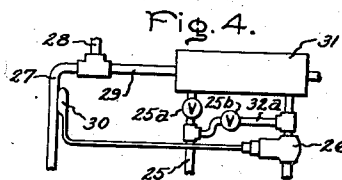
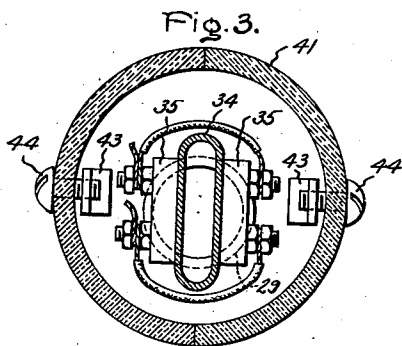
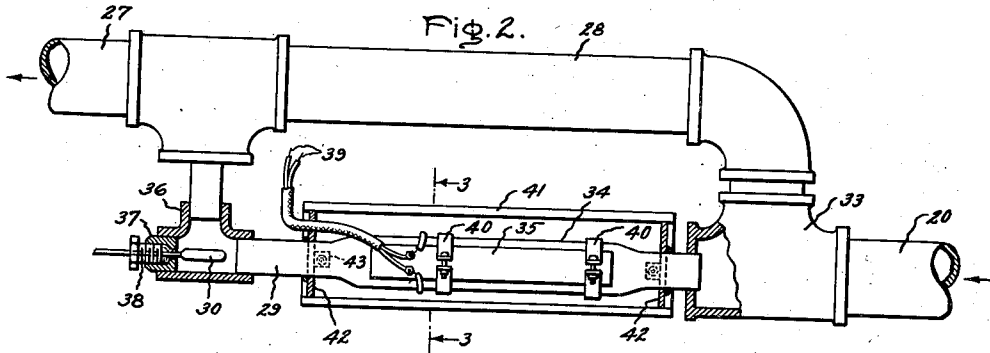
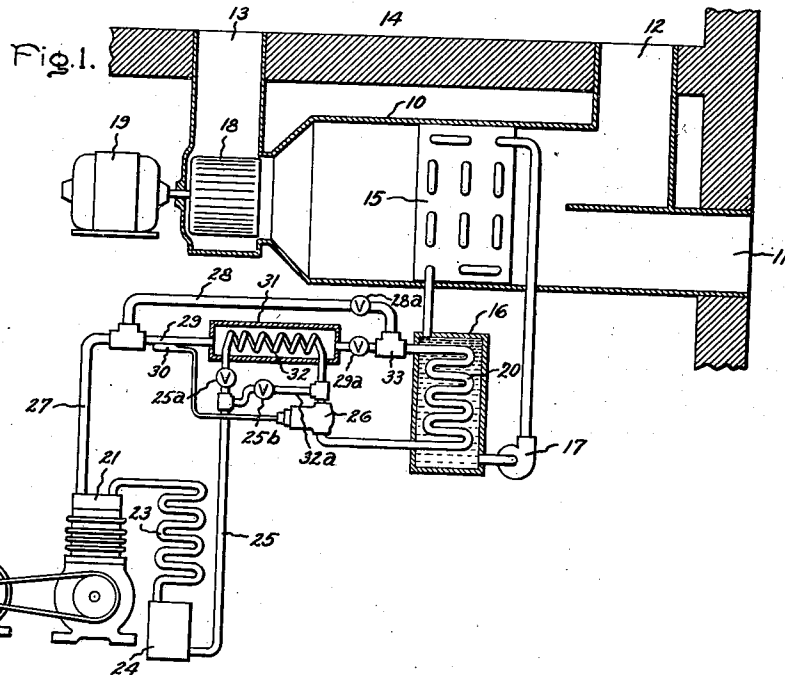


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W. A. SPOFFORD
REFRIGERATING SYSTEM
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REFRIGERATING SYSTEM

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Application December 30, 1938, Serial No. 248,490

14 Claims. (Cl. 62—8)

My invention relates to refrigerating systems, and particularly to arrangements for controlling the supply of liquid refrigerant to the evaporators of such systems.

Refrigerating systems such as those employed for air conditioning are commonly provided with thermostatic expansion valves for controlling the admission of liquid refrigerant to the evaporator. The thermostatic expansion valve is constructed so that its operation depends upon the pressure of the refrigerant in the evaporator and upon the temperature of the refrigerant discharged from the evaporator. The effect of this type of control is to supply liquid refrigerant to the evaporator in such quantities that the superheat of the vaporized refrigerant withdrawn from the evaporator remains substantially constant. The purpose of such a device is to minimize or prevent the return of liquid refrigerant to the compressor. In installations where there is very little difference in temperature between the evaporator and the surrounding medium, for example, in indirect cooling systems in which the evaporator is surrounded by a circulating brine solution, it is difficult to obtain sufficient difference between the temperature of the evaporator and that of the suction line to provide satisfactory operation of the thermostatic expansion valve.

Accordingly, it is an object of my invention to provide a refrigerating system including an improved arrangement utilizing a thermostatic expansion valve for satisfactorily controlling the flow of refrigerant to the evaporator of the system.

Another object of my invention is to provide a refrigerating system including an improved arrangement for controlling the admission of liquid refrigerant to the evaporator and for minimizing the return of liquid refrigerant to the compressor.

A further object of my invention is to provide an improved arrangement for controlling the admission of refrigerant to the evaporator of a refrigerating system when the difference in temperature is small between the liquid refrigerant admitted to the evaporator and the gaseous refrigerant discharged therefrom.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention, reference may be had to the accompanying draw-

ing in which Fig. 1 is a diagrammatic view of an air conditioning system utilizing a refrigerating system embodying my invention; Fig. 2 is an enlarged detail view of a modified form of the control device shown in Fig. 1; Fig. 3 is an enlarged sectional view along the line 3—3 of Fig. 2; and Fig. 4 is a diagrammatic view of a portion of the system shown in Fig. 1 and illustrating a modified arrangement of the expansion valve control element.

Referring now to the drawing, in Fig. 1, I have shown an air conditioning system including a duct 10 having fresh and return air inlets 11 and 12 respectively and an outlet duct 13 for discharging the conditioned air into an enclosure 14. A cooling unit 15 is provided in the duct 10 and is supplied with a brine solution or other cooling medium from a tank 16 by operation of a pump 17, brine being withdrawn from the bottom of the tank 16 and returned to the top thereof. Air is circulated through the duct 10 by a fan or blower 18 driven by an electric motor 19.

In order to cool the brine in the tank 16, I provide a refrigerating system including an evaporator 20 arranged in the tank 16, a compressor 21 driven by a motor 22, a condenser 23, and a liquid receiver 24 connected to supply liquid refrigerant to the evaporator 20 through a conduit 25 and a thermostatic expansion valve 26. Vaporized refrigerant is withdrawn from the evaporator and returned to the compressor through a conduit 27. It is desirable to operate the refrigerating system so that the brine solution or other liquid in the casing 16 is cooled as nearly as possible to the temperature of the evaporating refrigerant in the coil 20 and it is also desirable to circulate the brine by operation of the pump 17 so that the brine returning from the cooling element 15 is also at a temperature differing as little as practicable from that of the evaporating refrigerant.

An installation of this type obviously is difficult to control with the conventional thermostatic expansion valve since it is undesirable to maintain the brine solution or other liquid at a high enough temperature to superheat the vaporized refrigerant withdrawn from the evaporator sufficiently to attain the required superheat for actuation of the expansion valve. I have, therefore, found it desirable to provide some arrangement for increasing the effective temperature of the control element or bulb of the thermostatic expansion valve. Referring again to the drawing, I have shown the conduit 27 provided with a portion comprising two parallel branches 28

and 29, the conduit branch 28 being larger than the conduit branch 29 and carrying the major portion of the refrigerant returned to the compressor. Valves 28a and 29a may be provided in the branches 28 and 29 respectively, to adjust the relative amounts of refrigerant flowing in the two branches. The valve 26 is provided with a thermostatic control element or bulb 30 secured to the branch 29 of the conduit and responsive to the temperature of the vaporized refrigerant therein. In order to provide proper control of the expansion valve by means of the bulb 30, I provide an arrangement for heating the refrigerant gas passing through the branch 29 before it passes the bulb 30. In Fig. 1, I have shown a heat exchanger comprising a casing 31 forming part of the branch 29 of the conduit 27 and a coil 32 forming a portion of the liquid line 25 and arranged within the casing. The refrigerant gas passing through the casing 31 is heated by the warm liquid refrigerant passing through the coil 32. The refrigerant gas is thus heated prior to its passage through the portion of the conduit 29 to which the bulb is attached. This heating of the refrigerant supplies the additional heat necessary for satisfactory operation of the thermostatic expansion valve 26, it being evident that the effective differential of temperature has been increased between the inlet refrigerant and the refrigerant passing the bulb 30. In order to vary the quantity of liquid refrigerant passing through the coil 32, a by-pass 32a may be provided around the coil 32 and valves 25a and 25b may be arranged to control the relative amounts of liquid flowing in the coil 32 and by-pass 32a, respectively. The valves 25a and 25b may then be adjusted to vary the amount of heating of the refrigerant in the branch 29. Since it is desirable that no liquid refrigerant be returned to the compressor, and since the thermostatic expansion valve is provided to minimize the return of such liquid refrigerant, I arrange the branch 28 of the conduit 27 so that only gaseous refrigerant tends to pass therethrough and so that any liquid refrigerant discharged from the evaporator tends to flow through the branch 29, the liquid being vaporized by the heat supplied from the liquid refrigerant in the coil 32. In order to accomplish this separation of liquid and gaseous refrigerant, I connect the inlet end of the branch 28 by means of a T-connection 33 so that it is arranged at an angle to the direct line of discharge of the refrigerant from the evaporator and I connect the branch 29 directly in line with the direction of the discharged refrigerant flowing from the outlet of the evaporator so that the momentum of the liquid refrigerant tends to carry it into the branch 29 instead of the branch 28, and furthermore, I prefer to connect the branch 28 so that its inlet is at the top of the T-connection 33 so that the force of gravity will tend to keep the liquid refrigerant in the lower branch 29. With this separating arrangement, vaporization of all liquid refrigerant discharged from the evaporator is assured and sufficient superheat obtained and proper operation of the valve 26 is made possible.

In some installations, it may be desirable to provide heat by other means than by use of a heat exchanger as illustrated in Fig. 1, and in Fig. 2, I have shown an enlarged detail view of a modified form of the control arrangement shown in Fig. 1 and which utilizes an electric heater for supplying the heat necessary for vaporization of the liquid refrigerant and superheating of the

vaporized refrigerant necessary for proper control of the expansion valve 26. In Figs. 2 and 3, I have shown the conduit 29 provided with a flattened portion 34 on either side of which are arranged electric heaters 35. The control bulb 30 is arranged in the path of the refrigerant flowing through the branch 29, a small T-connection 36 being provided for this purpose. The bulb 30 is maintained in the stream of refrigerant flowing through the T-connection 36 and held in place by a plug 37 and sealing screw 38 secured in the opening of the T-connection opposite that to which the tube 29 is secured. The heaters 35 are supplied with energy from a suitable source through electric current supply lines 39. The heaters may be secured to the sides of the branch conduit 29 in any suitable manner such, for example, as by clamps 40. The heated portion of the branch conduit 29 is insulated from the surrounding atmosphere by a casing 41 of suitable heat insulating material. The casing 41 has been indicated as constructed of two semi-cylindrical portions secured to end pieces 42 by lugs 43 and screws 44, the lugs 43 being secured to the end pieces 42 and the screws 44 passing through the casing 41. One advantage provided by the use of electrical heaters is that the degree of superheat of the refrigerant gas may be varied if desired, it being obvious that when a greater amount of heat is supplied by the heaters, more liquid refrigerant may be admitted to the evaporator without returning liquid to the compressor.

During the operation of the air conditioning system shown in Fig. 1, the pump 17 is operated in any suitable manner to supply cooling fluid to the element 15 which absorbs heat from the air passing through the duct 10 thereby heating the brine in the cooling element and returning the brine to the casing 15 at a somewhat higher temperature. The heat is removed from the brine by operation of the refrigerating machine, it being absorbed by the liquid refrigerant within the evaporator 20 which is thereby vaporized and returned to the compressor 21 through the conduit 27. Any liquid refrigerant discharged from the evaporator 20 tends to pass through the branch 29 of the conduit 27 where it is vaporized by the heat exchanger 32 or by the heaters 35, the bulb 30 then effecting operation of the valve 26 in accordance with the superheat of the refrigerant passing through the branch 29. The hot compressed refrigerant discharged from the compressor 21 enters the condenser 23 where it is cooled and liquefied and from which it flows to the liquid receiver 24 and thence through the coil 32 and the valve 26 to the evaporator. In the event the electrical heaters 35 are employed instead of the coil 32 in order to heat the refrigerant in the branch conduit 29, the coil 32 is omitted and the liquid line 25 is connected directly to the valve 26 without the coiled portion.

In Fig. 4, I have shown a portion of the system illustrated in Fig. 1 including the heat exchanger and thermostatic expansion valve 26; in this arrangement the thermal element 30 of the valve 26 is secured to the suction line 27 between the compressor and the branches 28 and 29. The bulb 30, therefore, is responsive to the temperature of the gaseous refrigerant after it has passed through the branches 28 and 29. This arrangement may be employed particularly in installations where the primary purpose of the branch 29 and the heater associated therewith is to vaporize liquid refrigerant discharged from the evaporator and prevent liquid refrigerant

from reaching the compressor without requiring heating of all the refrigerant discharged from the evaporator.

In view of the foregoing, it is readily apparent that I have provided a refrigerating system including an improved arrangement for effecting the control of the liquid refrigerant admitted to the evaporator thereof which arrangement is relatively inexpensive and makes it unnecessary to provide large heat exchangers or other heating devices.

While I have shown my invention in connection with an air conditioning system utilizing a brine or indirect cooling system, other applications will readily be apparent to those skilled in the art. I do not, therefore, desire my invention to be limited to the constructions shown and described and I intend in the appended claims to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A refrigerating system including an evaporator having an inlet and an outlet, means including a liquid line connected to said inlet and a suction line connected to said outlet for supplying refrigerant to and for withdrawing refrigerant from said evaporator, said suction line having a portion comprising two branches arranged in parallel for receiving the vaporized refrigerant discharged through said outlet, means including a valve in said liquid line having a thermostatic element responsive to the temperature of the refrigerant in one of said branches of said suction line for controlling the admission of refrigerant to said evaporator, and separating means for causing any liquid refrigerant discharged from said evaporator to flow into said one branch only.

2. A refrigerating system including an evaporator, means including a liquid line and a suction line for supplying refrigerant to and for withdrawing refrigerant from said evaporator, said suction line having two branches arranged in parallel and so constructed and arranged that the major portion of any refrigerant leaving the evaporator will pass through one of said branches, means including a valve in said liquid line having a thermostatic element responsive to the temperature of the refrigerant in the other of said branches of said suction line for controlling the admission of refrigerant to said evaporator, and means for adjusting the relative amounts of refrigerant flowing in said two branches.

3. A refrigerating system including an evaporator, means including a liquid line and a suction line for supplying refrigerant to and for withdrawing refrigerant from said evaporator, said suction line having two branches arranged in parallel, means including a valve in said liquid line having a thermostatic element responsive to the temperature of the refrigerant in one of said branches of said suction line for controlling the admission of refrigerant to said evaporator, means for supplying heat to the refrigerant in said one of said branches, and means for varying the amount of heat supplied by said heating means.

4. A refrigerating system including an evaporator, means including a liquid line and a suction line for supplying refrigerant to and for withdrawing refrigerant from said evaporator, said suction line including a portion having two branches arranged in parallel, means for heat-

ing the refrigerant passing through one of said branches of said suction line, and means including a valve in said liquid line having a thermostatic element responsive to the temperature of refrigerant in said suction line after the heating of at least a portion thereof by said heating means for controlling the admission of refrigerant to said evaporator.

5. A refrigerating system including an evaporator, means including a liquid line and a suction line for supplying refrigerant to and for withdrawing refrigerant from said evaporator, said suction line having a portion comprising two branches arranged in parallel, means for directing liquid refrigerant discharged from said evaporator into one of said branches, means for heating the liquid refrigerant passing through said one branch, and means including a valve in said liquid line having a thermostatic element responsive to the temperature of the refrigerant in said suction line after its passage through said branches for controlling the admission of refrigerant to said evaporator.

6. A refrigerating system including an evaporator, means including a liquid line and a suction line for supplying refrigerant to and for withdrawing refrigerant from said evaporator, said suction line having two branches arranged in parallel, means including a valve in said liquid line having a thermostatic element responsive to the temperature of the refrigerant in one of said branches of said suction line for controlling the admission of refrigerant to said evaporator, said one branch of said suction line being arranged directly in the line of discharge of refrigerant from said evaporator and the other of said branches being arranged at an angle to the line of discharge of refrigerant from said evaporator whereby the momentum of liquid refrigerant discharged from said evaporator tends to cause the liquid refrigerant to pass through said one branch only.

7. A refrigerating system including an evaporator, means including a liquid line and a suction line for supplying refrigerant to and for withdrawing refrigerant from said evaporator, said suction line having two branches arranged in parallel, means including a valve in said liquid line having a thermostatic element responsive to the temperature of the refrigerant in one of said branches of said suction line for controlling the admission of refrigerant to said evaporator, said one branch of said suction line being arranged below the other of said branches whereby the force of gravity tends to cause any liquid refrigerant discharged from said evaporator to pass through said one branch only.

8. A refrigerating system including an evaporator, means including a liquid line and a suction line for supplying refrigerant to and for withdrawing refrigerant from said evaporator, said suction line having two branches arranged in parallel, means including a valve in said liquid line having a thermostatic element responsive to the temperature of the refrigerant in one of said branches of said suction line for controlling the admission of refrigerant to said evaporator, said one branch of said suction line being arranged below the other branch thereof and directly in the line of discharge of refrigerant from said evaporator whereby any liquid refrigerant discharged from said evaporator tends to pass through said one branch only.

9. A refrigerating system including an evaporator, means including a liquid line and a suc-

tion line for supplying refrigerant to and for withdrawing refrigerant from said evaporator, said suction line having two branches arranged in parallel and so constructed and arranged that the major portion of any refrigerant leaving the evaporator will pass through one of said branches, means including a valve in said liquid line having a thermostatic element responsive to the temperature of the refrigerant in the other of said branches of said suction line for controlling the admission of refrigerant to said evaporator, and means for heating the refrigerant passing through said other branch of said suction line.

10. A refrigerating system including an evaporator, means including a liquid line and a suction line for supplying refrigerant to and for withdrawing refrigerant from said evaporator, said suction line having two branches arranged in parallel, means including a valve in said liquid line having a thermostatic element responsive to the temperature of the refrigerant in one of said branches of said suction line for controlling the admission of refrigerant to said evaporator, said branches of said suction line being so arranged that liquid refrigerant discharged from said evaporator tends to pass through said one branch only, and means for heating the refrigerant passing through said one branch of said suction line.

11. A refrigerating system including an evaporator, means including a liquid line and a suction line for supplying refrigerant to and for withdrawing refrigerant from said evaporator, said suction line having two branches arranged in parallel, means including a valve in said liquid line having a thermostatic element responsive to the temperature of the refrigerant in one of said branches of said suction line for controlling the admission of refrigerant to said evaporator, and means utilizing heat withdrawn from the liquid refrigerant supplied to said evaporator for heating the refrigerant in said one branch of said suction line.

12. A refrigerating system including an evaporator, means including a liquid line and a suction line for supplying refrigerant to and for withdrawing refrigerant from said evaporator, said suction line having two branches arranged

in parallel, means including a valve in said liquid line having a thermostatic element responsive to the temperature of the refrigerant in one of said branches of said suction line for controlling the admission of refrigerant to said evaporator, said one branch of said suction line having a cross-sectional area substantially less than that of the other branch of said suction line, said branches of said conduit being so arranged that substantially all of any liquid refrigerant discharged from said evaporator passes through said one branch, and means for heating the refrigerant passing through said one branch, said thermostatic element being arranged to be responsive to the temperature of the refrigerant after it has passed said heating means.

13. A refrigerating system including an evaporator, means including a liquid line and a suction line for supplying refrigerant to and for withdrawing refrigerant from said evaporator, said suction line having two branches arranged in parallel, means including a valve in said liquid line having a thermostatic element responsive to the temperature of the refrigerant in one of said branches of said suction line for controlling the admission of refrigerant to said evaporator, means including a heating element secured to said one branch of said suction line for heating the refrigerant passing therethrough, and a casing of heat insulating material surrounding said heating element for minimizing the transfer of heat between said heating element and the surrounding air.

14. A refrigerating system including an evaporator, means including a liquid line and a suction line for supplying refrigerant to and for withdrawing refrigerant from said evaporator, said suction line having two branches arranged in parallel, means including a valve in said liquid line having a thermostatic element arranged in the path of the refrigerant passing through one of said branches of said suction line and responsive to the temperature thereof for controlling the admission of refrigerant to said evaporator, and means for heating the refrigerant passing through said one branch of said suction line prior to its passage over said thermostatic element.

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