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(54) **Refrigerant metering apparatus for multicircuit coil.**

(57) In a multicircuit evaporator coil where vaporized refrigerant is conducted simultaneously to a plurality of parallel circuits by way of individual distributor lines (12), provision is made to meter the refrigerant flow within each of the distribution lines (12) by way of individual expansion devices (17) disposed therein. In one embodiment, a cylinder having a central bore (19) formed therein is mounted within each of the distribution lines (12) by way of a brazing process. In another embodiment, the individual distribution lines (12) have contracted portions formed therein for metering the refrigerant in the respective circuits.

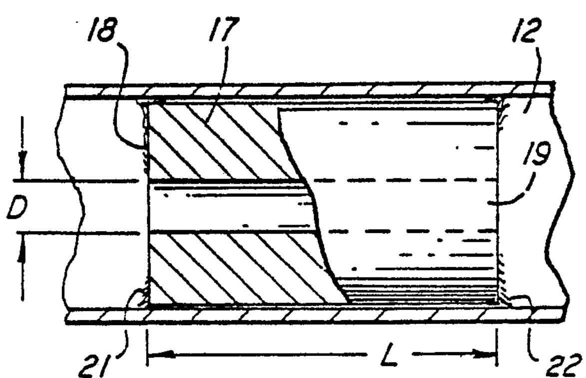

FIG.4

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REFRIGERANT METERING APPARATUS FOR MULTICIRCUIT COIL

Background of the Invention

This invention relates generally to air conditioning systems and, more particularly, to a refrigerant metering apparatus for multicircuit evaporator coils.

It is a common feature in evaporator coils to provide a plurality of refrigeration circuits, with refrigerant flowing simultaneously in parallel relationship through such circuits. The refrigerant is commonly delivered to those parallel circuits from a liquid line by way of a distributor which receives refrigerant from the liquid line and distributes it to the individual circuits by way of capillary tubes, with the capillary tubes performing the refrigerant expansion and metering functions in a well-known manner.

Several problems have been recognized with the use of capillary tubes as described above. For example, where a plurality of capillary tubes are nested together, which is generally the case, they tend to rub against each other and wear, which, in turn, can lead to failure and loss of refrigerant charge.

Another problem with capillary tubes is that it is difficult to obtain consistent flow characteristics for a given capillary tube length, since the inside diameter thereof tends to vary, even though they may be of the same nominal diameter. These inconsistencies, in turn, create inefficiency in the system.

Another disadvantage with such capillary tubes is that they are not particularly conducive to automated brazing processes. That is, in the interest of quality and productivity, it is now becoming common practice to solder return bends and header assemblies into a coil by way of an autobrazing process. However, because of their relatively small mass, when compared to header assemblies and return bends, capillary tubes cannot, as a practical matter, be attached by that process. Accordingly, they are generally installed by way of a hand brazing process, which is more labor intensive and less consistent in quality.

Finally, the use of capillary tubes in a system adds considerable cost thereto, primarily due to their labor intensive nature, but more significantly, by installation cost.

In evaporator coils having a single circuit, it has become common practice to provide a so called "accurater" in a circuit to perform the refrigerant metering function. Such a device is described in U.S. Patent 3,877,248 issued on April 15, 1975 and assigned to the assignee of the present invention. Such a use of a single metering device at a point upstream of the distributor in a multicircuit system has generally not been done because it is difficult to obtain proper distribution of the vaporized refrigerant to the multiple refrigeration circuits. Further, it was recognized by the Applicant that the use of such "accurater" devices in each of the refrigeration circuits would be prohibitively expensive.

It is therefore an object of the present invention to provide an improved refrigerant metering apparatus for a multicircuit evaporator coil.

Another object of the present invention is the provision in a multicircuit evaporator coil for a refrigerant metering apparatus which is conducive to automated brazing techniques.

Yet, another object of the present invention is the provision in a multicircuit evaporator coil for a refrigerant metering apparatus which is not susceptible to loss of refrigerant charge.

Still, another object of the present invention is the provision in a multicircuit evaporator coil for a refrigerant metering apparatus which is economical to manufacture and effective and efficient in use.

These objects and other features and advantages become more readily apparent upon reference to the following description when taken in conjunction with the appended drawings.

Summary of the Invention

Briefly, in accordance with one aspect of the invention, a multicircuit evaporator coil is provided with a header to receive liquid refrigerant from the liquid line and for distributing refrigerant to a plurality of feeder tubes which are in turn connected to respective refrigerant circuits in the coil. Disposed within each of the feeder tubes is an expansion device for metering the flow of refrigerant therethrough.

By another aspect of the invention, each of the expansion devices includes an orifice having a length-to-diameter, L D ratio in the range of 3-50, with such structure causing refrigerant expansion primarily by way of its sharp edged orifice, but also by way of friction in its bore.

In accordance with another aspect of the invention, the individual orifices are tailored in size to match the cooling requirements of the respective circuits, with those requirements, in turn, being related to the characteristics of the air flow through those respective circuits.

By yet another aspect of the invention, the expansion device comprises a cylinder with a central bore, and said cylinder is secured within said feeder line by a brazing process or by a mechanical fastening method.

By still another aspect of the invention, the expansion device comprises a short contracted portion of the feeder tubes, with such portion being formed by swaging or the like.

In the drawings as hereinafter described, a preferred embodiment is depicted; however, various other modifications and alternate constructions can be made thereto without departing from the true spirit and scope of the invention.

Brief Description of the Drawings

Figure 1 is a side view of a liquid refrigerant header apparatus in accordance with a preferred embodiment of the present invention.

Figure 2 is a perspective view of the extension device portion thereof.

Figure 3 is an axial, sectional view of the feeder tube and metering device portion of the invention.

Figure 4 is longitudinal, sectional view thereof.

Figures 5 and 5a are longitudinal and sectional views of an alternative embodiment of the present invention.

Figures 6 and 6a are longitudinal and axial sectional views of another alternative embodiment thereof.

Description of the Preferred Embodiment

Referring now to Figure 1, the invention is shown generally at 10 as applied to a multicircuit evaporator coil which is not shown but which is represented by the Figure 11 outlined in phantom lines. Typical of such multicircuit evaporator coils is the one shown in U.S. Patent 4,057,976 issued on November 13, 1977, and assigned to the assignee of the present invention. In such a coil, refrigerant vapor is introduced into the individual parallel circuits, and then the circuits function to absorb heat from the flow of air thereover. While the refrigerant is caused to flow simultaneously in the various parallel circuits with the volume flow to each being substantially equal, in order to optimize the performance of the coil, it is desirable that each of the circuits be tailored to a specific volume flow rate to thereby match the requirements of the respective circuits, such that the overall performance of the coil is optimized. Heretofore, this could only be accomplished by the use of capillary tubes of varying lengths, a solution that was not considered practical. With the present system, this is accomplished in a manner which is simple and effective.

Leading to each of the evaporator coil circuits is a distribution line 12 having a belled end 13 to facilitate the easy and effective attachment to the individual coils by way of an automated brazing process of the like. The other ends of the distribution lines 12 are integrally connected to a liquid header 14 by way of brazing or the like. As will be seen, the distribution lines 12 extend substantially normally from the common liquid header 14. On the other side of the liquid header 14 is a liquid line 16 which functions to bring liquid refrigerant into the liquid header 14 for distribution to the individual distribution lines 12.

As mentioned hereinabove, in order for the evaporator coils to function in the heat absorbing mode, it is necessary that refrigerant flowing therethrough be in the vaporized form. This is accomplished in the present invention by way of an expansion device 17 which is installed in each of the distribution lines 12 as will now be described.

As will be seen in Figure 2, expansion device 17 comprises a cylindrical billet having a flat face 18 on either end thereof and an axial bore 19 formed therein. The outer diameter of the cylinder is slightly smaller than the inner diameter of the distributor line 12 such that it can be securely mounted therein in a manner to be described hereinafter. The sizing of the axial bore 19 is more critical in that it is this size which determines the manner and degree to which the refrigerant is expanded prior to entering the individual evaporator circuits. Generally, the dimensions of the axial bore 19 will be determined in accordance with the guidelines set forth in the above-mentioned U.S. Patent 3,877,248; however, it should be recognized that strict adherence to the L/D relationship at 5-12 is not necessary, and that an L/D relationship of 3-50 is possible while remaining within the scope of the present invention.

Referring now to Figures 3 and 4, the expansion device 17 is shown in its installed position within the distributor line 12. Although each of the expansion devices 17 are shown in substantially the same longitudinal position within the distribution line 12, the position is not critical, and it should be understood that the expansion device 17 can be placed at almost any location along the length of the distribution line 12. It is necessary, however, that the expansion device 17 be securely fixed within the distribution lines 12 and that there be no leakage of refrigerant between the outer wall of the expansion device 17 and the inner wall of the distribution line 12. This is accomplished by a brazing process wherein the first step is to place a ring of brazing material 21 within the distribution line 12, with the outer diameter thereof being substantially equal to the inner diameter of the distribution line 12. The expansion device 17 is then placed in the distribution line 12 with its one end thereof abutting the ring of brazing material 21. Another ring of brazing material 22 is then placed in the distribution line 12 and moved against the other end of the expansion device 17 such that there is a ring on either end thereof. The assembly is then exposed to heating process which is suitable for brazing. As a result, the expansion device 17 is securely fastened within the distribution line 12 by way of brazed rings 21 and 22 around the periphery of the flat faces 18 of the expansion device 17. In order to optimize the efficiency of the coil as mentioned above, it is desirable that the diameter of each of the expansion devices be selected to meet the flow requirements of their respective circuits. Thus, it should be understood that the bore diameter of the expansion device in the distribution line serving a coil circuit with a larger volume of air flowing thereover may be greater than that in the expansion devices installed in the distribution line serving a coil with a smaller volume of air flowing thereover. In this way, the coil performance can be optimized with an apparatus which is easy to manufacture and which overcomes the problems associated with the use of capillary tubes.

Referring now to Figure 5 and 5a, the refrigerant metering portion of the invention is shown in an alternative form as an integral part of the distribution line 12. In this case, rather than installing an insert within the distribution line 12, a portion 23 of the distribution line is reduced in diameter such that its internal flow passage 24 has substantially the same L/D characteristics as the bore of the embodiment described hereinabove. The reduced diameter portion 23 can be formed by an appropriate crimping or swaging process.

Since it is difficult to obtain an abrupt radial contraction to the reduced diameter portion 23 in the distribution line 12, such that an angled face 26 is likely to result at the entrance to the internal flow passage 24 rather than a flat face as shown in the embodiment described hereinabove, the flow characteristics of the metering device may be affected and therefore require some modifications to the design. For example, since the resistance of the angled face would be less than that of the flat face, the bore dimensions would most likely need to be varied accordingly. That is, the bore for an angled face device would most likely need to be of a smaller diameter and/or longer in length than that for a flat faced device.

However, it is intended that the reduced diameter portion 23 functions in substantially the same way as the orifice 19 in the embodiment described hereinabove and therefore will have substantially the same L/D parameter relationships.

Referring now to Figures 6 and 6a, another embodiment of the present invention is shown wherein the distribution line is formed of male and female portions 26 and 27, respectively. The diameters of the male 26 and female 27 portions are substantially the same except that the male portion has an engagement section 28 of a smaller diameter such that its outer diameter is substantially the same as the inner diameter of the female portion 27. In this way, the male portion 26 may be installed into the female portion 27 by way of a force fit, with the two portions being connected in a secure manner by way of a braze bead 29 at one end of the female section 27 as shown. As will be seen in Figure 6 and 6a, the male portion engagement section 28 is further reduced in diameter at 31 to finally form a metering portion 32 with a central passage 33 whose L/D characteristics are substantially the same as those of the orifice described hereinabove. In this case, since the refrigerant would flow from left to right in Figure 6, the flow characteristics would be substantially the same as those of the Figure 5 design (i.e. with an angled face) discussed hereinabove.

While the present invention has been disclosed with particular reference to a preferred embodiment, the concepts of this invention are readily adaptable to other embodiments, and those skilled in the art may vary the structure thereof without departing from the essential spirit of the present invention. For example, although the present invention has been described in terms of particular structures in accordance with a preferred and alternative embodiment, it should be understood that other types of expansion devices and methods of mounting may be employed while remaining within the scope of the present invention.

Claims

1. In a heat exchanger coil of the type having a plurality of parallel circuits for receiving a gaseous refrigerant therein for the absorption of heat, an improved refrigerant metering apparatus comprising:
a header for receiving liquid refrigerant from the supply line for distribution to said plurality of parallel circuits;
a plurality of distribution lines fluidly interconnecting said header to said parallel circuits; and
an expansion device disposed in each of said distribution lines for metering the flow of refrigerant therethrough by way of an orifice.

2. An improved refrigerant metering apparatus of the type as set forth in claim 1 wherein said expansion device comprises a cylinder with a central bore, said cylinder being secured within said distribution line by a braze material on at least one end thereof.

3. An improved refrigerant metering apparatus as set forth in claim 1 wherein said expansion

device comprises a portion of said distribution line which is reduced in diameter.

4. An improved refrigerant metering apparatus as set forth in claim 3 wherein said reduced diameter portion is integral with the remaining portion of said distribution line.

5. An improved refrigerant metering apparatus as set forth in claim 3 wherein said reduced diameter portion is coaxially located within a non-reduced diameter portion of said distribution line.

6. A refrigerant metering apparatus as set forth in claim 1 wherein said orifice has a length to diameter ratio in the range of 3-50.

7. An improved refrigerant expansion apparatus of the type interconnecting a liquid line to a plurality of evaporator coil circuits comprising:
a plurality of feeder tubes with each being fluidly connected to one of said plurality of evaporator coil circuits;
a header which is attachable to receive a liquid refrigerant from the liquid line and to deliver the refrigerant to said plurality of feeder tubes; and
an expansion device disposed in each of said feeder tubes for transforming the refrigerant flow from a liquid to a gaseous state by way of an orifice.

8. An improved refrigerant expansion apparatus as set forth in claim 7 wherein said expansion device is secured within said feeder tube by way of a braze material on at least one end thereof.

9. A refrigerant expansion apparatus as set forth in claim 7 wherein said orifice has a length-to-diameter ratio in the range of 3-50.

10. An improved refrigerant metering apparatus as set forth in claim 7 wherein said expansion device comprises a reduced diameter portion of said feeder tube.

11. An improved refrigerant expansion apparatus as set forth in claim 10 wherein said reduced diameter portion is integral with a non-reduced diameter portion of said feeder tube.

12. An improved refrigerant expansion apparatus as set forth in claim 10 wherein said reduced diameter portion is coaxially disposed within a non-reduced diameter portion of said feeder line.

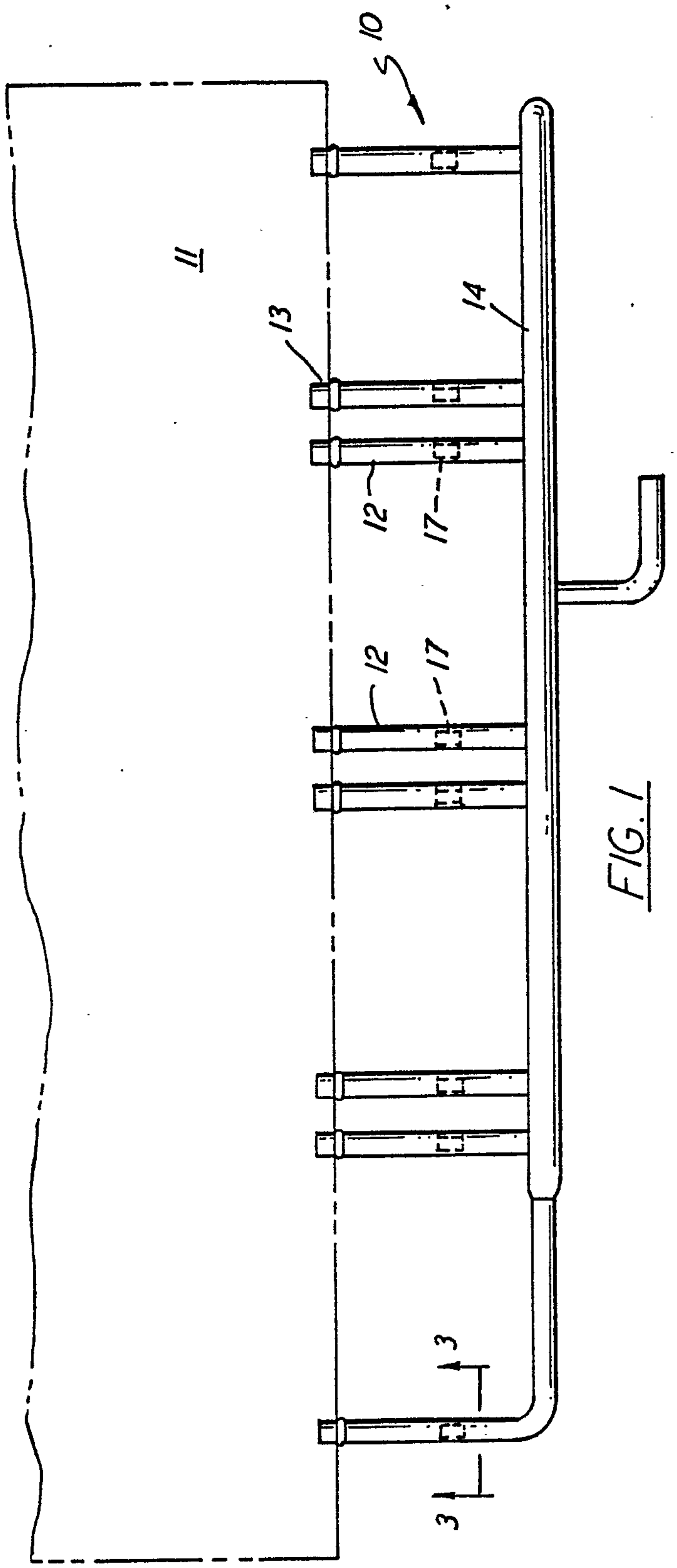

FIG. 1

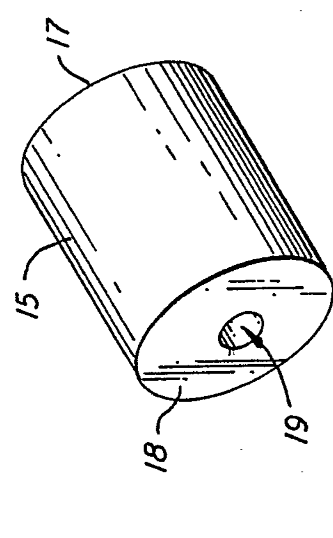

FIG. 2

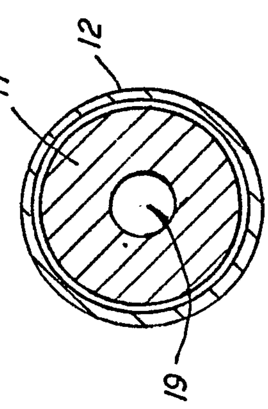

FIG. 3

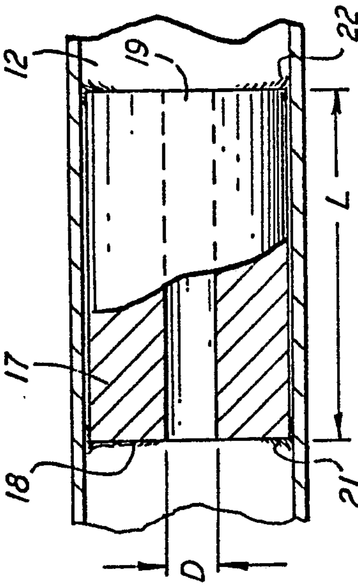

FIG. 4

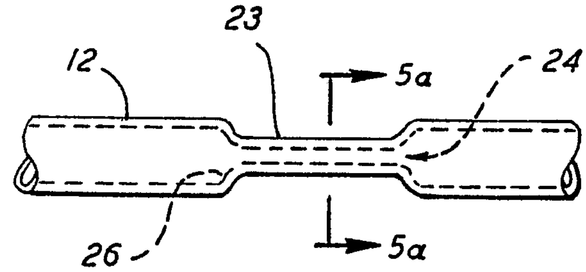

FIG. 5

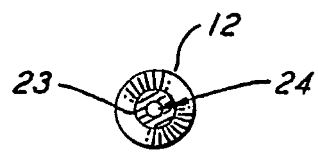

FIG. 5a

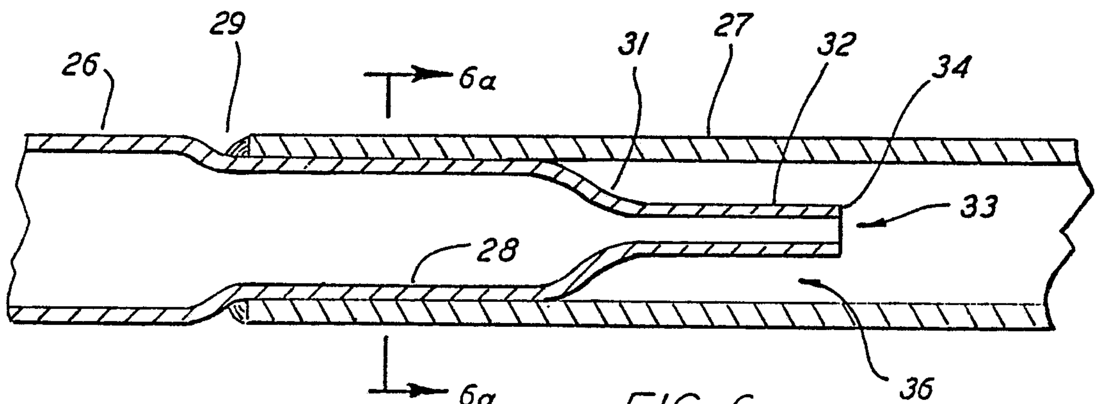

FIG. 6

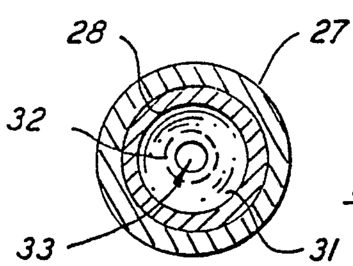

FIG. 6a