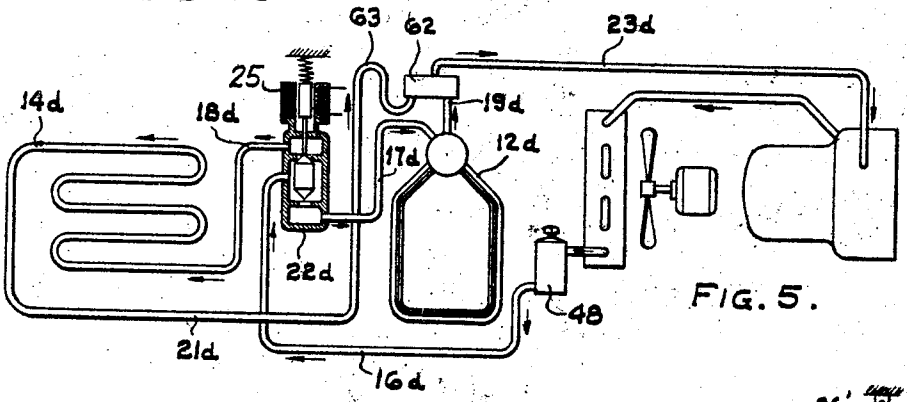


FIG. 5.

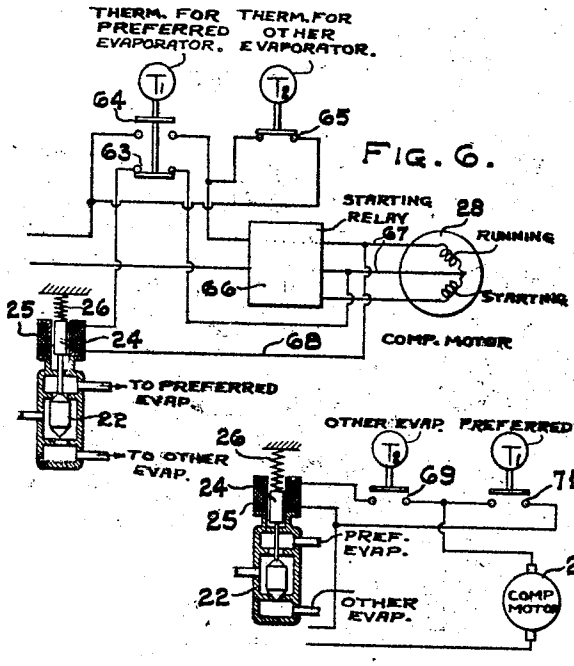


FIG. 6.

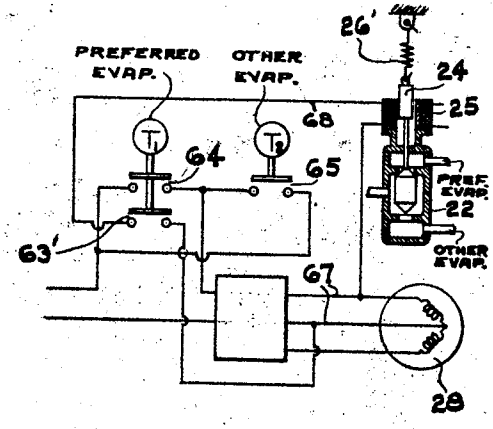


FIG. 7.

FIG. 8.

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UNITED STATES PATENT OFFICE

2,133,949

REFRIGERATION APPARATUS

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Application March 30, 1935, Serial No. 13,884

18 Claims. (Cl. 62—4)

My invention relates to refrigeration apparatus, more particularly to refrigeration apparatus embodying a plurality of evaporators operating at different temperatures, and it has for an object to provide improved apparatus.

A further object is to provide apparatus of the character set forth having a minimum number of parts, particularly moving parts such as valves.

Another object is to provide such apparatus in which the higher temperature evaporator operates at higher pressure to provide increased efficiency, and which apparatus has a minimum number of moving parts.

A further object is to prevent condensation of gaseous refrigerant in the lower temperature evaporator when the higher temperature evaporator is in operation at the higher pressure.

In accordance with the present invention, the lower temperature and the higher temperature evaporator, which operate at different times, are connected in parallel, and the means for reducing the pressure of the condensed refrigerant, such as an expansion valve, is common to both evaporators. A valve means is provided for controlling flow of refrigerant through at least one evaporator for selectively effecting refrigeration in either evaporator. However, the evaporators are in free communication with each other so that the pressure therein is substantially the same at all times. To avoid condensation of vaporous refrigerant in the lower temperature evaporator when the higher temperature evaporator is operating, a connection between the evaporators is arranged so that liquid refrigerant flows into and fills the lower temperature evaporator at such times.

In accordance with a further feature of invention, the supply of refrigerant is controlled in accordance with the requirements of whichever evaporator is in operation. In one form, a thermostatic expansion valve is provided and arranged to respond to the temperature of the vaporized refrigerant in the common suction line In another form, a low side float valve is provided to maintain a desired liquid level for either evaporator.

The above and other objects are effected by my invention as will be apparent from the following description and claims taken in accordance with the accompanying drawings, forming a part of this application, in which:

Figs. 1 to 5 are diagrammatic views illustrating different embodiments of the invention; and

Figs. 6, 7 and 8 are wiring diagrams showing three forms of control mechanism that may be used with any of the embodiments shown in Figs. 1 to 5.

Referring to Fig. 1 in detail, I show a refrigerator 10 having a compartment 11 which is refrigerated to a relatively low temperature by an evaporator 12, and a compartment 13 refrigerated by an evaporator 14 to a temperature which is higher than that maintained in the compartment 11. The temperature in the compartment 11 may be below freezing, in order to freeze ice and maintain frozen articles, while the temperature in the compartment 13 may be above freezing but sufficiently low for the preservation of food. The evaporator 12 is refrigerated or operated, that is, evaporation is effected therein, at a lower temperature and at a lower pressure than the evaporator 14, and is referred to herein as the lower temperature or colder evaporator while the latter is referred to as the higher temperature or warmer evaporator. The evaporators operate at different times, rather than simultaneously; each evaporator being operated at intervals for sufficient periods of time, preferably under thermostatic control, to maintain the respective temperature in its compartment.

Each evaporator may be of any desired form, either of the flooded type or of the type known in the art as a dry evaporator. In the embodiment shown in Fig. 1, the evaporator 12 is of the flooded type, comprising a header 12'. The evaporator 14 is of the dry type, having a long narrow passage through which a forced circulation of a mixture of liquid and vaporous refrigerant is effected during operation thereof. The evaporator 12 encompasses a group of ice trays 15, while the evaporator 14 is in the form of a cross-finned serpentine coil disposed in the upper portion of the compartment 13. The evaporator 14 has sufficient cooling surface to enable it to operate with small difference between the temperatures of the refrigerant and of the air, so as to maintain a high relative humidity in the compartment 13. The evaporators 12 and 14 are connected in parallel, refrigerant being supplied thereto from a common supply conduit 16 through branch conduits 17 and 18, respectively. As will be seen from the drawings, the branch conduit 17 extends downwardly from the conduit 16, while the conduit 18 extends upwardly from the conduit 16. Accordingly, liquid refrigerant supplied from the conduit 16 will flow through the branch conduit 17 into the evaporator 12 in preference to the conduit 18, when free to do so.

The evaporators 12 and 14 are connected

through outlet conduits 19 and 21, respectively, to a selector valve 22, which is adapted to place one of the evaporators in communication with a common suction conduit 23 and to cut off communication between the other evaporator and the conduit 23, so as to selectively provide flow of refrigerant through either one of the evaporators. The valve 22 is operated in any suitable manner, for example, it may have a core 24 which is actuated in one direction by a solenoid coil 25 and in the opposite direction by a compression spring 26. In the present embodiment, energization of the coil 25 places the valve in the position for effecting flow of refrigerant through the evaporator 14, and the spring 26 moves the valve to the opposite position for effecting flow through the evaporator 12 when the solenoid coil 25 is deenergized.

The suction conduit 23 communicates with the inlet of a compressor 27, which may be enclosed, together with its driving motor 28, in a hermetically sealed casing. The outlet of the compressor 27 communicates through a conduit 29 with a condenser 31. A fan 32 driven by a motor 33 may be provided to circulate air over the condenser for cooling the same. The condenser communicates through a conduit 34 with a liquid receiver 35. The latter in turn communicates through a conduit 36 with a thermostatic expansion valve 37, which discharges into the refrigerant supply conduit 16.

The valve 37 is of the type commonly known in the art as a thermostatic expansion valve. It comprises a diaphragm 38 which is biased in closing direction by the pressure in the evaporators. It further includes a thermostatic bulb 39 attached to the suction conduit 23 and containing a quantity of volatile liquid, preferably the same liquid used in the refrigerating system. The liquid within the bulb 39 provides a vapor pressure which is a function of the temperature of the refrigerant vapor in the conduit 23 and which pressure is imposed on the upper side of the diaphragm 38 to bias the valve 37 in opening direction. The diaphragm 38 is also biased in closing direction by a spring 41. The pressure on the under side of the diaphragm 38 is a function of the temperature at which evaporation takes place in whichever evaporator is in operation and the pressure on the upper side of the diaphragm is a function of the temperature of the vaporized refrigerant discharged from that evaporator, so that the difference between said pressures is a measure of the superheat of the discharged vapor. This difference in pressure operates against the spring 41 in the direction for opening the valve 37. As the superheat tends to increase, the valve opens to admit more refrigerant, and vice versa, thereby controlling the supply of refrigerant so as to maintain a substantially constant degree of superheat of the discharged refrigerant vapor, as is well known in the art. Such a valve controls the supply of refrigerant substantially in accordance with the capacity of the evaporator, since it admits such quantity as can be fully vaporized and slightly superheated.

The operation of this embodiment of my invention is as follows: assuming that refrigeration of the warmer compartment 13 is to be effected, the valve 22 is positioned to place the evaporator 14 in communication with the suction conduit 23 and to cut off communication between the evaporator 12 and the suction conduit. Operation of the motor 28 for driving the compressor 27 and the fan 32, respectively, is also effected. These operations are preferably effected by a thermostatic control, several forms of which will be described later. The refrigerant vaporized in the evaporator 14 is conveyed through the conduit 21, the valve 22 and the conduit 23 to the compressor, wherein its pressure is increased. It is then conveyed through the conduit 29 to the condenser 31 wherein it is liquefied. It then flows through the conduit 34 to the liquid receiver 35. From the latter, it flows through the conduit 36 to the valve 37, which regulates the flow thereof.

As the liquid refrigerant passes through the valve 37, its pressure is reduced, so that a portion of the liquid refrigerant flashes into vapor. The mixture of liquid and vaporous refrigerant is conveyed through the conduits 16 and 18 to the warmer evaporator 14, wherein the liquid refrigerant is vaporized in extracting heat from the compartment 13. The vaporous refrigerant is discharged from the evaporator 14 into the conduit 21 to be recirculated.

Since the compartment 13 is maintained at a higher temperature than the compartment 11, evaporation of liquid refrigerant in the evaporator 14 results in a higher pressure in the evaporators. Any vaporous refrigerant remaining in the evaporator 12 from previous operation thereof is condensed by the lower temperature in the compartment 11, causing refrigerant from the conduit 16 to flow into said evaporator to fill the space vacated by the vapor. Inasmuch as the conduit 17 extends downwardly from the connection with the conduits 16 and 18, the evaporator 12 is filled with liquid refrigerant, thereby preventing any further condensation and heating of said evaporator.

When the evaporator 14 is in operation, the thermostatic valve 37 operates to supply such quantity of refrigerant as can be fully vaporized and superheated to a given degree in said evaporator. The relatively high temperature of the discharged vapor results in a relatively high vapor pressure, since the degree of superheat is maintained constant.

To effect operation of the evaporator 12, the valve 22 is positioned, as by deenergizing the coil 25, to permit flow of refrigerant through the evaporator 12 and to cut off flow of refrigerant through the evaporator 14. Operation of the motors 28 and 33 is also effected. The operation is similar to that just described except that evaporation of liquid refrigerant takes place in the evaporator 12; the mixture of liquid and vaporous refrigerant being supplied thereto through the conduits 16 and 17, and the vaporized refrigerant being discharged from the top of the header 12' through the conduits 19 and 23 and the valve 22. The valve 37 again maintains a constant degree of superheat, but, since the temperature of the discharged vapor is lower, the pressure in the evaporators is necessarily lower. Since the conduit 18 extends upwardly from the conduit 16, liquid refrigerant cannot flow by gravity into the evaporator 14. The vapor in the latter is heated somewhat by the higher temperature in the compartment 13, but the pressure in the evaporators is not affected thereby.

Upon beginning operation of the evaporator 12 after operation of the evaporator 14, the former and its conduits 17 and 19 contain liquid refrigerant, while the latter and its conduits 18 and 21 contain vapor at higher pressure and liquid being vaporized which must be removed through the header 12' of the evaporator 12 and its conduits

17 and 19 in order to reduce the suction pressure. Consequently, liquid refrigerant is temporarily drawn into the suction conduit 23. A chamber 23' is preferably interposed in the latter beyond the thermostatic bulb 39 to retain said liquid temporarily. It is gradually vaporized by the superheated vapor.

In Fig. 2, I show an embodiment of my invention in which both evaporators are of the flooded type. The colder evaporator 12a is of a conventional type having a refrigerant inlet 42 at the bottom thereof and a header 43 at the top thereof. The warmer evaporator 14a is in the form of a coil having its inlet at the bottom and its outlet at the top. In this case, the conduit 36 connects the liquid receiver 35 to a float chamber 45 containing a low-side float valve 44. The float valve controls the admission of refrigerant to the float chamber so as to maintain a liquid level indicated at 46. The upper end of the colder evaporator 12a is connected by a conduit 40 to the chamber 45 below the liquid level 46, and the upper end of the warmer evaporator 14a is connected to the chamber 45 above said liquid level. A conduit 47 extends downwardly from the lower portion of the float chamber 45 and communicates with the lower or inlet ends of the evaporators through the selector valve 22a, which may be similar to the valve 22 of Fig. 1. The suction conduit 23a communicates with the chamber 45 above the liquid level.

To effect operation of the warmer evaporator 14a, the valve 22a is actuated to provide communication between the conduit 47 and the lower or inlet end of said evaporator, while communication with the inlet of the colder evaporator 12a is cut off. Operation of the compressor 27 and the fan 32 is also effected. Liquid refrigerant flows by gravity from the float chamber 45 through the conduit 47 into the lower end of the evaporator 14a to be evaporated therein. The vaporized refrigerant flows upwardly through the evaporator to the upper portion of the chamber 45, from which it is withdrawn through the suction conduit 23a, to be compressed, condensed, and recirculated. The vapor present in the colder evaporator 12a at the time of change-over is compressed by the higher suction pressure and either is condensed or flows to the chamber 45. It is replaced by liquid refrigerant from said chamber, inasmuch as the connection of said evaporator is below the liquid level in the chamber.

To effect operation of the colder evaporator 12a, the valve 22a is moved to the opposite position by deenergizing the coil 25, thereby placing the conduit 47 in communication with the evaporator 12a and cutting off communication with the evaporator 14a. As the liquid refrigerant remaining in the evaporator 14a from previous operation thereof is gradually evaporated, the suction pressure decreases and evaporation in the colder evaporator 12a begins. The compressor 27 then serves to withdraw vapor from the evaporator 12a to effect refrigeration therein. The liquid refrigerant flows downwardly through the conduit 47 into the lower end of the evaporator, and the vaporized refrigerant flows upwardly through the header 43 and the conduit 40 to the float chamber 45, from which it is withdrawn through the suction conduit 23a. During this operation, the evaporator 14a is dry, the lower end thereof being cut off by the valve 22a and the upper end communicating with the chamber 45 above the liquid level.

It will thus be seen that the float valve 44, in maintaining a common liquid level for the evaporators 12a and 14a, serves to admit such quantity of liquid refrigerant as can be evaporated in whichever evaporator is in operation. The excess quantity of refrigerant which is present when the colder evaporator 12a is in operation is automatically stored in the liquid receiver 35, due to the action of the float valve 44.

In Fig. 3, I show a further embodiment of my invention in which the conduit 34 conveys the condensed refrigerant to the high side float valve 48, which valve operates to pass such quantity of refrigerant as is condensed in the condenser 31. In this embodiment the evaporators are both of the dry type and the connection between the float valve and the evaporators is such that liquid refrigerant flows into the colder evaporator 12b in preferance to the warmer evaporator 14b. In this case, this is effected by projecting a conduit 49 communicating with the float valve 48 downwardly into a conduit 51 which connects with the inlet of the colder evaporator 12b and by connecting a conduit 52, which conveys refrigerant to the warmer evaporator 14b, to the conduit 51 at a level above the lower end of the conduit 49. In this embodiment the selector valve 22b controls communication of the outlet ends of the evaporators with the suction conduit 23b. A storage tank 53 is preferably provided in the suction conduit 23b.

Assuming first that the valve 22b is positioned to place the colder evaporator 12b in communication with the suction conduit 23b, the liquid refrigerant conveyed through the conduit 49 is free to flow into the colder evaporator. The warmer evaporator 14b is deprived of liquid refrigerant at this time, since it would be necessary for such liquid refrigerant to rise in the conduit 51 to the connection with the conduit 52. During the operation of the evaporator 12b, there will be an excess of liquid refrigerant, since the evaporator 14b is deprived of the same. Such excess quantity of liquid refrigerant collects in the chamber 53.

To effect refrigeration in the warmer evaporator 14b, the valve 22b is moved to the opposite position to place said evaporator in communication with the suction conduit 23b. Liquid refrigerant from the conduit 49 flows through the conduit 51 into the evaporator 12b to the extent necessary to fill the space occupied by vaporous refrigerant present from previous operation and which is now condensed due to the higher suction pressure. Further refrigerant is forced upwardly through the upper portion of the conduit 51 to the conduit 52 and then through the evaporator 14b. The liquid refrigerant in the chamber 53 is vaporized by the superheat contained in the refrigerant vapor discharged from the warmer evaporator 14b. If the connecting passage is sufficiently large, some of the liquid may flow by gravity into the evaporator 14b to be evaporated therein.

In Fig. 4, I show my invention applied to a refrigerator 54 having food liner 55, which is divided by a horizontal partition 56 into an upper warmer compartment 13c and a lower colder compartment 11c, in accordance with the invention of M. Kalischer covered in application Serial No. 751,324, filed Nov. 3, 1934, now matured into Patent No. 2,103,683. The colder evaporator 12c is in the form of a serpentine coil disposed on the underside of the bottom wall portion of the food liner in heat conducting relation thereto, in ac-

cordance with the invention of J. H. Ashbaugh, covered in application Serial No. 751,309, filed Nov. 3, 1934, now matured into Patent No. 2,103,-682. The warmer evaporator 14c is in the form of a serpentine coil disposed on the rear surface of the back wall portion of the food liner in heat conducting relation thereto. In this embodiment, both evaporators are of the dry type, and a thermostatic expansion valve 37c, similar to the valve 37 of Fig. 1, is provided. The valve 37c discharges into a conduit 16c, and a conduit 18c extends upwardly from said conduit to the upper or inlet end of the evaporator 14c, while a conduit 17c extends downwardly to the inlet end of the colder evaporator 12c. A conduit 21c provides communication between the lower or outlet end of the evaporator 14c direct with the suction conduit 23c, without any valve therebetween, while a conduit 19c connects the outlet end of the colder evaporator 12c with the suction conduit 23c through a valve 57, which thus controls flow of refrigerant through the evaporator 12c.

In this embodiment, I show a heat exchanger 58 having one passage interposed in the suction conduit 23c and a second passage interposed in the liquid refrigerant conduit 36c, thereby effecting transfer of heat from the warm condensed refrigerant to the colder vaporized refrigerant under low pressure going to the compressor. Such heat exchangers per se are well-known in the art, and may be provided in any of the other embodiments. A storage chamber 59, may be provided if found desirable, for storing liquid refrigerant which may enter the suction conduit 23c at certain times, such as when beginning operation of the colder evaporator 12c after previous operation of the warmer evaporator 14c. If it is found that lubricant is not drawn through the chamber 59 and accumulates therein, suitable provision may be made for removing the same when an objectionable quantity has accumulated. An outlet 60 having a valve 61 may be provided for this purpose.

The operation of the embodiment shown in Fig. 4 is as follows: To effect refrigeration of the warmer compartment 13c, the valve 57 is closed. The compressor and condenser operate in the usual manner, as described in connection with Fig. 1, supply condensed refrigerant to the thermostatic valve, which regulates the supply thereof to the evaporators through the conduit 16c. The conduit 16c supplies liquid refrigerant to the colder evaporator 12c to replace any vapor present from previous operation and which is now condensed. After the evaporator 12c is filled with liquid refrigerant, the mixture of vaporous and liquid refrigerant supplied through the conduit 16c is conveyed through the conduit 18c and evaporated. Liquid refrigerant is vaporized therein and the vaporous refrigerant is discharged through the conduit 21c to the suction conduit 23c. In the heat exchanger 58, the vaporous refrigerant extracts heat from the condensed refrigerant, and then flows on through the chamber 59 to the compressor. The thermostatic expansion valve 37c operates to regulate the supply of refrigerant in accordance with the requirements of the evaporator 14c as in Fig. 1, and the colder evaporator 12c is again filled with liquid refrigerant to prevent condensation of vaporous refrigerant therein, except such refrigerant as may be trapped therein from previous operation thereof, which quantity is relatively small.

To effect refrigeration in the colder compartment 11c, the valve 57 is opened to permit flow of refrigerant through the colder evaporator 12c. While both evaporators are now in communication with the suction conduit 23c, the liquid refrigerant flows through the colder evaporator, due to the gravity head imposed by the conduit 18c. The refrigerant vaporized in the colder compartment 12c is discharged at a lower temperature, so that the thermostatic expansion valve 37c operates to maintain a lower suction pressure, supplying such quantity of refrigerant as can be completely vaporized in the colder evaporator. The refrigerant which is vaporized upon leaving the valve 37c may flow upwardly through the conduit 18c and through the warmer evaporator 14c, thereby effecting a slight degree of cooling of the warmer compartment and also slightly superheat said vapor. It is conveyed through the conduit 21c to the suction conduit and removed along with the vaporized refrigerant removed from the colder evaporator.

When operation of the colder evaporator is begun after previous operation of the warmer evaporator, the former and the conduit 19c are filled with liquid refrigerant, so that liquid refrigerant may be drawn into the suction conduit 23c before the thermostatic valve 37c can operate to reduce the quantity of liquid refrigerant in the low side. Such liquid refrigerant is retained temporarily in the chamber 59 and slowly vaporized by the superheated vaporized refrigerant circulated therethrough.

In Fig. 5, I show an embodiment of my invention in which a float valve 48 is provided to pass all of the refrigerant as fast as it is condensed and in which a selector valve 22d is connected between the refrigerant supply conduit 16d and the conduits 17d and 18d connected to the colder evaporator 12d and the warmer evaporator 14d, respectively. The evaporator 12d is of the flooded type, the vapor outlet being connected through a conduit 19d to a chamber 62. The suction conduit 23d is connected to the top of said chamber. The warmer evaporator 14d is connected to the chamber 62 through a conduit 21d, which is looped upwardly above the chamber 62, as shown at 63, before connecting therewith.

To effect operation of the colder evaporator 12d, the selector valve 22d is positioned to supply refrigerant thereto. Inasmuch as the quantity of liquid refrigerant supplied to the evaporator 12d is in excess of the quantity that can be contained therein, a portion thereof is drawn through the conduit 19d into the chamber 62 in which it is retained during the operation of said evaporator. Refrigerant vaporized in the evaporator is withdrawn through the conduit 19d and the chamber 62 to the suction conduit 23d. Liquid refrigerant is prevented from entering the warmer evaporator 14d through the conduit 21d because of the loop 63 formed therein.

When the valve 22d is positioned to supply refrigerant to the warmer evaporator 14d, liquid refrigerant in the chamber 62 is forced by the increased suction pressure and by gravity through the conduit 19d into the colder evaporator 12d, to completely fill the same with liquid refrigerant. The remaining refrigerant in the chamber 62, which is required for operation of the warmer evaporator 14d, is gradually vaporized by the superheated vapor discharged from said evaporator. It is compressed, condensed, and supplied to the warmer evaporator to effect refrigeration therein.

In Fig. 6, I show one form of control mechanism which may be applied to any one of the

above embodiments of refrigerating apparatus. This mechanism includes a thermostat T_1 which is disposed in whichever refrigerated compartment is to have preference, and a thermostat T_2 for the other compartment. The thermostat T_1 has contacts **64** which are closed and contacts **63** which are opened when the thermostat calls for refrigeration, and the thermostat T_2 is provided with contacts **65** which are closed when the same calls for refrigeration. The contacts **64** and **65** are connected in parallel in one side of the line going to a starting relay **66**. The starting relay is connected to the compressor motor **28** by the necessary number of conductors, including conductors **67** connected to the running winding of the motor. A circuit **68** extends from one of the conductors **67** through the coil **25** and the contacts **63** to the other conductor **67**. The core **24** actuated by the solenoid coil **25** is connected to the valve **22** in such manner that, when the coil is not energized, the spring **26** positions the valve **22** so that refrigerant is circulated to that evaporator which is to have preference when both evaporators are calling for refrigeration, and so that, when the coil **25** is energized, the valve **22** is positioned to circulate refrigerant to the other evaporator.

The operation of this control mechanism is as follows: Assume that this control system is applied to the apparatus shown in Fig. 1, that the thermostat T_1 is located in the colder compartment **11** to give the same preference and that the thermostat T_2 is located in the warmer compartment **13**. The core **24** and the valve **22** are connected as in Fig. 1. Assuming that the warmer compartment is calling for refrigeration and that the other is not, the contacts **65** and **63** are closed and the contacts **64** opened, as shown in Fig. 6. The closing of the contacts **65** effects energization of the compressor motor, and of the conductors **67**. The contacts **63** being closed, the circuit **68** is now closed to energize the coil **25**, thereby positioning the valve to circulate refrigerant through the warmer evaporator **14**.

When the thermostat T_1 in the colder compartment calls for refrigeration, the contacts **64** are closed and the contacts **63** opened. The contacts **64** effect energization of the motor and of the conductors **67**, but, in this case, the contacts **63** prevent energization of the solenoid **25**, regardless of whether the thermostat T_2 is calling for refrigeration. The valve **22** is thus positioned to circulate refrigerant through the colder evaporator. When the refrigeration demand of the colder compartment is satisfied, the contacts **63** are closed to enable the thermostat T_2 to effect refrigeration in the warmer compartment. With this embodiment, it will be noted that the valve **22** is positioned for circulation of refrigerant through the preferred evaporator when neither thermostat is calling for refrigeration.

In Fig. 7, I show another form of control mechanism comprising thermostats T_1 and T_2 which operate contacts **64** and **65**, respectively, as in Fig. 6, but in which the thermostat T_1 closes contacts **63'** when calling for refrigeration. In this case, the core **24** is connected to the valve in such manner that refrigerant is circulated through the preferred evaporator when the coil **25** is energized, since the contacts **63'** close the circuit **68** when the preferred thermostat T_1 calls for refrigeration. The core and valve are biased to the opposite position by a tension spring **26'** when the coil is deenergized.

The operation of this embodiment is as follows: When the thermostat T_1 calls for refrigeration, the contacts **64** effect energization of the compressor motor **28** and the contacts **63'** energize the coil **25** to circulate refrigerant through the preferred evaporator, regardless of whether the other evaporator requires refrigeration. When the thermostat T_2 calls for refrigeration, the contacts **65** effect energization of the compressor motor **28**, but refrigerant will be circulated to the second evaporator associated therewith only when the thermostat T_1 becomes satisfied and opens the contacts **63'**. With this embodiment, the valve **22** is positioned for circulation of refrigerant to the non-preferred evaporator when neither thermostat calls for refrigeration.

In Fig. 8, I show a third form of control mechanism in which the thermostat T_2 is provided with contacts **69** in series with the coil **25** and in series with the compressor motor **28**. The preferred thermostat T_1 is provided with contacts **71** which are connected in parallel with the coil **25** and the contacts **69** and in series with the motor **28**. When the thermostat T_2 calls for refrigeration and the thermostat T_1 does not, the contacts **69** close a circuit through the coil **25**, the contacts **69**, and the motor **28** in series, thereby effecting refrigeration in the non-preferred evaporator. When the thermostat T_1 closes the contacts **71**, the compressor motor **28** is energized, while the coil **25** is deenergized regardless of whether the contacts **69** are closed, since the current through the coil is shunted to the contact **71**, and the core **24** and the valve **22** are positioned by the compression spring **26** for operation of the preferred evaporator. In this case, the core **24** is connected to the valve **22** in such manner that refrigerant is circulated through the preferred evaporator when the coil is not energized.

It will be noted that any one of the three forms of control mechanisms shown in Figs. 6, 7, and 8 may be applied to any one of the embodiments of refrigerating mechanism by merely connecting the solenoid in correct relation to the selector valve **22**.

In each of the above embodiments, the portions of the low side conduits outside the refrigerated compartments are preferably heat-insulated or arranged in some suitable way to avoid or minimize absorption of heat. While the drawings are diagrammatic in many respects in order to clearly show the features of invention, it is to be understood that the apparatus is constructed in accordance with the usual knowledge and skill of the art and may embody any other suitable features.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and I therefore desire that only such limitations shall be placed thereupon as are imposed by the prior art or as are set forth in the appended claims.

What I claim is:

1. In a refrigerating system, the combination of a lower temperature and a higher temperature evaporator connected in parallel and in unrestricted communication with each other so that the pressure therein is substantially the same at all times, means including a compressor and a condenser for effecting evaporation of liquid refrigerant in said evaporators and for supplying liquid refrigerant thereto, said means

being operative to effect evaporation of liquid refrigerant in the higher temperature evaporator at a temperature above the temperature of the lower temperature evaporator and at a pressure higher than the pressure corresponding to said temperature of the lower temperature evaporator, means common to said evaporators for reducing the pressure of the liquid refrigerant supplied thereto, and valve means for controlling flow of refrigerant through at least one evaporator for selectively effecting refrigeration in either evaporator, said evaporators being connected in such manner that liquid refrigerant flows into the lower temperature evaporator in preference to the higher temperature evaporator.

2. In a refrigerating system, the combination of a lower temperature and a higher temperature evaporator, means for compressing and condensing refrigerant vaporized in said evaporators, means common to said evaporators for reducing the pressure of the condensed refrigerant, means for conveying liquid refrigerant from the pressure-reducing means to said evaporators, said conveying means providing unrestricted communication between said evaporators at all times and being arranged so that liquid refrigerant flows into the lower temperature evaporator in preference to the higher temperature evaporator, and valve means for controlling flow of vaporized refrigerant from at least one evaporator to the compressing means for selectively effecting refrigeration in either evaporator, said conveying means serving to maintain the higher temperature evaporator substantially dry while said valve means is adjusted to effect refrigeration in the lower temperature evaporator.

3. In a refrigerating system, the combination of a lower temperature and a higher temperature evaporator, means for compressing and condensing refrigerant vaporized in said evaporators, means common to said evaporators for reducing the pressure of the condensed refrigerant, means conveying refrigerant from the pressure reducing means, said conveying means providing unrestricted communication between said evaporators and being arranged so that liquid refrigerant flows into the lower temperature evaporator in preference to the higher temperature evaporator, and valve means for selectively providing communication between the vapor outlet of either evaporator and the compressing means and shutting off flow from the vapor outlet of the other evaporator.

4. In a refrigerating system, the combination of a lower temperature and a higher temperature evaporator, a compressor, a condenser, means for conveying condensed refrigerant from the condenser to said evaporators, a thermostatic expansion valve in a portion of said conveying means common to said evaporators, means for conveying vaporized refrigerant from said evaporators to the inlet of said compressor, means responsive to the temperature of a portion of said conveying means common to said evaporators for governing the operation of said thermostatic expansion valve, and means for selectively effecting refrigeration in either evaporator.

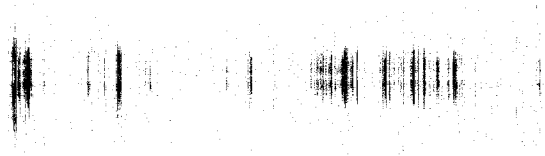
5. In a refrigerating system, the combination of a low temperature and a higher temperature evaporator, a compressor, a condenser, means for conveying condensed refrigerant from the condenser to said evaporators, a thermostatic expansion valve in a portion of said conveying means common to said evaporators, means for conveying vaporized refrigerant from said evaporators to the inlet of said compressor, means responsive to the temperature of a portion of said conveying means common to said evaporators for governing the operation of said thermostatic expansion valve, and valve means for providing circulation of refrigerant through either evaporator and for shutting off circulation thereof through the other evaporator, whereby refrigeration may be selectively effected in either evaporator.

6. In a refrigerating system, the combination of a lower temperature and a higher temperature evaporator, a compressor, a condenser, means for conveying condensed refrigerant from the condenser to said evaporators, means for controlling the flow and reducing the pressure of the refrigerant in a portion of said conveying means common to said evaporators, and means for selectively placing the vapor outlet of either evaporator in communication with the inlet of said compressor for selectively providing refrigeration in either evaporator, and means whereby, when the higher temperature evaporator is in operation, the lower temperature evaporator only receives liquid refrigerant when the same is in operation and whereby the lower temperature evaporator is filled with a static body of liquid refrigerant and liquid refrigerant is supplied to the higher temperature evaporator and evaporated therein at a temperature above the temperature of the lower temperature evaporator and at a pressure higher than the pressure corresponding to said temperature of the lower temperature evaporator.

7. In a refrigerating system, the combination of a lower temperature and a higher temperature evaporator, a compressor, a condenser means for conveying condensed refrigerant from the condenser to said evaporators, means for controlling the flow and reducing the pressure of the refrigerant in a portion of said conveying means common to said evaporators, and means for selectively supplying liquid refrigerant to the low temperature evaporator and preventing the admission of appreciable quantity of liquid refrigerant to the high temperature evaporator, for operation of the low temperature evaporator, or supplying liquid refrigerant to the higher temperature evaporator and effecting evaporation therein at a temperature above the temperature of the lower temperature evaporator and at a pressure higher than the pressure corresponding to said temperature of the lower temperature evaporator while maintaining the lower temperature evaporator substantially filled with a static head of liquid refrigerant.

8. In refrigerating apparatus, the combination of a lower temperature evaporator and a higher temperature evaporator, means for liquefying refrigerant, means for conveying liquid refrigerant from said liquefying means to said evaporators, a valve in a portion of said conveying means common to both evaporators, means for conveying vaporized refrigerant from said evaporators to said liquefying means, means responsive to the temperature of the refrigerant in a portion of the last-mentioned means common to said evaporators for controlling said valve so as to pass such quantity of refrigerant as is being evaporated in whichever evaporator is effective, and means for selectively effecting refrigeration in either evaporator.

9. In a refrigerating system, the combination of a low temperature and a higher temperature evaporator, a compressor, a condenser, means



sor, said second-mentioned means serving to prevent liquid refrigerant entering the warmer evaporator while said valve is open.

17. In refrigerating apparatus, the combination of a colder evaporator and a warmer evaporator, means for supplying liquid refrigerant to said evaporators and for effecting evaporation of liquid refrigerant therein, a valve for controlling the flow of liquid refrigerant from said supply means to said warmer evaporator, and a connection providing unrestricted communication at all times between said evaporators and the inlet of said compressor and arranged so that liquid refrigerant flows into the colder evaporator in preference to the warmer evaporator and through which connection vaporized refrigerant flows from the colder evaporator during operation thereof and from the warmer evaporator during operation thereof, said connection serving to prevent liquid refrigerant entering the warmer evaporator when said valve is closed.

18. In a refrigerating system, the combination of a colder evaporator and a warmer evaporator, means including a compressor and a condenser for effecting evaporation of liquid refrigerant in said evaporators and for supplying liquid refrigerant thereto, the warmer evaporator having an inlet and an outlet through which refrigerant respectively enters and leaves while evaporation of refrigerant is effected therein, a valve controlling flow of liquid refrigerant from said supply means to the inlet of the warmer evaporator, and means providing unrestricted communication at all times between the colder evaporator, the outlet of the warmer evaporator, and the inlet of the compressor and arranged so that liquid refrigerant flows therefrom to the colder evaporator in preference to the warmer evaporator, said last-mentioned means serving to prevent liquid refrigerant entering the warmer evaporator while said valve is closed.

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