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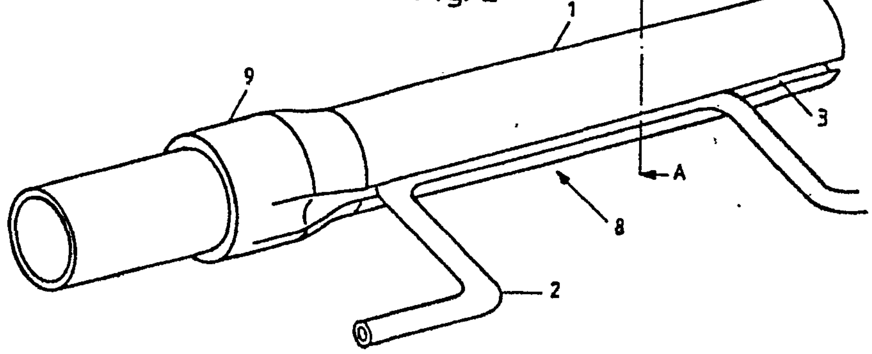
(54) **Suction tube heat exchanger and method of manufacture.**

(57) The invention concerns a suction type heat exchanger for locating in cooling circuits, comprising a suction tube (1) and a capillary tube (2). The suction tube is provided with one or more integrated grooves (3) shaped complementary to and dimensioned for insertion of the capillary tube. The method for manufacturing the suction heat exchangers is based on exposure to the plastic deformation of both tubes after insertion of the capillary tube (2) into the groove (3) in the suction tube.

Fig. 2



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Norsk Hydro a.s.
Oslo / Norway

Suction tube heat exchanger and method of manufacture

Priority: July 6, 1984 - Norway - No. 842755

P 2579-EP

The present ivention concerns a heat exchanger of the so-called suction tube type for locating in the cooling circuit of a refrigerator/freezer in the compressor's suction line, and furthermore a method for manufacturing such heat exchangers.

Heat exchangers of this type, incorporated into cooling systems in conjunction with a compressor, comprise a capillary tube connected to the system's suction line. The purpose of this arrangement is that heat from the condensing fluid in the capillary tube is transferred to vapor drawn into the compressor through the suction tube. In this way, the efficiency of the cooling system is increased while simultaneously preventing the intake of unevaporated fluid into the compressor.

Various types of heat exchangers fabricated of copper or stainless steel are presently used in refrigerators/freezers. The classical heat exchanger design is based on the insertion of the capillary tube into the suction line, providing direct contact between the medium flowing in the suction line and the surface of the capillary tube. This design is characterized by two principal disadvantages. For one, a soldering operation is required in connection with the insertion of the capillary tube through the wall of the suction tube. This increases the cost of the assembly work and imposes a limitation on the choice of materials. In practice, copper tubing is primarily used.

For the other, problems occur with the freezing of the capillary tube, forcing one to overdimension, i.e. by increasing the length of both tubes in order to achieve a satisfactory heat exchange.

Furthermore, it is known to apply heat exchangers where the capillary tube is either wound around the suction line externally or soldered along the outside of the suction tube. A relatively poor heat transfer through a purely mechanical contact in the case of wound capillary tubing, and problems as to the limited choice of materials and high costs, when the tubes are soldered as described above, are the disadvantages of this design. Even with soldered capillary tubing made of copper, the heat exchange is not optimal due to the contact surface between the tubes being limited to 30-35% at most of the capillary tube's surface.

The object of the present invention is therefore to provide a heat exchanger that is cheaper to manufacture, yet qualitatively on a par with the heat exchangers of this type hitherto known and used.

Another object of the present invention is to provide a method for the fabrication of heat exchangers which provides a simple, effective, and mechanically/thermally reliable joint between the tubes in the heat exchanger. This is achieved by the heat exchanger and the fabrication method as stated in the characterizing parts of the patent claims 1 and 4 of the present application.

In conformity with an advantageous design of the heat exchanger according to the invention, the suction line is given an oval cross-section, which is transformed to an essentially circular cross-section in the joining process of plastic deformation.

The invention will be described more explicitly here with references to the enclosed drawings, Figs. 1-7, where:

Fig. 1 shows a schematic outline of a compressor cooling system for a refrigerator/freezer.

Fig. 2 shows the heat exchanger according to the invention.

Fig. 3 shows the heat exchanger in vertical cross-section along the line A-A in Fig. 2.

Fig. 4 shows the suction line and capillary tube as individual components in vertical cross-section prior to the joining operation.

Fig. 5 shows another design of the heat exchanger according to the invention, and

Figs. 6 and 7 show in vertical cross-section two alternative designs of the suction tubing.

Fig. 1 shows a schematic outline of a compressor cooling system comprising a condensor (10), an evaporator (15) and a compressor (5) with a capillary tube (2) connecting the condensor with the evaporator. A suction accumulator (4) is also displayed in the figure, with the suction line (1) incorporated in the heat exchanger (8) in front of the compressor connection.

In Fig. 2, a heat exchanger (8) is shown in more details, comprising a suction line (1) and a capillary tube (2) inserted and fastened in the groove (3) in the suction tube. Two standard tube fittings (9) connect the ends of the suction tube to the cooling circuit. (Only one of the fittings is shown in the figure.)

Fig, 3, which shows a vertical cross-section of the heat exchanger at line A-A on Fig. 2, illustrates the superior joint between the suction tube (1) and the capillary tube (2), where up to 80% of the surface of the capillary tube is engaged, and thereby in heat-transferring contact with the walls of the suction line through the inwardly protruding groove (3).

The process for joining the tubing/fabricating the heat exchanger itself is best illustrated in Fig. 4, which shows both tubes in a vertical cross-section prior to the joining operation.

The suction line (1) is illustrated in the preferred embodiment with an oval (elliptical) cross-section and an inwardly projecting groove (3) forming a recess in the tube's circumference. The cross-section of the groove and the diameter of the capillary tube are dimensioned to facilitate insertion of the tube into the groove. The subsequent plastic deformation of the suction line, which is transformed to an essentially circular cross-section, results in the walls (32) of the groove being elongated around the perimeter of the tube, partly enclosing the capillary tube. Thus, a simple mechanical joining method ensures that intimate contact is established and maintained between the tubes, providing superior heat transfer between the two mediums - warm fluid in the capillary tube and coolant in the suction line.

Another advantageous heat exchanger embodiment (8) according to the present invention is shown in Fig. 5. The integrated groove (3) in the suction line (1) is formed as a projection protruding out from the surface of the tube.

As evidenced by Fig. 6, showing a vertical cross-section of the suction tube (1) and the capillary tube (2) prior to joining, the suction tube has an essentially circular cross-section. The plastic deformation occuring in the process of joining the tubes is limited in this case to the deformation of the walls of the groove (32), which encompass the capillary tube after joining, resulting in a solid, reliable mechanical and heat exchanging contact between the tubes.

Fig. 7 shows still another embodiment of the suction tube (1) having an essentially circular cross-section with an inwardly protruding groove (3). Free surface of the capillary tube inserted and fastened in such a groove will achieve a direct contact with the circulating fluidum in the suction tube and result in further improvement of the heat transfer characteristic.

The above described joining operation (not shown in the figures) may be performed employing all familiar, relevant methods, such as pressing, rolling or drawing of the tubing while simultaneously calibrating the tubes.

The heat exchanger according to the invention is not limited to the preferred embodiments discussed above and illustrated in the figures. Different requirements as to heat exchanging capacity, compact design of the cooling system, etc., may call for the incorporation of more than one capillary tube per suction line, for instance without excluding this variant from the scope of the present invention.

Furthermore, both the suction line and the capillary tube may be fabricated of aluminium, since neither the design nor the fabrication of heat exchangers according to the invention raise any limits on the choice of materials. As known, aluminium applied as construction material provides obvious advantages in the form of weight reduction and less problems associated with connections and corrosion in the cooling circuit.

Claims

1. Suction line heat exchanger for locating in cooling circuits, comprising a suction tube (1) and a capillary tube (2),
c h a r a c t e r i z e d i n t h a t
the suction tube (1) is formed as a metal tube provided with one or more integrated, half-closed grooves (3) running longitudinally, providing fastening means for the capillary tube (2), and where the cavity of the grooves is formed complementary to and dimensioned for the insertion of the capillary tube (2).

2. Suction line heat exchanger according to claim 1,
c h a r a c t e r i z e d i n t h a t
the suction tube (1) is formed with an oval cross-section and where the integrated longitudinally running groove (3) is projecting inwards into the suction tube as a recess in the tube's circumference.

3. Suction line heat exchanger according to claim 1,
c h a r a c t e r i z e d i n t h a t
the suction tube (1) is formed with an essentially circular cross-section, and where the integrated groove (3) is projecting outwards from the circumference of the tube.

4. Suction line heat exchanger according to claim 1,
c h a r a c t e r i z e d i n t h a t
the suction tube (1) is formed with an essentially circular cross-section, and where the integrated groove (3) is projecting inwards from the tube wall.

5. Suction line heat exchanger according to one or more of the preceding claims,
c h a r a c t e r i z e d i n t h a t
the suction tube (1) and the capillary tube (2) are extruded aluminium tubing.

6. Method for fabrication of the suction tube heat exchanger according to one or more of the preceding claims, where the capillary tube (2) is inserted into the complementarily formed grooves (3) in the suction tube (1), and the assembled tubing (1,2) is subsequently subjected to plastic deformation,
c h a r a c t e r i z e d i n t h a t
the walls (32) of the groove (3) are uniformly deformed into an intimate contact with the capillary tube along the entire length of the joining area between the capillary tube (2) and the suction tube (1).

7. Method according to claim 6,
c h a r a c t e r i z e d i n t h a t
the oval cross-section of the suction tube (1) is also acquiring an essentially circular cross-section along the joining area between the tubes (1,2) during the plastic deformation process.

8. Method according to claim 6,
c h a r a c t e r i z e d i n t h a t
the plastic deformation is limited to the walls of the groove (32).

9. Method according to claim 6, 7 or 8,
c h a r a c t e r i z e d i n t h a t
the plastic deformation joining is accomplished by employing a press operation, a drawing operation or a rolling operation.

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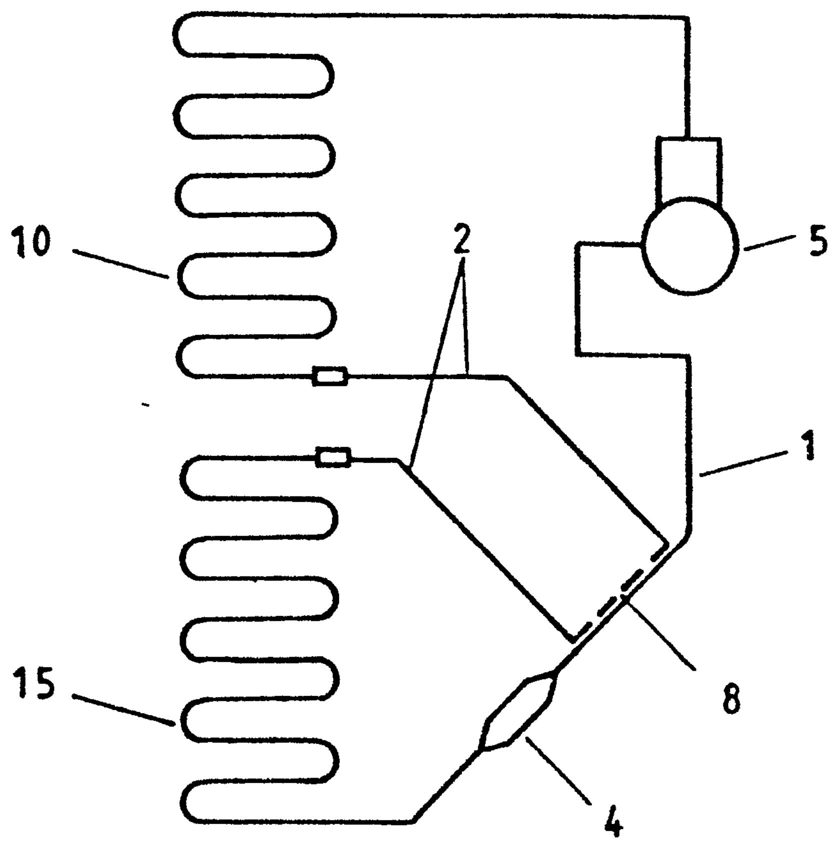

Fig. 1

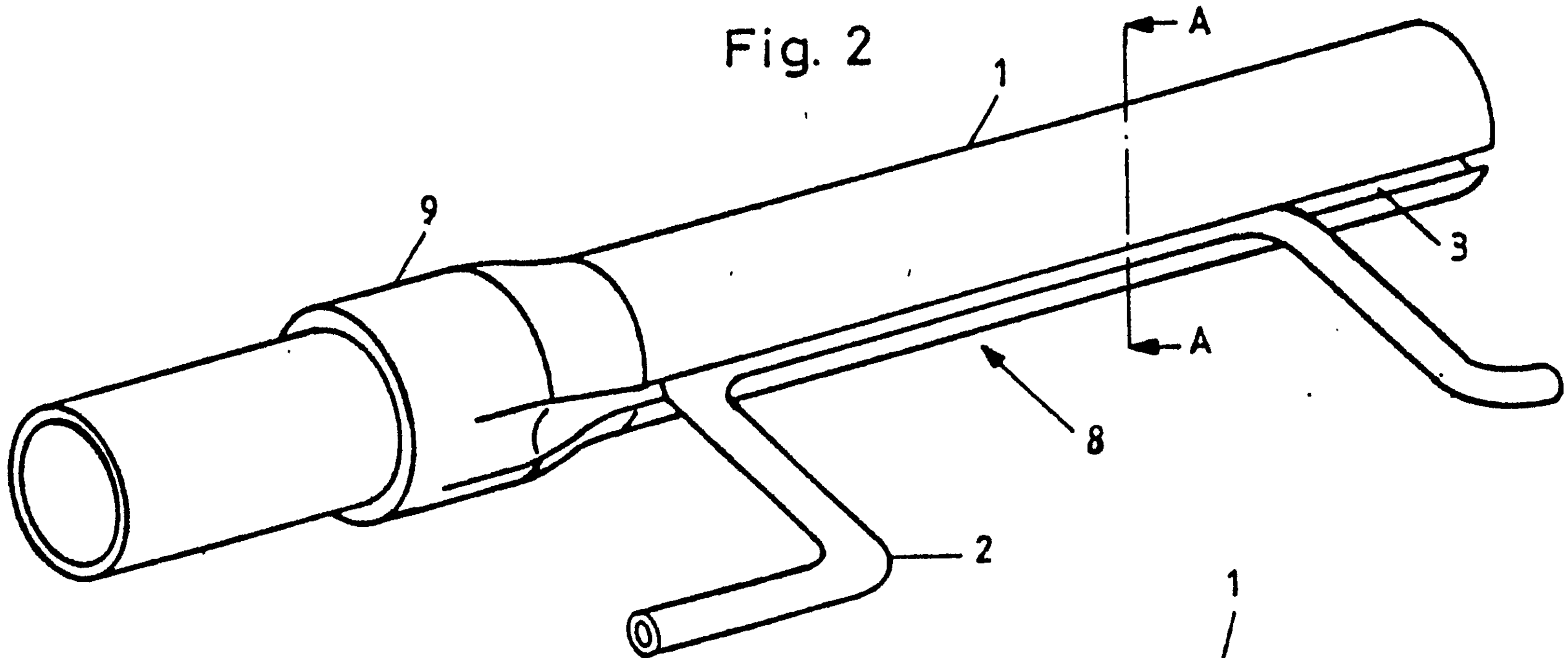

Fig. 2

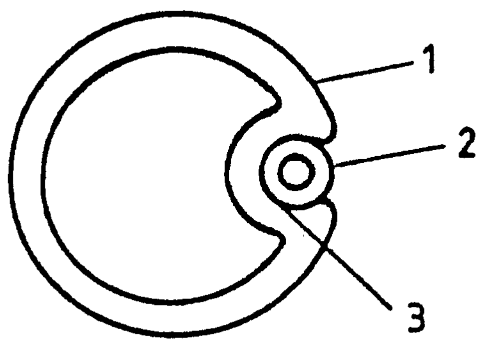

Fig. 3

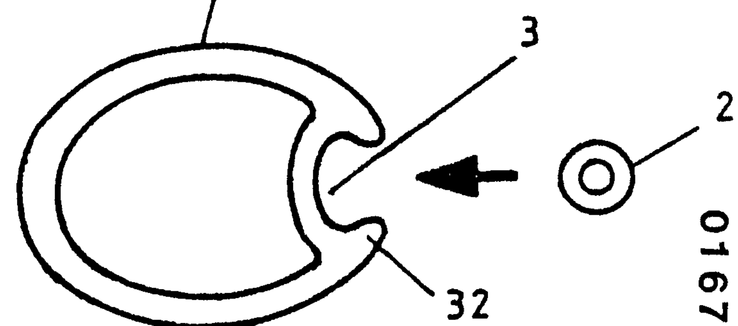

Fig. 4

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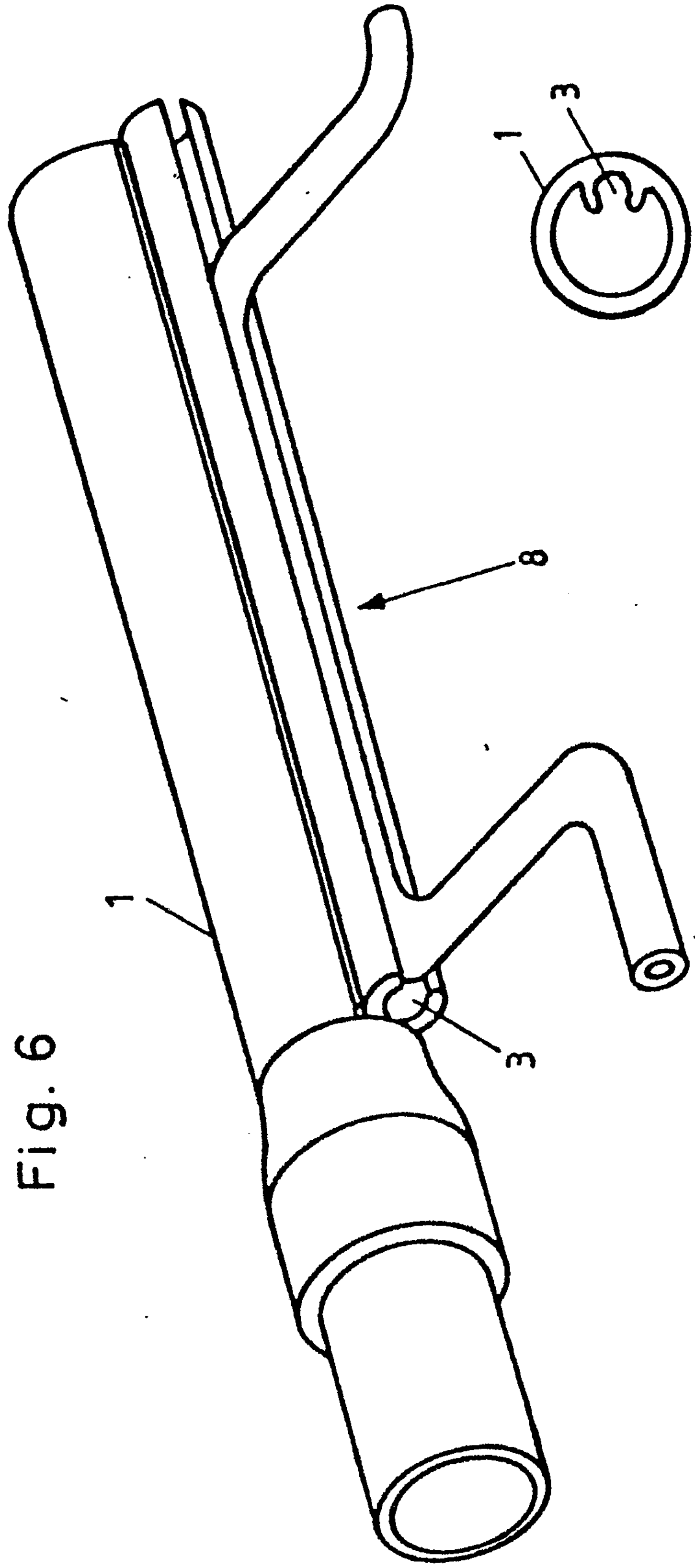

Fig. 5

Fig. 7

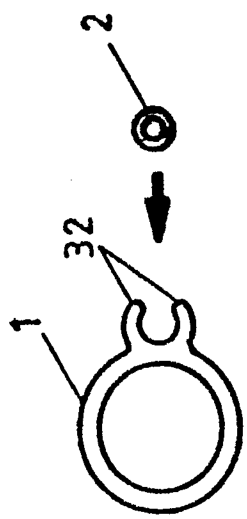

Fig. 6