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(71) Applicant: **DYTECH - Dynamic Fluid Technologies S.p.A.**
10123 Torino (IT)

(72) Inventor: **Zanardi, Mariofelice**
10123 Torino (IT)

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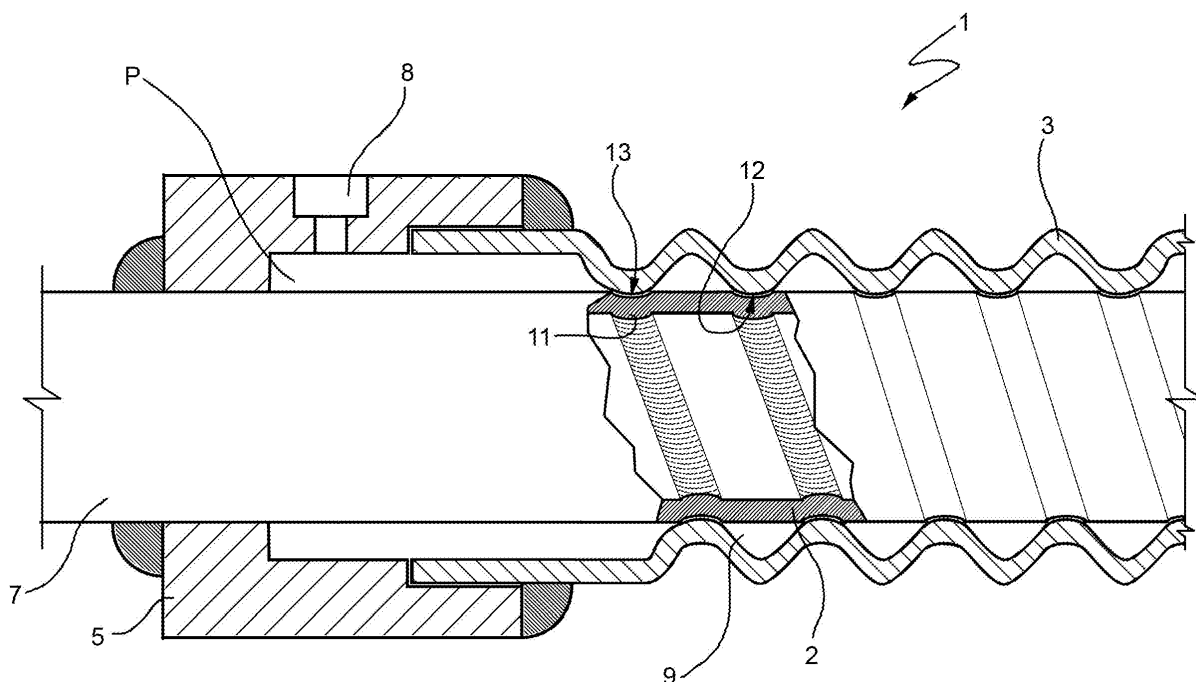
(74) Representative: **Jorio, Paolo et al Studio Torta S.p.A.**
Via Viotti, 9
10121 Torino (IT)

(54) **Heat exchanger especially for an air conditioning system of a vehicle**

(57) A heat exchanger (1) for an air conditioning circuit of a vehicle comprising a central tube (2) for refrigerating fluid and a tubular covering (3) housing the central tube (2) and defining a fixed pipe (4) for the refrigerating

fluid with the central tube (2), wherein at least the tubular covering (3) defines a helical relief (10) obtained by means of plastic deformation to convey the refrigerating fluid along a helical path around the central tube (2).

FIG. 1



Description

[0001] The present invention relates to a preferably counter-current heat exchanger for an air conditioning system for motor vehicles.

[0002] It is known that an air conditioning system for a motor vehicle comprises a compressor, a condenser, an expansion system, an evaporator and a fluidic unit to connect the previously mentioned components together.

[0003] In particular, airflow passes through the evaporator, which is then ducted by means of specially provided ducts to the vehicle interior and the compressor can be arranged in the engine compartment, either at the front or the back.

[0004] The compressor provides work to bring a heat exchanger fluid from a relatively low temperature and pressure, for example 2°C and 2 bar respectively, to a relatively high temperature and pressure, for example 80°C and 15 bar.

[0005] The fluid sends-off heat to the outside environment in the condenser and flows to the evaporator through an expansion valve that, in causing a drop in pressure, brings about the evaporation of the fluid in the evaporator with consequent irradiation of heat from the airflow that passes through the evaporator and which is conveyed to the vehicle interior.

[0006] Downstream of the evaporator, the compressor must provide work to the fluid equal to the enthalpy jump between intake and delivery. In order to render the cooling cycle more efficient and reduce pollutant emissions, it is known to provide a heat exchanger wherein the fluid leaving the evaporator is heated by the fluid leaving the condenser. In this way, the fluid sucked in by the compressor has a greater pressure and temperature and both the enthalpy drop and, in consequence, the work of the compressor decrease.

[0007] In the case of an air conditioning system having the compressor arranged in a frontal position inside the engine compartment, the pipes of the fluidic unit are side by side along the greater part of the path inside the engine compartment and the heat exchanger is counter-flow so as to have an elongated shape that follows the path of these pipes.

[0008] There are known heat exchangers that comprise a main body to transport both the heat exchanger fluid to be heated and the heating fluid, and a pair of connectors mounted at the respective ends of the main body to connect the heat exchanger to the pipes of the air conditioning system.

[0009] The main body defines a central pipe and a plurality of peripheral pipes that surround the central pipe. The central pipe is defined by a tubular wall. The peripheral pipes are defined in the radial direction by the tubular wall of the central pipe and an outer tubular wall concentric with the tubular wall of the central pipe and, in the circumferential direction, by a plurality of rectilinear separators angularly equidistant from each other.

[0010] The central pipe transports the heat exchanger

fluid leaving the evaporator and heading to the intake of the compressor and the peripheral pipes transport the heat exchanger fluid leaving the condenser in counter-current.

[0011] It is preferable that a counter-flow heat exchanger for an air conditioning system of a motor vehicle has low manufacturing costs. In addition, high thermal efficiency enables energy consumption to be further reduced.

[0012] Patent application EP-A-2228613 illustrates a counter-flow heat exchanger comprising an outer wall that is plastically deformed to define a plurality of pipes in combination with an inner tubular wall.

[0013] However, the effectiveness of the heat exchanger could be improved without affecting the production costs.

[0014] The object of the present invention is to make a counter-current heat exchanger for an air conditioning system without the above-indicated drawback.

[0015] The object of the present invention is achieved by means of a heat exchanger according to claim 1.

[0016] The invention shall now be described with reference to the attached drawings, which show non-limitative examples of embodiment, where:

- Figure 1 is a longitudinal cross-sectional view of a portion of the end of the heat exchanger according to the present invention, and
- Figure 2 is a longitudinal cross-sectional view of a portion of the end of the heat exchanger in Figure 1 during an intermediate step of manufacture.

[0017] In Figure 1, reference numeral 1 indicates, as a whole, a heat exchanger for an air conditioning system of a motor vehicle comprising a central tube 2 that can be connected to the inlet of a compressor of the air conditioning system (not shown) and a tubular covering 3 housing the central tube 2 and defining at least one pipe 4 that can be connected to the outlet of a condenser of the air conditioning system (not shown). The heat exchanger 1 further comprises a pair of fittings 5 (of which only one is shown in Figure 1) to firmly fix the tubular covering 3 to the central tube 2 and to partially define the pipe 4.

[0018] In particular, each fitting 5 has a toroidal shape defining a through hole for housing an end portion 7 of the central tube 2, and a radial hole 8 for the inflow/outflow of refrigerating fluid coming from the condenser. Each fitting 5 also defines a circular seat for housing an end portion 9 of the tubular covering 3. The seat has a diameter greater than the hole and is set apart from the latter in the axial direction so that the fitting 5 and the central tube 2 define an annular cavity P fluidically connected between the pipe 4 and the radial hole 8. Preferably, each fitting 5 is fixed in a fluid-tight manner to both an outer surface of end portion 7 and an inner surface of end portion 9 by welding. For example, the central tube 2, the tubular covering 3 and the fitting 5 are made of a metal

material, preferably an aluminium alloy, and the welding is continuous with a weld bead of filler metal.

[0019] According to a preferred embodiment of the present invention, the tubular covering 3 is configured such that the pipe 4 has a helical path around the central tube. Furthermore, the central tube 2, at least along the section surrounded by the tubular covering 3, also defines an internal relief surface along a helical path. In this way, it is possible to increase the turbulence of the refrigerating fluid leaving the compressor and therefore the heat exchange performance.

[0020] Advantageously, the tubular covering 3 is plastically deformed so as to define a helical relief 10 facing towards the central tube 2.

[0021] Even more advantageously, the helical relief 10 interferes with the central tube 2 so as to plastically deform the latter to obtain a helical relief 11 such that the turbulence of the refrigerating fluid entering the compressor is increased. In particular, a peak 12 of the helical relief 10 is at least partially housed in the radial direction within a helical cavity 13 defined by the helical relief 11 and having the concavity facing the tubular covering 3. The peak 12 of the helical relief 10 makes contact with the central tube 2 in the helical cavity 13 and the latter matches the shape of the peak.

[0022] The heat exchanger 1 can be made in the following manner.

[0023] Initially, the central tube 2 and the tubular covering 3 are undeformed pieces of pipe having different diameters and the fitting 5 is a forged part.

[0024] Each fitting 5 is subsequently fixed by two weld beads to the central tube 2 and to the tubular covering 3 respectively.

[0025] After this, by means of a plastic deformation machine, a die deforms the side wall of the tubular covering 3 so as to generate the helical relief 10. The depth of die penetration is such that the helical relief 10 makes contact with the side wall of the central tube 2 and also deforms the latter along a helical impression so as to define the helical relief 11. Thus, the helical relief 10 has a peak in contact with the helical relief 11 and both reliefs 10 and 11 are made on a single plastic deformation work station.

[0026] According to a preferred embodiment, the thickness of the wall of the central tube 2 is less than that of the tubular covering 3. In this way, the plastic deformation to make to helical relief 11 is simpler.

[0027] The advantages of the heat exchanger 1 are the following.

[0028] The helical reliefs 10 and 11 increase the thermal efficiency of heat exchanges.

[0029] In particular, the plastic deformation processing is inexpensive and the helical reliefs 10 and 11 can be made on a single work station without the need to retool the plastic deformation machine and/or remove/remount the heat exchanger on the machine itself. The helical relief 11 increases the turbulence, and therefore the exchange of heat, in tube 2 without a substantial impact on

production costs.

[0030] The starting components are simple pipes that are inexpensive and readily available on the market. Advantageously, the plastic deformation processing of the central tube 2 and the tubular covering 3 are similar and therefore it is possible to make these components starting from the same metal material, for example aluminium of the AL3000 series, preferably AL3103. Each fitting 5 is preferably made by forging and therefore is preferably of a superior material with respect to that used for making the central tube 2 and the tubular covering 3, for example aluminium of the AL6000 series, preferably AL6082.

[0031] Finally, it is apparent that changes and modifications may be made to the heat exchanger described and illustrated herein without leaving the scope of protection, as defined in the appended claims.

[0032] It is possible that the fittings 5, the central tube 2 and the tubular covering 3 be rigidly connected to each other by laser welding. In this case, it is preferable that these components are made of AL6000 series aluminium, for example the central tube 2 and the tubular covering 3 in AL6063 and the fittings 5 in AL6061 or 6082.

25 Claims

1. A heat exchanger (1) for an air conditioning circuit of a vehicle, comprising a central tube (2) for refrigerating fluid and a tubular covering (3) housing said central tube (2) and defining a fixed pipe (4) for the refrigerating fluid with said central tube (2), wherein at least said tubular covering (3) defines a helical relief (10) obtained by means of plastic deformation to convey the refrigerating fluid along a helical path around said central tube (2) and wherein said central tube (2) defines a further helical relief (11) made through plastic deformation, **characterized in that** said helical relief (10) makes contact with said central tube (2) through a helical portion (12) at least partially housed in a helical depression (13) defined by said further helical relief (11).
2. A heat exchanger according to any of the preceding claims, **characterized in that** said central tube (2) and said tubular covering (3) are made of the same aluminium-based metal material.
3. A heat exchanger according to any of the preceding claims, **characterized in that** it comprises at least one fitting (5) and **in that** said central tube (2) and said tubular covering (3) are rigidly connected by said fitting (5).
4. A heat exchanger according to claim 3, **characterized in that** the rigid connection is obtained by laser welding.
5. A method of manufacturing a heat exchanger ac-

according to any of the preceding claims, **characterized in that** it comprises the steps of:

- fixing said tubular covering (3) to said central tube (2); 5
- performing the plastic deformation of said tubular covering (3) and of said central tube (2) on a single work station so that said further helical relief (11) defines a helical impression reproducing the helical shape of a peak of said helical relief (10). 10

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FIG. 1

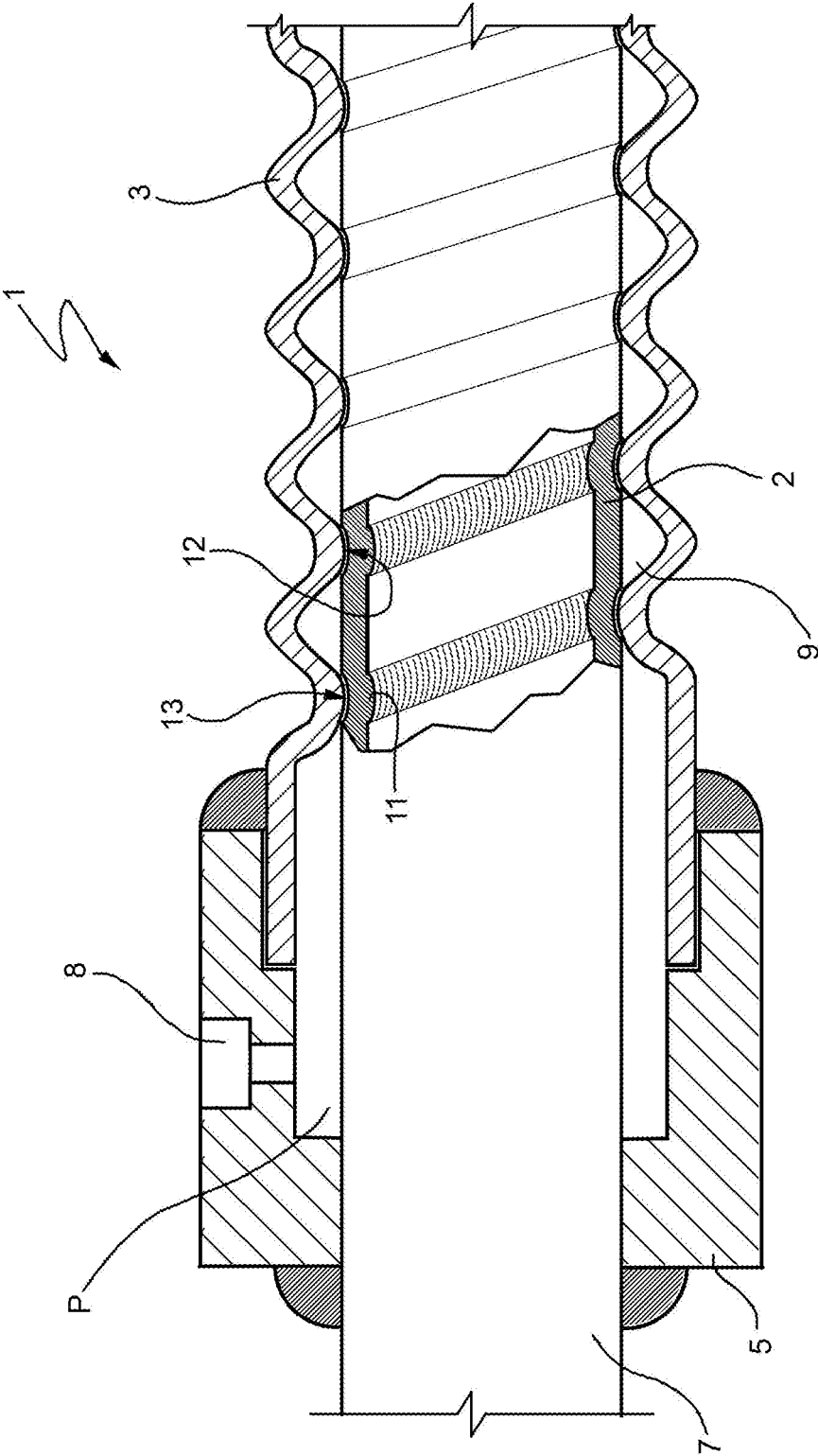
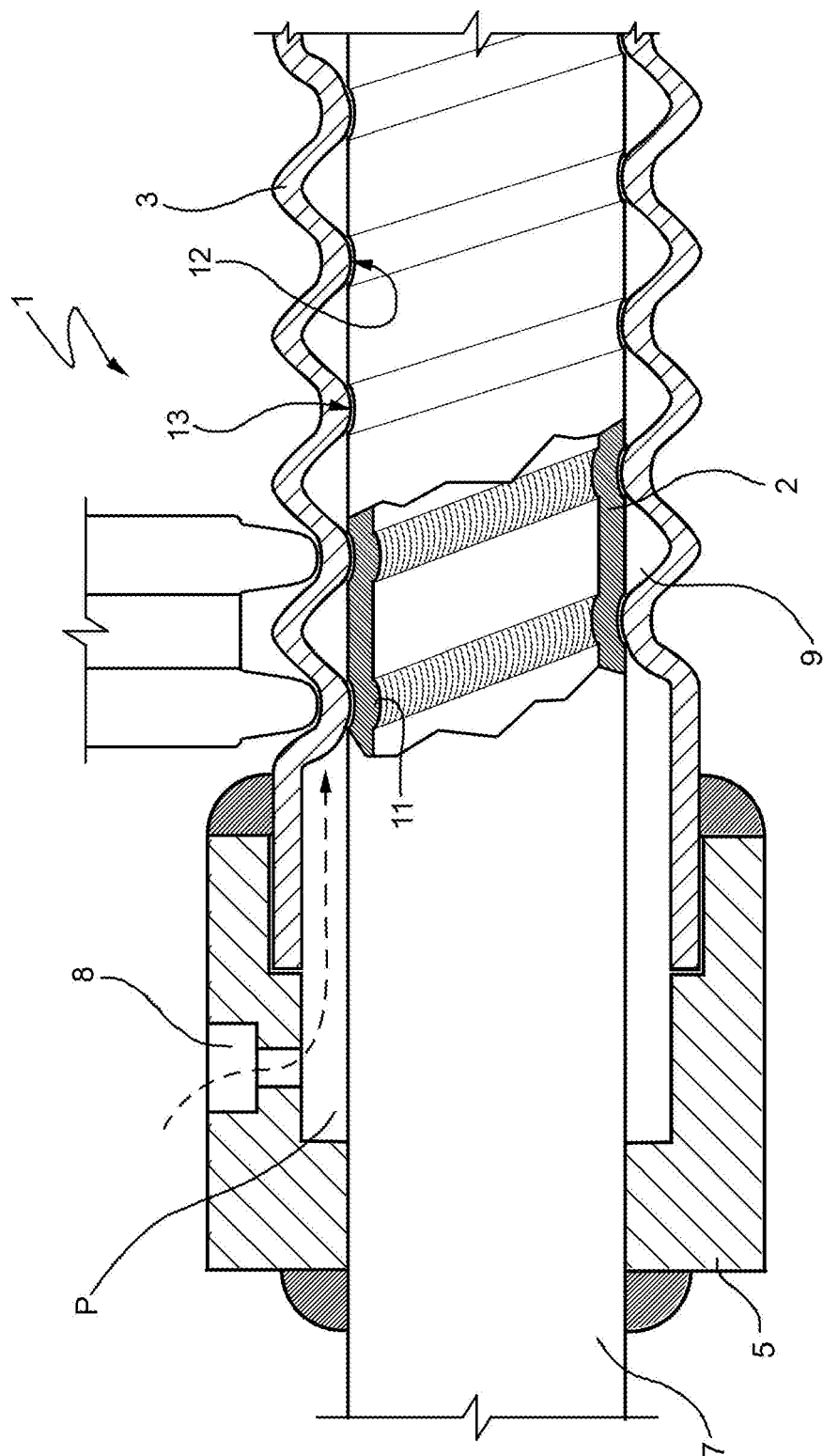


FIG. 2





EUROPEAN SEARCH REPORT

Application Number
EP 11 18 1723

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 16 January 2012	Examiner Vassoille, Bruno
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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