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REFRIGERATION SYSTEM INCLUDING METERING AND DISTRIBUTING MEANS

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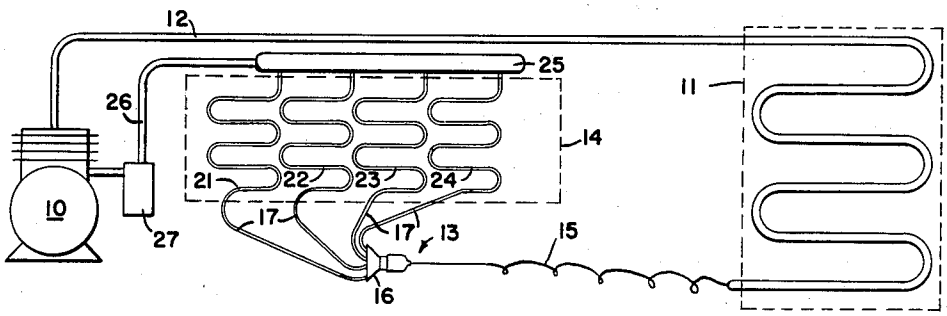


FIG. 1

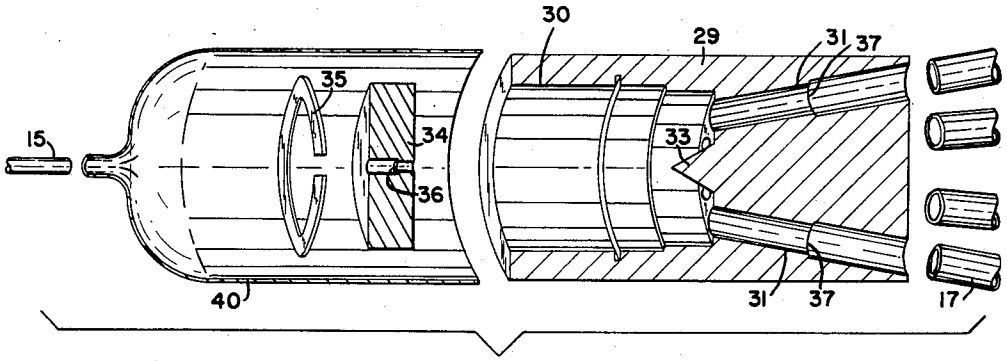


FIG. 2

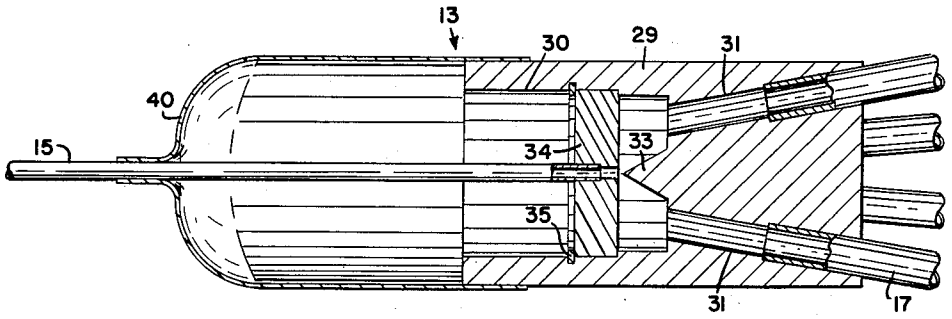


FIG. 3

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REFRIGERATION SYSTEM INCLUDING METERING AND DISTRIBUTING MEANS

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This invention relates to refrigeration systems and more particularly to a refrigeration system having novel refrigerant metering and distributing means therein comprising a capillary tube and a distributor.

In refrigeration systems comprising a compressor, a condenser, expansion means, and a multiple circuit evaporator, difficulty has been encountered in assuring adequate and uniform distribution of refrigerant from the expansion means to the evaporator over a wide range of operating conditions. The expansion means may comprise either a thermal expansion valve or a capillary tube. Normally the refrigeration system utilizing a thermal expasion valve includes a distributor mechanism disposed between the thermal expansion valve and each circuit of the evaporator. Within the conventional distributor mechanism there is an orifice, which produces a secondary pressure drop, for assuring proper distribution of refrigerant to each evaporator circuit. Cost-wise the thermal expansion valve is expensive by comparison to a capillary tube. Accordingly, it is often desirable to utilize a capillary tube in place of a thermal expansion valve in a refrigeration system.

To utilize capillary expansion means in a refrigeration system operable over a wide range of operating conditions, particular care must be given to the rate of refrigerant flow and to the saturated condensing temperature. Water cooled condensers present little problem, for condensing conditions are closely controlled. Air-cooled condensers, however, operate in extremes of outdoor temperature. The refrigeration system utilizing an air-cooled condenser should be designed for storing refrigerant to backload the condenser coil so as to assure adequate refrigerant feed through the capillary tube at all operating conditions.

One method of feeding refrigerant to a multiple circuit evaporator is to provide a separate capillary tube for each circuit. There is difficulty, however, in balancing the feed of refrigerant to each circuit of the evaporator. Too, it is expensive to utilize a plurality of capillary tubes in place of a single capillary tube and a distributor mechanism.

It has been proposed that a single capillary tube be used to feed refrigerant to a conventional thermal expansion valve distributor mechanism having an orifice therein. However, the usual distributor mechanism appears to be unsuitable for refrigeration systems having capillary expansion means because the high velocity and turbulence within the distributor mechanism required for good distribution produces a secondary pressure drop. In refrigeration systems utilizing a thermal expansion valve, distributor pressure drop is not necessarily a liability, however, in refrigeration systems having capillary tube expansion means, pressure drop in the distributor mechanism is undesirable. Capillary control performance is adversely affected. Distributor mechanisms having low pressure drop usually do not feed refrigerant uniformly to each of a plurality of circuits.

An object of this invention is to provide a refrigeration system having capillary tube expansion means feeding a plurality of evaporator circuits wherein the disadvantages and deficiencies of prior constructions are obviated.

An object of the present invention is to provide a refrigeration system having refrigerant metering and distributing means comprising a capillary tube and a refrigerant distributor wherein the disadvantages and deficiencies of prior systems are obviated.

Another object of this invention is to provide a refrigeration system with improved metering and distributing means comprising a capillary tube and a distributor for uniformly feeding refrigerant from the capillary tube to each of the circuits of a multiple-circuit evaporator. Other objects of my invention will be readily perceived from the following description.

This invention relates to a refrigeration system comprising the combination of a compressor, a condenser, a multiple-circuit evaporator, and means connecting the condenser and the evaporator comprising a capillary tube and distributor means, the distributor means comprising a housing having an inlet bore and a plurality of outlet bores therein, each outlet bore being in communication at one end with the inlet bore and at the other end with a line adapted to communicate with a circuit of the evaporator, a generally conical member in the distributor housing for directing refrigerant uniformly into each outlet bore, the capillary tube being connected at one end to the condenser and at the other end within the inlet bore of the distributor housing, the end of the capillary tube within the distributor housing being positioned adjacent the apex of the generally conical member so as to maximize pressure drop within the capillary tube and minimize pressure drop within the distributor means.

The invention will now be described by reference to the attached drawing wherein like numerals in each of the several views refer to like elements and wherein:

FIGURE 1 is a diagrammatic view of a refrigeration system embodying the refrigerant metering and distributing means of the present invention;

FIGURE 2 is an exploded perspective view, with parts broken away, of the refrigerant metering and distributing means of the present invention; and

FIGURE 3 is a cross-sectional view of the refrigerant metering and distributing means of the present invention.

Referring to FIGURE 1 of the drawing, there is shown the usual refrigeration system including compressor 10 connected to condenser 11 by discharge line 12. Refrigerant flows from condenser 11 to each circuit of evaporator 14 through refrigerant metering and distributing means 13.

Though the evaporator is shown as having only four circuits it will be obvious that more circuits may be used, it being understood that each circuit will be connected to the refrigerant metering and distributing means 13 through a separate line or tube 17. Each of the circuits 21, 22, 23 and 24 of the evaporator are connected to header 25. From the header, refrigerant passes through suction line 26, accumulator 27 in suction line 26 proximate the outlet from header 25 and is returned to compressor 10.

FIGURE 2 shows an exploded perspective view of the refrigerant metering and distributing means of the present invention. Such means comprises body 29 having therein an inlet bore 30 communicating with capillary tube 15 and outlet bores 31, each communicating with a line 17. Centrally of the outlet bores within the distributor body 29 there is a conical-shaped member 33. The end of the capillary tube may be positioned within and secured to capilary positioner 34. The capillary positioner is inserted into inlet bore 30 until the face thereof abuts a shoulder in body 29. Retainer ring 35 is provided behind capillary positioner 34 to secure the positioner in place within inlet bore 30. The apex of the cone or conical-shaped member 33 is adjacent the end of the capillary tube 15 and does not extend into or restrict the end of the capillary tube. The opening from the

capillary tube is unrestricted and cone 33 serves only to direct liquid refrigerant uniformly from the capillary tube into each of the outlet bores 31.

For convenience in manufacture, the ends of each of the outlet bores 31 may be counterbored as at 37 to receive each of the lines 17. The lines are each suitably connected to the distributor by means of solder, for example.

Connector support 40 is secured at one end to distributor body 29 and at the other end to capillary tube 15. The support maintains a predetermined length of tube 15 axial with respect to inlet bore 30.

It has been experimentally determined that the straight length of capillary tube adjacent the end thereof connected within the distributor body 29 is critical in assuring proper distribution of refrigerant to each of the circuits of the evaporator. In the presently preferred embodiment of the invention the end of capillary tube must be straight for a distance of at least twenty (20) times the internal diameter of the capillary tube to assure proper feeding of refrigerant from the capillary tube. Where the capillary tube was bent at a lesser distance from its end, it was found that the loading upon the evaporator was unequal. However, when the capillary tube was of the proper straight length, then for the identical system, as aforetested, the evaporator was loaded according to the design requirements. Accordingly, it must be concluded that this straight length of the end of the capillary tube is an important part of the present invention.

Refrigerant compressor 10 forwards high pressure vaporous refrigerant through discharge line 12 to condenser 11. The refrigerant within condenser 11 passes in heat exchange relationship with a cooling medium, either air or water, to condense and subcool the refrigerant. Such condensed and subcooled refrigerant passes through refrigerant metering and distributor means 13 to evaporator 14. As the refrigerant passes through each of the circuits of the evaporator it expands and cools the air passing over the heat exchange surface of the evaporator. The expanded refrigerant is collected in header 25 and returned to compressor 10 through accumulator 27 and suction line 26.

The purpose of the capillary tube is to reduce the pressure of the liquid refrigerant leaving the high pressure condenser to a suitable pressure required in the evaporator to provide the required cooling performance of the evaporator and to maintain a refrigerant flow rate required by the refrigeration system as a whole under the specific operating conditions encountered at any given time. The pressure reduction obtained with a capillary tube of specified internal bore and tube length is a function of the frictional resistance of the liquid refrigerant passing through the tube and the point in the tube where pressure is reduced to the saturation point and vaporization into a gaseous state starts to occur. From this point to the end of the capillary the resistance is increased due to the presence of gas bubbles in the liquid stream which increases the volume of the refrigerant mixture, thereby increasing the velocity and resulting in an increased pressure drop through the remainder of the capillary tube. Thus it is seen that the flow through a capillary tube is dependent upon the pressure of the liquid entering the tube, which creates the driving force, and upon the temperature of the liquid entering the tube, which determines the point at which the refrigerant vaporizes and bubbles start to occur in the tube.

In a refrigeration system employing an air-cooled condensing coil, both the condensing pressure and the liquid temperature can be varied by the amount of charge introduced into the refrigeration system. The greater the charge in the system, the more liquid refrigerant that will be back-loaded into the condenser coil, thereby reducing the condensing surface. There is a resultant increase in head pressure and an increase in subcooling surface, accompanied by a lower liquid temperature. In a refrigeration system employing an accumulator in the suction line a given amount of refrigerant can be stored in the accumulator. When needed, this refrigerant can be introduced into the refrigeration system to load the condenser coil in order to maintain the required flow rate under a wide range of air temperature over the condenser coil, particularly during winter or low temperature load conditions. Thus it is seen that the capillary tube as employed in this type of system can maintain a satisfactory performance over a large range of condensing conditions. These performance characteristics can be obtained only if the expansion of liquid refrigerant is accomplished largely within the capillary tube itself. In refrigeration systems which have a secondary expansion through a distributor orifice, the refrigerant flow control obtained by reducing a liquid temperature is greatly limited.

By virtue of the present invention the pressure drop occurring as the liquid flows through the refrigerant metering and distributing means is primarily confined to that occurring within the capillary tube. The pressure drop within distributor body 29 is minimized so as to assure more uniform distribution of refrigerant from capillary tube 15 to each circuit 21, 22, 23 and 24 of evaporator 14. The proper feeding of refrigerant to each of the circuits of the evaporator is important, for poor refrigerant distribution results in unequal evaporator loading and in reduction in evaporator capacity.

By the present invention there has been provided a novel refrigerant metering and distributing means for direct expansion evaporators having a plurality of circuits. The refrigerant metering and distributing means assures optimum performance under varying conditions of load. The present invention maintains homogeneous mixture of liquid refrigerant and vaporous refrigerant in the refrigerant metering and distributing means until equal portions of liquid and vapor are delivered to each evaporator circuit. The novel refrigerant metering and distributing means is relatively inexpensive to manufacture and satisfactorily overcomes the problem of unequal distribution encountered with previous refrigerant metering and distributing means in refrigeration systems utilizing capillary tube expansion means.

While I have described a preferred embodiment of my invention, it will be understood that my invention is not limited thereto, since it may be otherwise embodied within the scope of the following claims.

I claim:

1. In a refrigeration system, the combination of a compressor, a condenser, a multi-circuit evaporator and means connecting said condenser to said evaporator comprising a capillary tube and distributor means, said distributor means comprising a housing having an inlet bore and a plurality of outlet bores, each outlet bore being in communication at one end with said inlet bore and at the other end with a line adapted to communicate with a circuit of the evaporator, a generally conical member in said distributor housing for directing refrigerant from the capillary tube into the outlets, means for positioning an end of said capillary tube within the inlet bore of said distributor housing, means for retaining said positioning means in place within said housing, the opposite end of said tube communicating with the condenser, the end of the capillary tube within said distributor housing being positioned adjacent the apex of the generally conical member, and a support member for supporting said tubing, the pressure drop within the capillary tube being larger than the pressure drop within the distributor means.

2. A refrigeration system as in claim 1 wherein the end of the capillary tube adjacent the generally conical member is straight for a distance of at least twenty inside diameters of the capillary tube to assure proper feeding of refrigerant to the distributor means from the capillary tube.

3. Refrigerant metering and distributing means for use in a refrigeration system comprising a capillary tube and a distributor connected thereto, said distributor including a housing having an inlet and a plurality of outlets, each of said outlets adapted to be connected to a multiple-circuit evaporator in the refrigeration system, a generally conically-shaped member in said distributor for directing refrigerant from the end of said capillary tube into each outlet, means for positioning an end of said capillary tube within said housing adjacent the conically-shaped member, means for retaining said positioner in place in said housing, said capillary tube and distributor being so constructed that the pressure drop within the capillary tube is larger than the pressure drop within the distributor, and a support member for supporting said tubing.

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