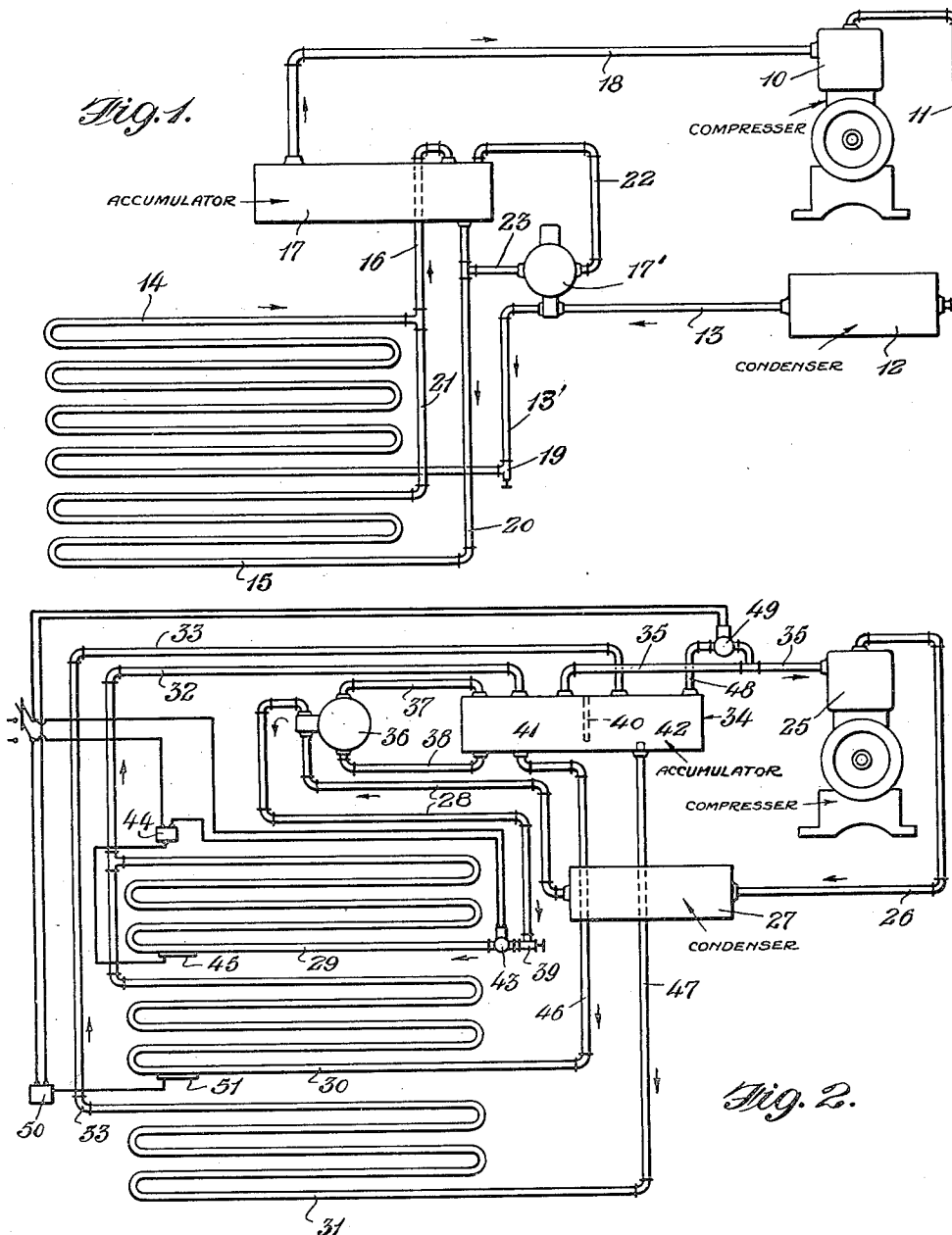


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REFRIGERANT FEED CONTROL

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REFRIGERANT FEED CONTROL

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This invention relates to a refrigerating system employing one or more evaporators or cooling coils for producing the cooling effect, the number of evaporators in the system being dependent upon the amount of refrigeration required.

Heretofore certain types of evaporators, especially those formed of relatively long lengths of tubing and carrying heavy refrigerating loads, have been found difficult to flood and if operated flooded, large quantities of entrained liquids are carried over with the suction gas which entrained liquid has been found difficult to provide for.

It is an object of the present invention to provide a refrigerating system having means for automatically controlling the supply of refrigerant from the condenser, for automatically controlling the circulation of the refrigerant in the cooling coils to produce the desired refrigerant effect, for automatically maintaining the fluid or other substance refrigerated at a definite temperature, and for securing a flooded condition in the coils.

A further object of the invention is to provide a system in which fine adjustment of expansion valves or the like is avoided and, where the adjustment permits liquid to pass over with the gas, the system is arranged to handle the entrained refrigerant.

Other objects and advantages will be apparent from the following description taken in connection with the accompanying drawing wherein,

Fig. 1 is a diagrammatic view illustrating one application of the invention.

Fig. 2, a similar view of a modified form.

Referring to Fig. 1 of the drawing, compressed refrigerant is discharged from a compressor 10 through a pipe 11 to a condenser 12 where it is liquefied. Liquid refrigerant passes through pipe 13 to evaporator coil 14 where evaporation occurs and heat is absorbed thereby.

The refrigerant vapor is sucked back to the compressor through suction line 16, accumulator 17 and suction line 18. The above described elements are in themselves of usual or conventional construction and form no part of the present invention. Furthermore these elements may be of any desired construction other than that illustrated, for example, the coils 14 and 15 may be of double pipe construction for cooling liquids.

The flow of liquid refrigerant through pipe 13 is controlled by an automatic valve 17, connected by pipes 22 and 23 respectively with the upper portion of the accumulator and a depending liquid receiving pipe 20, operates responsive to

liquid level. The liquid refrigerant passing the valve 17 flows through pipe 13' and expansion valve 19 into the lowermost turn of the cooling coil 14.

The expansion valve 19 is preferably of the adjustable type in order that it may be set as desired to permit expansion from the high to the low side of the system.

From the upper portion of the coil 14 into which the refrigerant has been admitted from the pipe 13' through expansion valve 19 the gaseous refrigerant, after having performed its refrigerating function and absorbed heat, is sucked back to the compressor through pipe 16, accumulator 17 and suction line 18. Along with this gaseous refrigerant a quantity of entrained liquid will be carried and the entrained liquid will be separated by gravity from the gaseous refrigerant and deposited in the accumulator 17.

Liquid in the accumulator 17 will drain downwardly into pipe 20 which is connected at its lower end to the bottom portion of the lower or secondary evaporating coil 15. The upper portion of the coil 15 has a connection 21 with the suction line 16 so that refrigerant gas will be sucked from the coil 15 at the same time that it is sucked from the coil 14 and entrained refrigerant may also be carried into the accumulator through the pipe 21 from the coil 15.

Expansion valve 19 is preferably manually set to give the correct quantity or an amount slightly in excess of the correct quantity of the liquid refrigerant which will just entirely evaporate in both of the coils 14 and 15. Any slight excess of refrigerant withdrawn from the coils 14 and 15 and trapped out in the accumulator can be readily returned by gravity to the lower coil 15 because this coil is made of a length and size such that the pressure drop under the desired operating conditions, is not too great to overcome the gravity head of liquid from the accumulator and thereby prevent its return.

Fine adjustment of the expansion valve 19 is not required due to the fact that if the adjustment of the valve is excessively wide it permits a greater flow than is necessary. The liquid level will rise in pipe 20 and after the pipe 20 is filled the system will gradually become filled. When the liquid level has risen above a predetermined point the valve 17 closes and by so doing prevents excess refrigerant from flowing into the evaporator coils. Accordingly liquid will no longer be entrained with gas withdrawn from the evaporator coil 14 to further fill up the pipe 20 or accumulator 17 and with the absorption of heat

the supply of liquid refrigerant in the evaporator coil 15, pipe 20, and accumulator 17, will be evaporized or boiled off and the vapor sucked back to the compressor until the quantity of liquid refrigerant is reduced sufficiently to cause reopening of the automatic valve 17'.

In Fig. 2 is shown a refrigerating system similar to that of Fig. 1 but modified to the extent of employing an additional evaporator coil and modified accumulator construction. According to the construction of Fig. 2 a compressor 25 discharges compressed refrigerant through pipe 26 into a condenser 27 where the refrigerant is liquefied. The refrigerant from the condenser 27 passes through pipe 28 to an evaporator consisting of coils 29, 30 and 31 which coils like those of Fig. 1 may also be of conventional construction. Refrigerant vapor is withdrawn from the upper part of coils 29 and 30 through a suction line 32 and from the coil 31 through a suction line 33, both lines 32 and 33 discharging into an accumulator 34 from whence refrigerant vapor is sucked through pipe 35 back to the compressor.

Flow of liquid refrigerant through the liquid line 28 is controlled by an automatic valve 36 connected by pipes 37 and 38 with the accumulator and which operates responsive to liquid refrigerant level similar to valve 17' of Fig. 1. When the automatic valve 36 is open refrigerant flows past the expansion valve 39 into the bottom of the upper coil 29. The expansion valve 39 is preferably of the adjustable type similar to valve 19 of Fig. 1 and is capable of being manually set to permit expansion from the high to the low side of the system.

The accumulator 34 is provided with a partition 40 which divides the accumulator into chambers 41 and 42, the automatic valve 36 being adapted to close when the liquid level in the chamber 41 reached a predetermined height. On the low side of the system adjacent the valve 39 is located an electrically operated valve 43 controlled by a thermostat 44 from a thermostat bulb 45.

Refrigerant gas and entrained liquids are withdrawn from the evaporator 29 through pipe 32 to chamber 41 of the accumulator where liquid and gas are separated, the gaseous refrigerant being sucked through pipe 35 to the compressor and the liquid refrigerant draining by gravity through pipe 46 into the bottom of the second or intermediate evaporator coil 30 from which refrigerant vapor and entrained liquid are drawn through pipe 32 into the accumulator.

The baffle 40 in the accumulator terminates near the bottom of the accumulator and refrigerant in the chamber 41 flows past the baffle into the chamber 42. Liquid refrigerant from the chamber 42 flows downwardly through pipe 47 into the bottom of the evaporator coil 31 from which gaseous refrigerant and any entrained liquid is carried through the pipe 33 into the chamber 42 of the accumulator. Vapor from the chamber 42 of the accumulator is withdrawn through pipe 48 into the suction line 35 extending to the compressor.

A thermostatically operated valve 49 controls the suction of the refrigerant gas through the pipe 48 from the chamber 42 to the compressor 25, the valve 49 being controlled from any desired point in the circuit by a thermostat 50 having a bulb 51 in thermal contact with fluid or other substance being cooled and the thermostat being set to operate the valve when the temperature drops below a predetermined value. It is to be

understood that other types of valves which can be operated in accordance with temperature conditions may be employed.

When the valve 49 is closed, due to heat absorption in the evaporator coil 31, refrigerant in the coil 31 is evaporated which can no longer be returned to the compressor and therefore the pressure in the chamber 42 of the accumulator increases above the pressure in the chamber 41. This causes liquid refrigerant to flow through the opening beneath the baffle 40 from the chamber 42 into the chamber 41. Since the pipe 47 projects upwardly into the chamber 42 of the accumulator slightly above the bottom of the same as shown, passage of liquid refrigerant from the chamber 42 into the chamber 41 will uncover the upper end of the pipe 47 and prevent further passage of liquid refrigerant into pipe 47 thereby cutting off the supply of liquid refrigerant to the coil 31. As no further cooling will be accomplished in this coil the capacity of the system will be reduced. If the fluid being cooled by the coils 29, 30 and 31 rises in temperature due to insufficient cooling, the valve 49 will reopen to permit equalization of refrigerating levels in chambers 41 and 42 of the accumulator and liquid refrigerant will again be supplied through the pipe 47 to refrigerating coil 31.

When the valve 49 is closed, forcing liquid from chamber 42 of the accumulator into chamber 41, the liquid level in chamber 41 may rise sufficiently to close the valve 36 which will further reduce the capacity of the system. However this condition is only temporary for as soon as the liquid level drops in chamber 41, valve 36 will reopen, restoring the feeding of liquid refrigerant. If the temperature of the liquid being cooled drops to a predetermined point, valve 43 will close cutting off the supply of refrigerant from the condenser to all of the coils until such time as the temperature of the fluid being cooled, rises to open the valve 43. Upon a still further rise in temperature the valve 49 will be reopened causing coil 31 also to be put into operation.

Expansion valve 39 similarly to expansion valve 19 in Fig. 1 above, is set to supply refrigerant sufficient or somewhat in excess of that required to be evaporated in all the coils of the cooler and therefore a mixture of gaseous and liquid refrigerants is withdrawn from each of the coils 29, 30 and 31 without damage. Gaseous refrigerant and entrained liquid withdrawn from the coils 29 and 30 is separated in chamber 41 of the accumulator, the gaseous refrigerant passing to the suction line and the liquid refrigerant draining down to the line 46. The gaseous refrigerant with entrained liquid withdrawn from the coil 31 is discharged into chamber 42 of the accumulator, the gaseous refrigerant passing through pipe 48 into suction line 35 and the liquid refrigerant draining through pipe 47. If an excess of liquid refrigerant is fed through the valve 39 the level of liquid refrigerant will rise in the accumulator 34 until the valve 36 closes, shutting off the supply. Thereafter liquid refrigerant passing from the accumulator through pipes 46 and 47 will partially evaporate due to heat absorption and the level in the accumulator since no liquid is flowing in will be reduced, until the liquid level in the accumulator has decreased sufficiently to cause the opening up of valve 36.

The valves 43 and 49 may be controlled from different points such as points 45 and 51 so that a combination of their location and temperature

setting will cause the desired results or if desired the more logical method is to control both these two valves from the outlet temperatures of the liquid being cooled. Thermostats which control these valves are preferably set at slightly different temperature levels.

It will be obvious to those skilled in the art that various other changes may be made in the construction and arrangement of parts without departing from the spirit of the invention and therefore the invention is not limited to what is shown on the drawing and described in the specification but only as indicated in the appended claims.

I claim:

1. A method of refrigeration comprising supplying liquid refrigerant, evaporating a portion of said liquid refrigerant, withdrawing the vaporous and entrained liquid from the place of evaporation, separating liquid from the vapor, evaporating a portion of the separated liquid, withdrawing the vaporous and entrained liquid from the second place of evaporation, separating liquid from the vapor, equalizing the liquid level between the two separated liquids, and utilizing part of the entrained liquid from the second separation for a subsequent evaporation.

2. A method of refrigeration comprising supplying liquid refrigerant, evaporating a portion of said liquid refrigerant, withdrawing the vaporous and entrained liquid from the place of evaporation, separating liquid from the vapor, evaporating a portion of the separated liquid, withdrawing the vaporous and entrained liquid from the second place of evaporation, separating liquid from the vapor, equalizing the liquid level between the separated liquids, utilizing part of the entrained liquid from the second separation for a subsequent evaporation and utilizing liquid refrigerant from the second separation to cut off the supply for the final evaporation.

3. In a refrigerating system comprising an evaporator formed of a plurality of sections and an accumulator having a plurality of sections for separating entrained liquid refrigerant from gaseous refrigerant, means for supplying liquid refrigerant to one section of the evaporator, means for returning some of the separated liquid to another section of the evaporator, equalizing the liquid level between two sections of the accumulator, and means for cutting off one section of the evaporator.

4. A refrigerating system comprising an evaporator having a plurality of sections and an accumulator having at least two sections, means for supplying liquid refrigerant to one of said evaporator sections in excess of the amount that may be evaporated therein, separating the excess liquid from the gaseous refrigerant drawn from the evaporator in one section of the accumulator, returning a portion of the separated liquid to another section of the evaporator, equalizing the liquid level between the sections of the accumulator, and feeding part of the liquid from the second section of the accumulator to a third evaporator section.

5. A refrigerating system comprising an evaporator having a plurality of sections and an accumulator having at least two sections, means for supplying liquid refrigerant to one of said evaporator sections in excess of the amount that

may be evaporated therein, separating the excess liquid from the gaseous refrigerant drawn from the evaporator in one section of the accumulator, returning a portion of the separated liquid to another section of the evaporator, equalizing the liquid level between the sections of the accumulator, feeding part of the liquid from the second section of the accumulator to a third evaporator section, and means for forcing liquid refrigerant from the second section of the accumulator in a manner to cut off the liquid supply to the third section of the evaporator.

6. A refrigerating system of connected elements including an evaporator composed of sections, an accumulator, means for supplying refrigerant deposited in the accumulator from one evaporator section into another evaporator section, means responsive to accumulator liquid level for altering the refrigerant supplied to the evaporator, and means between said last mentioned means and an evaporator section for restricting the refrigerant supply thereto.

7. A refrigerating system of connected elements including an evaporator formed of sections, an accumulator for trapping out liquid entrained with gaseous refrigerant as it is drawn from the evaporator, means for supplying refrigerant deposited in the accumulator into an evaporator section, means responsive to accumulator liquid level for altering the refrigerant supply to the evaporator, and means between said last mentioned means and an evaporator section for restricting the refrigerant supply.

8. The method of refrigeration comprising the stages of supplying refrigerant to a first place of evaporation, evaporating a portion of said refrigerant, passing evaporated refrigerant and entrained liquid refrigerant to a place of separation, separating the liquid refrigerant from the gaseous refrigerant, passing said separated liquid refrigerant to a second place of evaporation, controlling the supply of refrigerant to the first place of evaporation in accordance with the quantity of refrigerant fluid passed from the first place of evaporation, and further restricting said supply to the first place of evaporation to thereby maintain a supply of refrigerant in both places of evaporation.

9. A refrigerating system of connected elements including an evaporator composed of sections, an accumulator, means for supplying refrigerant deposited in the accumulator from one evaporator section into another evaporator section, means for altering the refrigerant supplied to the evaporator, responsive to an excess of refrigerant supplied thereto, and means between said last mentioned means and an evaporator section for restricting the refrigerant supply thereto.

10. A refrigerating system of connected elements including an evaporator formed of sections, means for supplying refrigerant to a first evaporator section, means for supplying refrigerant from said first evaporator section to a second evaporator section, a valve for shutting off the supply of refrigerant to the first evaporator section responsive to an excess of refrigerant supplied thereto, and a second valve between the first valve and the first evaporator section for restricting the supply of refrigerant.