

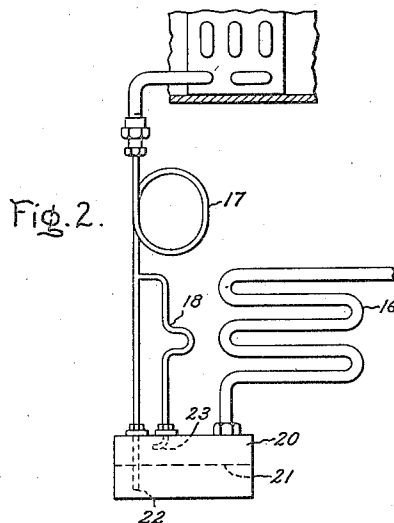
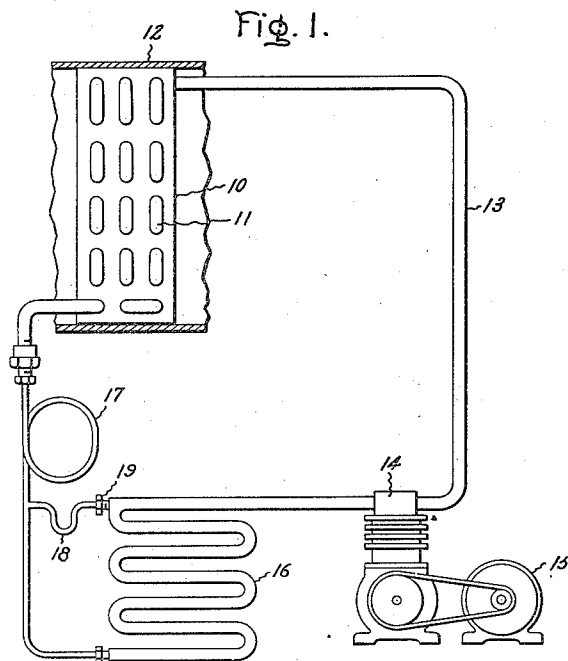
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REFRIGERATING MACHINE

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REFRIGERATING MACHINE

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4 Claims. (Cl. 62—8)

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My invention relates to refrigerating machines and particularly to such machines having elongated restrictors or capillary tubes for controlling the flow of liquid refrigerant from the condensing apparatus to the evaporator. This application is a division of my copending application, Serial No. 472,818, filed January 19, 1943, and assigned to the same assignee as the present application.

Refrigerating machines generally comprise an apparatus for condensing gaseous refrigerant to provide liquid refrigerant at a relatively high pressure which is then supplied through some suitable pressure reducing device to an evaporator where the liquid is vaporized by the absorption of heat from the medium surrounding the evaporator, the vaporized refrigerant being withdrawn from the evaporator and returned to the condensing apparatus. Various types of mechanically operated valves have been employed to regulate the flow of liquid refrigerant from the condensing apparatus to the evaporator. However, satisfactory operation over at least a limited range of operating temperatures of the condensing apparatus can be obtained by employing a length of tubing having a small internal diameter such that it presents resistance to the flow of refrigerant and effects a gradual reduction of pressure from the high pressure at the condensing apparatus to the low pressure at the evaporator. These tubes are commonly called restrictors or capillary tubes. The rate of flow of refrigerant through the capillary tube depends upon the difference in pressure between the intake and discharge ends of the tube, and, in any particular case, is determined by the length of the tube and the cross-sectional area of its passage. It is common practice to design the capillary tube for a given machine so that it will conduct the requisite flow of refrigerant to the evaporator under a predetermined pressure difference. Normally some of the liquid refrigerant vaporizes within the capillary tube during its passage therethrough and this vaporization of liquid determines to a considerable extent the rate of flow of refrigerant through the tube. As the pressure difference increases a condition is reached such that the capillary tube can convey the liquid refrigerant to the evaporator at a greater rate than it is condensed, and consequently efficiency of operation is lost. For many types of operation it is desirable to provide a refrigerant control device which will pass the same amount of liquid refrigerant over a wide range of pressure differences between the high and low pressure sides

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and over a wide range of operating temperatures or pressures of the condensing apparatus. For example, when the evaporator load and temperature vary over a relatively small range while the temperature and pressure of the condensing apparatus vary over a wide range it is desirable to prevent the admission of excess refrigerant to the evaporator during the high pressure conditions in the condensing apparatus.

It is an object of my invention to provide a refrigerating machine of the type employing a capillary tube for controlling the flow of liquid refrigerant to the evaporator and an improved arrangement for maintaining the flow of liquid refrigerant within predetermined limits over a wide range of changes in the pressure within the condensing apparatus.

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 part of this specification.

For a better understanding of my invention reference may be had to the accompanying drawing in which Fig. 1 illustrates diagrammatically a refrigerating machine embodying my invention and Fig. 2 illustrates a similar machine including another embodiment of the invention.

Briefly, the refrigerating machine shown in the drawing comprises an evaporator and a condensing apparatus for liquefying vaporized refrigerant withdrawn from the evaporator and a capillary tube restrictor for controlling the return of liquid refrigerant from the condensing apparatus to the evaporator. In order to maintain the flow of refrigerant through the capillary tube substantially constant regardless of changes in temperature and pressure within the condensing apparatus there is provided an arrangement for increasing the proportion of vaporized refrigerant passing through the capillary tube in accordance with increases in pressure within the condensing apparatus. In the illustrated arrangement a second capillary tube is connected to conduct high temperature gaseous refrigerant from the condenser to an intermediate portion of the flow controlling capillary tube; this arrangement introduces additional vaporized refrigerant to vary the flow upon changes in condensed pressure so that an increase in pressure in the condenser will not produce a corresponding increase in the amount of refrigerant flowing to the evaporator.

Referring now to the drawing the refrigerating

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machine shown in Fig. 1 includes an evaporator 10 comprising a zigzag tubing 11 and arranged within an air duct 12 to cool the air passing through the duct. Heat is absorbed from the air passing through the duct and liquid refrigerant within the evaporator is vaporized and the vapor is withdrawn through a suction line 13 by operation of a compressor 14 driven by an electric motor 15. The vaporized refrigerant after having been compressed is discharged to a condenser 16 which may be cooled in any suitable manner in accordance with usual refrigeration practice. The cooled compressed refrigerant is liquefied within the condenser 16 and flows from the condenser through a capillary tube or elongated restrictor 17 back to the evaporator 10.

During the operation of the refrigerating machine the temperature of the medium, such as air, employed to cool the condenser 16 may vary over a wide range so that the pressure of the refrigerant within the condenser will vary accordingly. As the pressure in the condenser is increased the difference of pressure between the inlet and outlet ends of the tube 17 is increased and more refrigerant tends to flow through the capillary tube. However, the evaporator 10 does not require additional refrigerant and consequently it is desirable to limit the flow of refrigerant through the capillary tube 17 so that it does not increase substantially with the increased pressure in the condenser. In order to counteract the tendency toward increased flow of refrigerant through the capillary tube, I connect an intermediate portion of the capillary tube 17 to the condenser by a length of capillary tube 18; the tube 18 enters the tube 16 through a connection 19 in the upper portion of the condenser which contains compressed gaseous refrigerant so that gaseous refrigerant is admitted to the intermediate portion of the tube 17 in an amount varying with changes in the condenser pressure. When the pressure within condenser 16 is decreased, for example, because of a decrease in the temperature of the cooling medium surrounding the condenser the amount of vaporized refrigerant introduced by the tube 18 into the path of the refrigerant flowing through the tube 17 is decreased and the resistance to flow within the tube 17 is decreased so that although there is a decrease in the pressure difference across the tube 17 the resistance of the tube is also decreased and the amount of the refrigerant flowing in the evaporator is not materially changed. The reverse of this action takes place upon an increase in the pressure in the condenser. In other words, the flow of refrigerant to the evaporator is maintained within predetermined acceptable limits regardless of changes in pressure in the condenser.

The system shown in Fig. 2 is similar to that shown in Fig. 1 and corresponding parts are designated by the same numerals. This system includes a liquid receiver 20 in which liquid is collected to a level 21, the capillary tube 17 enters the receiver 20 and the inlet of the tube 17, as indicated at 22, is located below the level 21 of liquid refrigerant so that only liquid refrigerant enters the inlet to the tube 17. The capillary tube 18 for introducing gaseous refrigerant at the intermediate point between the ends of the tube 17 is connected in communication with the upper portion of the receiver 20, as indicated at 23, so that gaseous refrigerant flowing from the condenser and which has been separated from the liquid within the receiver at the condenser pressure enters the tube 18 from the receiver.

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In the arrangement of both Figs. 1 and 2 the length of the capillary tube 17, the point at which the tube 18 admits uncondensed vapor to the tube 17 and the length and diameter of the tube 18 are selected so that the desired degree of compensation is obtained. The direct admission of uncondensed vapor to the tube 17 results in relatively little time delay between a change of pressure within the condenser and the compensating action produced by the change and, furthermore, effective regulation of the flow of refrigerant through the capillary tube 17 is obtained.

Although the refrigerant flow controlling arrangements described herein are intended primarily for application to refrigerating machines in which the evaporator conditions remain substantially constant, appreciable regulation may also be obtained under proper conditions in systems where there is a variation in evaporator pressure and where the condenser pressure remains substantially constant; and regulation may be expected in some systems to compensate for changes in pressure drop across the capillary tube regardless of whether it is due to evaporator pressure changes or to condenser pressure changes. It has been found that in a system employing a capillary tube flow controlling device there is a critical pressure of the evaporator below which the change in pressure in the evaporator has substantially no effect upon the rate of flow through the capillary tube; effective compensation for changes in evaporator pressure may be obtained provided the system is operating with the evaporator pressure above this critical pressure.

Both of the compensating arrangements described above may be employed with any of the well known types of refrigerating systems. For example, the use of this compensating device does not preclude the use of efficiency increasing devices such as the commonly employed heat exchanger between the liquid and suction lines of a refrigerating machine.

From the foregoing it is readily apparent that I have provided a simple and effective arrangement for increasing the useful range of operation of a capillary tube employed as a pressure reducing device in a refrigerating machine in which there may be a wide range of pressures within the condensing apparatus.

While I have shown particular arrangements of my invention in connection with a compressor type mechanical refrigerating system other applications and embodiments will readily be apparent to those skilled in the art. I do not, therefore, desire my invention to be limited to the particular arrangements 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 machine including an evaporator, means for withdrawing vaporized refrigerant from said evaporator, means for condensing the withdrawn refrigerant to liquefy the same, a capillary tube restrictor for conducting liquid refrigerant from said condensing means to said evaporator, and means associated with a portion of said tube intermediate the ends thereof for admitting to said tube gaseous refrigerant from said condensing means for maintaining the flow of refrigerant to said evaporator within a predetermined range regardless of changes of pressure within said condensing means.

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2. A refrigerating machine including an evaporator and a compressor and a condenser, a capillary tube for conducting liquid refrigerant from said condenser to said evaporator and a second capillary tube providing communication between said condenser and a portion of said first mentioned tube intermediate the ends of said first tube to conduct gaseous refrigerant from said condenser to said intermediate portion for maintaining the flow of refrigerant to said evaporator within predetermined limits regardless of changes of pressure of refrigerant in said condenser.

3. A refrigerating machine including an evaporator, means for withdrawing vaporized refrigerant from said evaporator, means connected to said withdrawing means for liquefying the withdrawn refrigerant, said liquefying means including a condenser and a receiver for collecting refrigerant liquefied thereby, a capillary tube having its inlet end located below the level of liquid refrigerant in said receiver for controlling the flow of liquid refrigerant from said receiver to

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said evaporator, and a second capillary tube connected to said liquefying means to convey gaseous refrigerant therefrom to a point intermediate the ends of said first tube for maintaining the flow of refrigerant to said evaporator within predetermined limits regardless of changes of pressure within said condensing means.

4. A refrigerating machine including an evaporator and a compressor and a condenser, a receiver for collecting refrigerant liquefied by said condenser, a capillary tube having its inlet end located below the level of liquid refrigerant in said receiver for controlling the flow of liquid refrigerant from said receiver to said evaporator, and a second capillary tube connected to convey gaseous refrigerant from said receiver to a point intermediate the ends of said first tube for maintaining the flow of refrigerant to said evaporator within predetermined limits regardless of changes of pressure within said condenser.

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