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REFRIGERATION SYSTEM
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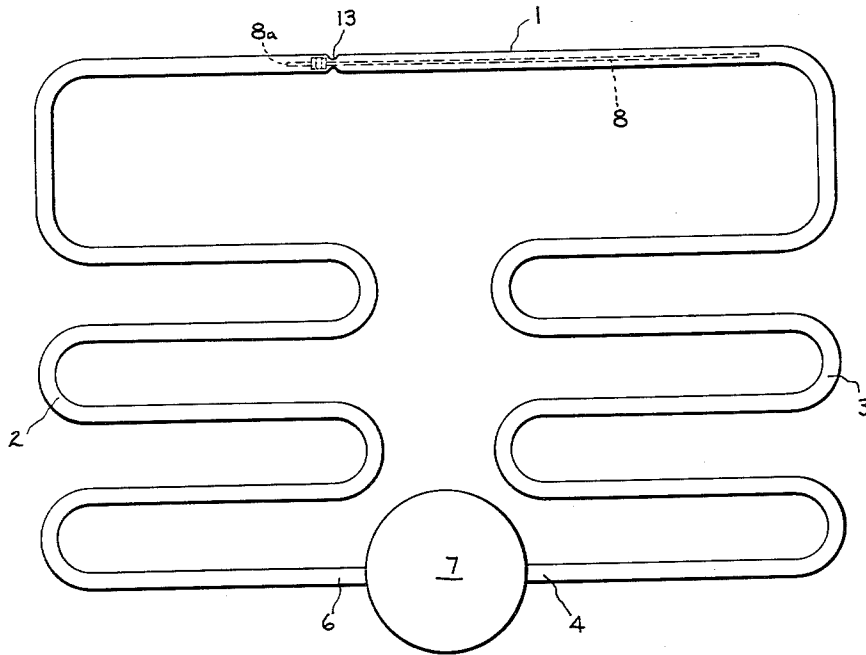


FIG. 1

FIG. 3

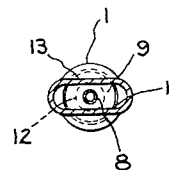
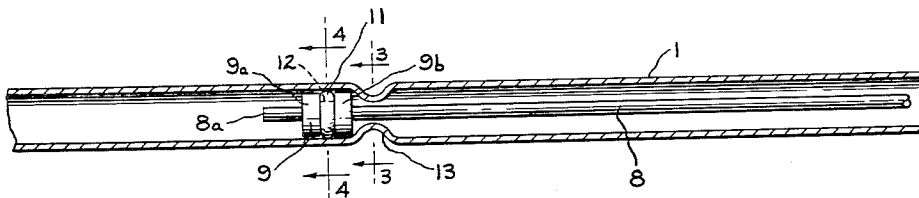
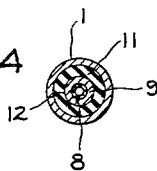


FIG. 2

FIG. 4



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REFRIGERATION SYSTEM

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4 Claims. (Cl. 62—511)

The present invention relates to a refrigeration system and more particularly to a refrigeration system utilizing a capillary expansion tube for maintaining the pressure differential between the evaporator and condenser of the system.

It is an object of the present invention to provide an improved arrangement for incorporating a capillary expansion means into a refrigeration system.

It is another object of the present invention to provide a refrigeration system in which the evaporator and condenser are formed of a continuous length of refrigerant conduit which does not require joints therein for connecting the expansion means between the evaporator and condenser.

More specifically, it is an object of the present invention to provide an improved arrangement for mounting a capillary expansion tube within a refrigerant conduit and for maintaining a refrigerant pressure differential between the condenser and evaporator formed from the conduit.

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

In carrying out the objects of the present invention there is provided a refrigeration apparatus having a condenser, and an evaporator formed from a continuous length of refrigerant conduit which is connected at its opposite ends thereof to the suction inlet and discharge outlet of a compressor. In order to provide a pressure differential between the condenser and the evaporator, a capillary expansion tube is positioned entirely within the refrigerant conduit between the condenser and the evaporator. The capillary tube extends through a cylindrical-shaped plug which is connected in sealing relationship with the outer surface of the capillary. Positioned in a groove formed around the outer circumference of the plug is a resilient ring which is compressed between the inner circumference of the refrigerant conduit and the cylindrical plug thereby providing a refrigerant seal between the inner circumference of the conduit and the plug. In order to hold the plug and the capillary in a desired position between the condenser and the evaporator, an indented portion is formed in the refrigerant conduit on the evaporator side of the plug so that the inner surface of the conduit abuts against the edge of the plug thereby preventing movement of the plug and capillary toward the evaporator.

For a better understanding of the invention reference may be had to the accompanying drawing in which:

Fig. 1 is a schematic drawing of a refrigeration system embodying the present invention;

Fig. 2 is an enlarged view in cross-section of that portion of the refrigeration system carrying the capillary expansion tubing;

Fig. 3 is a cross-sectional view of the refrigerant conduit and capillary tube taken along line 3—3 of Fig. 2; and

Fig. 4 is a cross-sectional view of the refrigerant con-

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duit, plug and capillary tube taken along line 4—4 of Fig. 2.

Referring now to Fig. 1, there is shown a refrigeration system which includes a condenser 2 and an evaporator 3 which are formed of a single continuous length of refrigerant tubing or conduit 1. Although the conduit 1 is shown in the drawing without fins, it will be understood that the conduit could be passed in serpentine fashion through a plurality of plate fins in the evaporator and condenser portion of the system, or the conduit itself could have a continuous length of helically wrapped fin material attached thereto in the manner well known in the art. Opposite ends 4 and 6 of the continuous length of conduit 1 are connected respectively with the suction inlet and the discharge outlet of a compressor, generally designated by the reference numeral 7. Thus, suction gas is drawn into the compressor 7 through the end 4, or suction end of the conduit which connects with the evaporator 3, and high pressure gas is discharged from the compressor through the end 6, or discharge end of the conduit, where it flows into the condenser 2. In order to maintain a pressure differential in the system between the condenser and evaporator, the system employs a refrigerant flow restriction means in the form of a capillary tube 8 which expands the gas from condenser pressure to evaporator pressure. The capillary tube is positioned axially entirely within the refrigerant conduit itself and effects a flow restriction between the condenser and the evaporator in a manner to be hereinafter described.

As may better be seen in Fig. 2, the capillary 8 is inserted into the conduit 1 and is retained therein by a plug 9 which surrounds the capillary tube and which is sealed to the capillary tube by means well known in the art, such as welding or brazing. The plug 9 is cylindrical in shape and has a diameter slightly less than that of the diameter of the conduit 1 so that the plug may be fitted into and moved axially with respect to the conduit. In order to maintain an effective refrigerant seal between the two sides of the system except for the flow through the capillary tube 8, there is provided a resilient ring 11 which is seated in a groove or peripheral depression 12 formed around the cylindrical plug 9. The resilient ring may be formed of Teflon or any of the inert plastic resilient materials now available on the market, but must be resistant to deterioration or decomposition by the particular refrigerant used in the system. As may be seen in Figs. 2 and 4, the resilient ring 11 fits into the groove 12 and is retained therein by the elasticity or resiliency of the ring and by the two side portions 9a and 9b of the cylindrical plug. The resilient ring 11 has an outer diameter greater than the inner diameter of the conduit 1 and is retained in compression between the inner surface of the conduit and the cylindrical plug when inserted into the conduit. As may be seen in Fig. 4, the inner circumference of the ring 11 is seated around the outer circumference of the groove 12 of the cylindrical plug 9 and maintains a good refrigerant seal therewith. Thus, when the plug, with its resilient ring 11, is forced into the conduit 1, the ring 11 prevents the flow of refrigerant along the conduit 1 except through the capillary 8 so that a pressure differential is maintained on opposite sides of the ring within the conduit. In the preferred embodiment of the invention, the plug 9 with its resilient sealing ring 11 is positioned adjacent the upstream end 8a or condenser end of the capillary tube 8 in order to assure that the opening in the capillary is, at most times, exposed to liquid refrigerant.

During operation of the refrigeration system, a substantial pressure difference exists on opposite sides of the resilient sealing ring 11 and the resultant force on the ring 11, plug 9, and capillary 8 as a unit is likely to promote movement of this unit in the direction of refrigerant flow.

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It is necessary, therefore, in order to retain the capillary and the plug in their proper positions within the conduit 1 to provide some means for preventing movement of the plug and capillary in the downstream direction or toward the evaporator 3. Thus, the conduit 1 is provided within a "pinched" portion or indentation 13 which reduces at least one dimension of the conduit in this portion to an amount less than the diameter of the cylindrical plug 9. The shoulder or edge of the plug abuts against the upper portions of the conduit 1 in the area of the indentation 13 and prevents movement of the plug and capillary tube in the downstream direction or in the direction of low pressure.

As may be seen in Fig. 3, when the conduit is formed by "pinching" forces applied on opposite sides of the conduit it becomes larger in one direction as its width is reduced in the other direction. Since the horizontal width of the deformed portion of the conduit, as seen in Fig. 3, is likely to be greater than the diameter of the sealing ring 11, it is necessary to maintain the sealing ring a substantial distance away from this portion of the tubing. The use of the cylindrical plug 9 for retaining the capillary tube 8 in position axially with respect to the conduit 1 also retains the ring 11 a short distance away from the indentation 13 so that the ring is within that portion of the conduit which is substantially round and against which the sealing ring 11 will maintain an effective refrigerant seal. That is, the portion 9b of the plug between the resilient ring 11 and the indentation 13 is made wide enough to maintain the resilient sealing ring far enough away from the indentation 13 as to be unaffected by those portions of the tubing which are deformed and enlarged due to the indentation of the tubing.

The method of manufacturing this tubing is relatively simple. An indentation 13 or pinched area is made in a straight length of refrigerant conduit at the desired location between that portion of the conduit which is to be formed into the condenser and that portion of the conduit which is to be formed into the evaporator. The capillary with its plug and sealing ring is inserted into the condenser end 4 of the conduit and pushed into the conduit until the plug 11 abuts against the indented section 13. The desired condenser and evaporator turns are then formed in opposite sides of the conduit and the ends 4 and 6 are then connected onto the compressor of the system. Since the capillary 8, plug 9, and sealing ring 11 as a unit may be moved to almost any desired location in the conduit 1 it is a simple matter to position the capillary merely by measuring the desired distance from the end 4 of the conduit and making an indentation at this point on the conduit and then move the plug into abutting relationship with the indentation.

Thus, this capillary arrangement not only has a functional advantage in that there are less joints and, therefore, less likelihood of refrigerant leaks, but also realizes a manufacturing advantage by virtue of the elimination of connecting joints between the ends of the capillary end of the conduit.

While in accordance with the patent statutes there has been described what at present is considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, the aim of the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

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

1. A refrigeration apparatus including in combination a compressor, a condenser and an evaporator formed from a continuous length of refrigerant conduit having opposite ends thereof connected in refrigerant flow relationship with said compressor, and restriction means in said conduit between said condenser and said evaporator comprising a capillary tube mounted entirely within said

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refrigerant conduit, a substantially cylindrical-shaped plug surrounding said capillary tube and connected in sealing relationship with the outer circumference of said capillary tube, said cylindrical-shaped plug having a diameter less than the diameter of said refrigerant conduit and having a groove formed around the outer circumference thereof, a resilient ring positioned in said groove on said plug, said resilient ring having an outer diameter greater than the inner diameter of said refrigerant conduit and adapted to be compressed by said conduit to provide a refrigerant seal between the inner circumference of said conduit and said resilient ring, an indented portion in said conduit between said condenser and said evaporator against which said cylindrical plug is positioned on the condenser side of said indentation for preventing movement of said plug and said capillary along said conduit.

2. A refrigeration apparatus including in combination a compressor, a condenser and an evaporator formed from a continuous length of refrigerant conduit having opposite ends thereof connected in refrigerant flow relationship with said compressor, and restriction means in said conduit between said condenser and said evaporator comprising a capillary tube mounted entirely within said refrigerant conduit, a substantially cylindrical-shaped plug surrounding said capillary tube and connected in sealing relationship with the outer circumference of said capillary tube, said cylindrical-shaped plug having a diameter less than the diameter of said refrigerant conduit and having a groove formed around the outer circumference thereof, a resilient ring seated in said groove in said plug, said resilient ring having an outer diameter greater than the inner diameter of said refrigerant conduit and adapted to be compressed by said conduit to provide a refrigerant seal between the inner circumference of said conduit and said resilient ring, an indented portion in said conduit between said condenser and said evaporator against which one end of said cylindrical plug is positioned on the condenser side of said indentation for preventing movement of said plug and said capillary along said conduit, said cylindrical plug between said resilient ring and the end thereof abutting said indentation being of sufficient length to maintain said resilient ring away from that portion of said conduit that is deformed as a result of said indentation in said conduit.

3. A refrigeration apparatus including in combination a compressor, a condenser and an evaporator formed from a continuous length of refrigerant conduit having opposite ends thereof connected in refrigerant flow relationship with said compressor, a capillary tube mounted entirely within said refrigerant conduit for providing a restriction means between said condenser and said evaporator, a substantially cylindrical-shaped plug surrounding said capillary tube and connected in sealing relationship with the outer circumference of said capillary tube, said cylindrical-shaped plug having a diameter less than the diameter of said refrigerant conduit and having a grooved portion formed around the outer circumference thereof, a resilient ring having an inner diameter that is normally less than the outer diameter of said grooved portion of said cylindrical-shaped plug, said resilient ring being seated in sealing relationship around said grooved portion of said cylindrical-shaped plug, said resilient ring having a diameter greater than the diameter of said refrigerant conduit and adapted to be compressed by said conduit to provide a refrigerant seal between the inner circumference of said conduit and said resilient ring, a pinched portion in said conduit between said condenser and said evaporator against which one end of said cylindrical plug abuts on the condenser side of said pinched portion for preventing movement of said cylindrical plug and said capillary along said conduit toward said evaporator, said cylindrical plug between said end abutting said pinched portion and said resilient ring being of sufficient length to hold said ring away from said portion

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of said conduit that is deformed as a result of said pinched formation of said conduit.

4. A refrigeration apparatus including in combination a compressor, a condenser and an evaporator formed from a continuous length of refrigerant conduit having opposite ends thereof connected in refrigerant flow relationship with said compressor, a capillary tube mounted entirely within said refrigerant conduit for providing a restriction means between said condenser and said evaporator, a substantially cylindrical-shaped plug surrounding said capillary tube adjacent one end thereof and connected in sealing relationship with the outer circumference of said capillary tube, said cylindrical-shaped plug having a diameter less than the diameter of said refrigerant conduit and having a grooved portion formed around the outer circumference thereof, a resilient ring positioned in said groove on said cylindrical-shaped plug having a diameter less than the diameter of said refrigerant conduit and having a groove formed around the outer circumference thereof, a resilient ring positioned in said

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groove on said plug, said resilient ring having an outer diameter greater than the inner diameter of said refrigerant conduit and adapted to be compressed by said conduit to provide a refrigerant seal between the inner surface of said conduit and said resilient ring, an indented portion in said conduit between said condenser and said evaporator against which said cylindrical plug is positioned on the condenser side of said indentation with said capillary tube extending through said indentation into the downstream portions of said conduit, said indentation preventing movement of said plug and said capillary along said conduit toward said evaporator.

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