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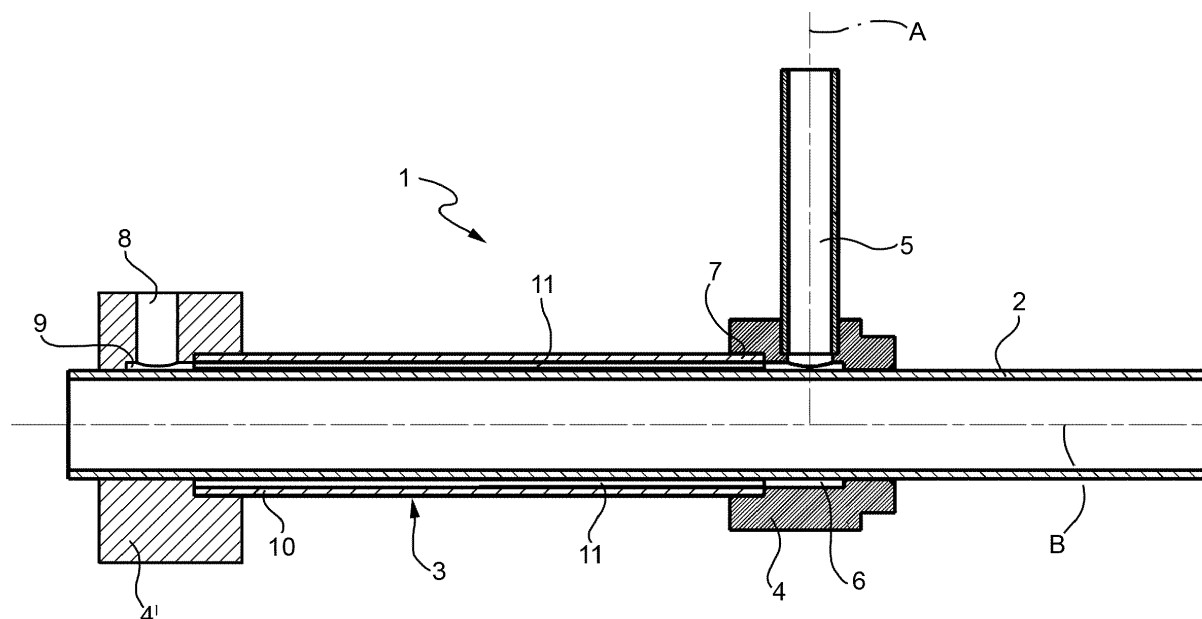
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(54) **Heat exchanger**

(57) A heat exchanger comprises a through pipe (2), a first flange (4) and a second flange (4'), which are traversed by said through pipe (2) and define, respectively, at least one inlet (5) and one outlet (8), and a sleeve (3), which houses at least partially in an axial direction the through pipe (2) and is fixed to the latter in a fluid-tight way via the first and second flanges (4, 4'). Moreover, a

plurality of channels (11) are defined at least partially between the through pipe (2) and the sleeve (3), a first annular chamber (6) is fluidically set between the channels (11) and the inlet (5), and a second annular chamber (9) is fluidically set between the channels (11) and the outlet (8). In particular, the hydraulic resistance (R1) of the channels (11) varies along the circumference for controlling the flowrate of fluid at inlet to each channel (11).

FIG. 1



Description

[0001] The present invention regards a heat exchanger in particular for an air-conditioning circuit of a vehicle.

[0002] Known to the art are heat exchangers for an air-conditioning circuit functioning in counter-current comprising a through central pipe and a sleeve mounted on the outside of the central pipe. Respective annular flanges block in a fluid-tight way the sleeve on the central pipe. A first heat-exchange circuit is defined between an inlet and an outlet delimited by the respective flanges and a plurality of channels defined between the central pipe and the sleeve. A second heat-exchange circuit is defined by the central pipe.

[0003] Flowing in said circuits is, for example, a cooling fluid; in particular, flowing in the outer sleeve is the hot fluid in the liquid state, whilst flowing in the central pipe is the cold fluid in the gaseous state. Between the two fluids there heat exchange takes place, which contributes to improving the cooling effect of the air-conditioning circuit.

[0004] For combined requirements of layout and reduction of costs, the inlet for the hot fluid in the liquid state can be set transverse to the connection flange, and the fluid tends to distribute in the first circuit in a non-uniform way in the annular chamber defined between the flange and the central pipe so that the efficiency of heat exchange is adversely affected.

[0005] The aim of the present invention is to provide a heat exchanger that will be free from the drawback specified above. The aim of the present invention is achieved via a heat exchanger according to Claim 1.

[0006] For a better understanding of the present invention a preferred embodiment is now described, purely by way of nonlimiting example, with reference to the attached drawings, wherein:

- Figure 1 is a longitudinal section of a heat exchanger according to the present invention;
- Figure 2 is a cross section of a component of Figure 1; and
- Figure 3 is a hydraulic diagram of the heat exchanger of Figure 1.

[0007] In Figure 1 designated as a whole by 1 is a heat exchanger comprising a through central pipe 2, an outer sleeve 3 mounted on the outside of the through central pipe 2, and a pair of annular flanges 4 and 4' traversed by the through central pipe 2 for anchorage to the latter of the outer sleeve 3.

[0008] In particular, the annular flange 4 defines both an inlet 5 having an axis A not aligned with respect to an axis B of the central pipe 2 and an annular chamber 6 at least together with a portion of the through central pipe 2. Moreover, the annular flange 4 is connected in a fluid-tight way both on the central pipe 2 and to an end portion 7 of the sleeve 3 to seal at least the annular chamber 6 towards the external environment.

[0009] Accordingly, the annular flange 4' defines both an outlet 8 having an axis preferably not coinciding with the axis B and an annular chamber 9 at least via a further portion of the through central pipe 2. Moreover, the annular flange 4' is connected in a fluid-tight way both on the central pipe 2 and to an end portion 10 of the sleeve 3 to seal at least the annular chamber 9 towards the external environment.

[0010] The annular chamber 6 is configured for distributing the incoming fluid into channels 11 defined in a radial direction by the through central pipe 2 and by the sleeve 3, and the annular chamber 9 functions as header so that the fluid will be directed towards the outlet 8.

[0011] Preferably (Figure 2), the channels 11 are delimited by side walls so as to have a variable cross section between one channel 11 and the adjacent one. Advantageously, if we designate by C a plane (the trace of which is represented in Figure 2) containing the axes A and B, the cross sections of the channels 11 are symmetrical with respect to the plane C as are the annular chambers 6 and 9. It may in fact be presumed that in said conditions the inlet flow is divided in a symmetrical way with respect to the plane C. To obtain a desired cross section, it is advantageous to keep the height constant and vary the width of the channels 11. Consequently, as illustrated in Figure 2, a width L1 of a channel 11 is equal to the width L1'.

[0012] According to a preferred embodiment, if we define a plane D passing through the axis B and perpendicular to the axis A and, in the case illustrated, also to the plane C, the channels 11 arranged on the same side of the inlet 5 with respect to the plane D have a smaller cross section than those arranged on the other half. In particular, the width L1, L1' is smaller than the width L2, L2'.

[0013] Advantageously, the annular chambers 6 and 9 are the same as one another, and the inlet 5 and the outlet 8 are coplanar and arranged on the same side of the plane D so as to provide a path that is balanced with respect to the plane C and symmetrical with respect to a plane perpendicular to the axis B and set in the middle between inlet 5 and outlet 8.

[0014] Even more preferably, the channels 11 have cross sections that increase progressively the further away they are, along the circumference, from the channel 11 the mouth portion of which is connected to the inlet 5 via the lowest hydraulic resistance. For example, said condition can be satisfied by the channel 11 having its mouth portion the middle of which defines with the middle of the inlet 5 the smallest angle where the middles are projected in a plane parallel to that of the cross section of Figure 2.

[0015] The production of a heat exchanger 1 in which the channels 11 have a variable cross section is particularly simple and presents contained costs in such a way as to adapt to the requirements of the automotive market. Likewise, the annular chambers have concentric cylindrical walls and preferably are the same as one another

so that the flanges 4, 4' can be easily obtained even via a process of cold plastic deformation. The sleeve 3 has a profile having rectilinear and parallel generatrices and can consequently advantageously be obtained by extrusion.

[0016] Figure 3 illustrates a hydraulic diagram of the heat exchanger 1 where each channel 11 defines a hydraulic resistance R1 of its own, and is connected to the inlet 5 and to the outlet 8 in such a way that it is possible to calculate respective equivalent hydraulic resistances R2 and R3, which, arranged according to the diagram of Figure 3, enable calculation of the division of flowrates itself between the channels 11, which can be measured and/or simulated numerically in a real heat exchanger.

[0017] The value of each hydraulic resistance is affected by numerous factors, which comprise the roughness of the wet surfaces and the geometry of the channels 11 and of the annular chambers 6 and 9. In particular, the value of the hydraulic resistance is the greater the smaller the area of the cross section of the corresponding channel 11.

[0018] Once the geometry of the annular chambers 6 and 9, the position of the single inlet 5 and of the single outlet 8, and the type of surface finish have been fixed, each resistance R2 and R3 is fixed, and each channel 11 is sized and/or has a roughness such that the sum R1, R2 and R3 for each duct is a pre-set constant.

[0019] In this way, the inlet flow divides in a substantially balanced way in each channel 11 without the marked asymmetries that may be encountered in heat exchangers with ducts having the same cross section. The efficiency of heat exchange is consequently improved.

[0020] According to the present embodiment, the heat exchanger has a configuration symmetrical with respect to the plane C. However, in the case where for layout requirements the flow at inlet into the annular chamber 6 has an asymmetrical component, for example of an inertial type, it is possible to take into account said asymmetry to balance the flowrate at inlet to each channel 11.

[0021] Alternatively, the asymmetrical component of the inlet flow can be due to the fact that the axes A and B are skew.

The resistances R2 and R3 corresponding to each channel 11 and that generate in the annular chambers 6 and 9 can be evaluated via computer simulations of fluid-dynamics using known programs available on the market.

[0022] Finally, it is clear that modifications or variations may be made to the heat exchanger 1 described and illustrated herein, without thereby departing from the sphere of protection as defined by the annexed claims.

[0023] In automotive applications in an air-conditioning circuit it is preferable for the inlet 5 to be single as likewise the outlet 8 for requirements of layout but in other automotive circuits it is possible for there to be present further inlets and/or further outlets.

[0024] Moreover, the number of channels 11 and the difference between the resistance R1 of one channel 11

and that of an adjacent channel 11 can be modified also as a function of geometrical parameters of the end product and of the lay-out of the system or of particular requirements of heat exchange and/or head loss. For example, it is possible for the resistances R1 not to be symmetrical with respect to a plane.

Claims

1. A heat exchanger comprising a through pipe (2), a first flange (4) and a second flange (4'), which are traversed by said through pipe (2) and define, respectively, at least one inlet (5) and one outlet (8), and a sleeve (3), which houses at least partially in an axial direction said through pipe (2) and is fixed to the latter in a fluid-tight way via said first and second flanges (4, 4'), a plurality of channels (11) being defined at least partially between said through pipe (2) and said sleeve (3), a first annular chamber (6) being fluidically set between said channels (11) and said at least one inlet (5), and a second annular chamber (9) being fluidically set between said channels (11) and said outlet (8), said heat exchanger being **characterized in that** the hydraulic resistance (R1) of said channels (11) varies along the circumference for controlling the flowrate of fluid at inlet into each channel (11).
2. The heat exchanger according to Claim 1, **characterized in that** the cross section of said channels (11) varies along the circumference.
3. The heat exchanger according to any one of the preceding claims, **characterized in that** said through pipe (2) and said inlet (5) have respective axes belonging to a first plane (C) and **in that** said channels (11) are symmetrical with respect to said plane (C).
4. The heat exchanger according to any one of the preceding claims, **characterized in that** the channels (11) arranged on the same side of said inlet (5) with respect to a second plane (D) perpendicular with respect to a first axis (A) of said inlet (5) and comprising a second axis (B) of said through pipe (2) have a hydraulic resistance (R1) higher than the channels (11) set on the opposite side of said inlet (5) with respect to said second plane (D).
5. The heat exchanger according to either Claim 3 or Claim 4, **characterized in that** said hydraulic resistances (R1) decrease starting from the channel (11) closest, along the circumference, to said inlet (5).
6. The heat exchanger according to any one of the preceding claims, **characterized in that** said first and second annular chambers (6, 9) are defined at least via concentric cylindrical surfaces.

7. The heat exchanger according to Claim 6, **characterized in that** said sleeve (3) has a profile defined via rectilinear and parallel generatrices.

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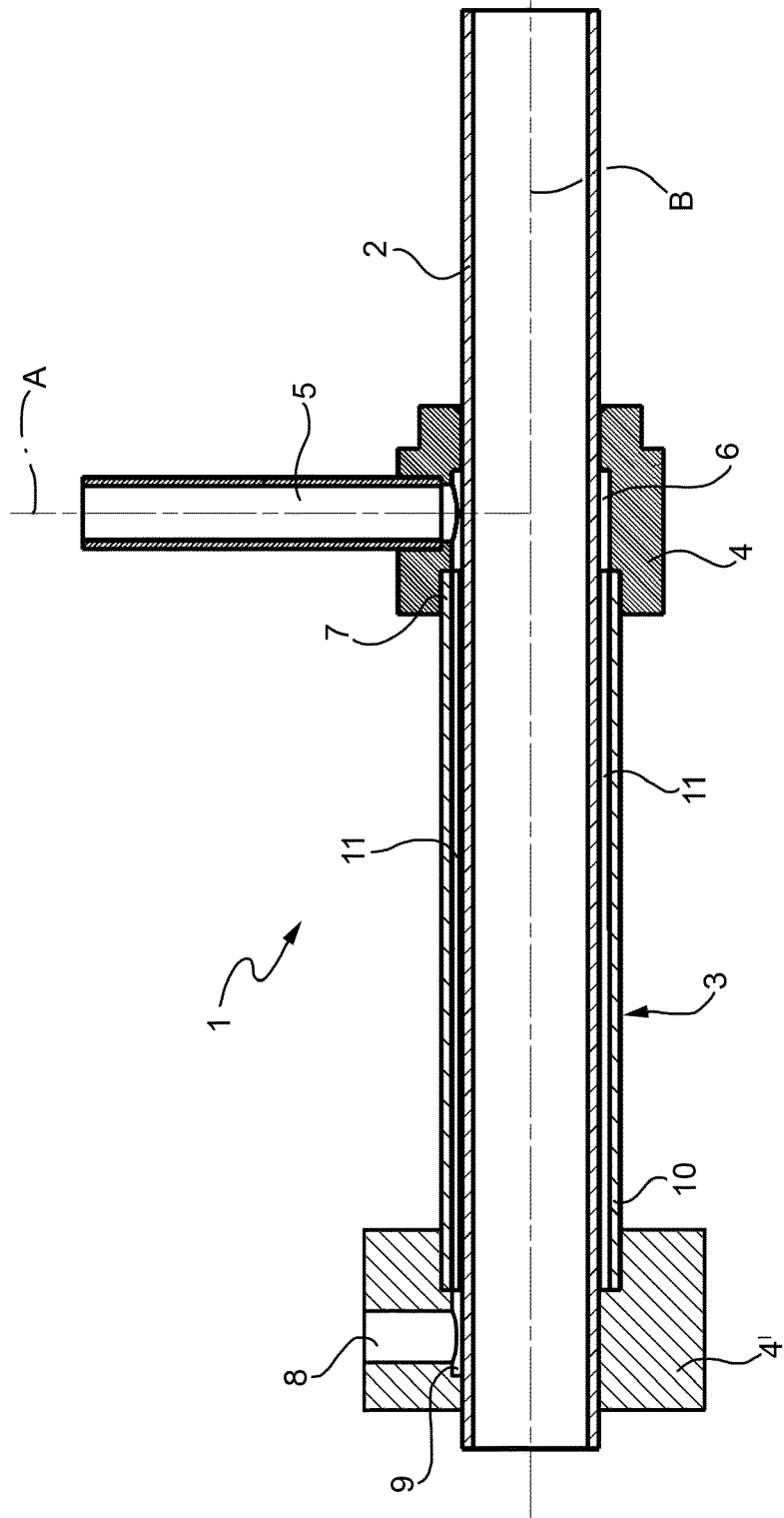


FIG. 1

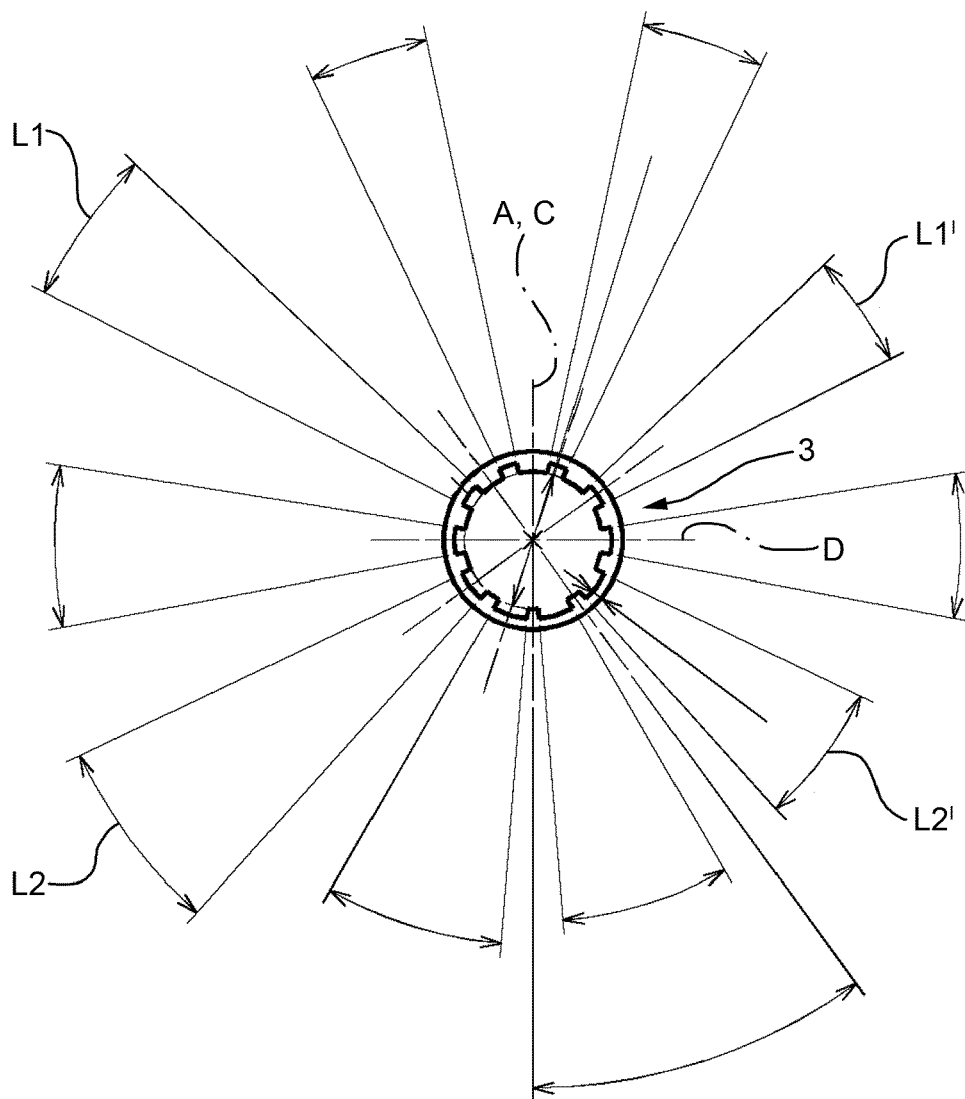


FIG. 2

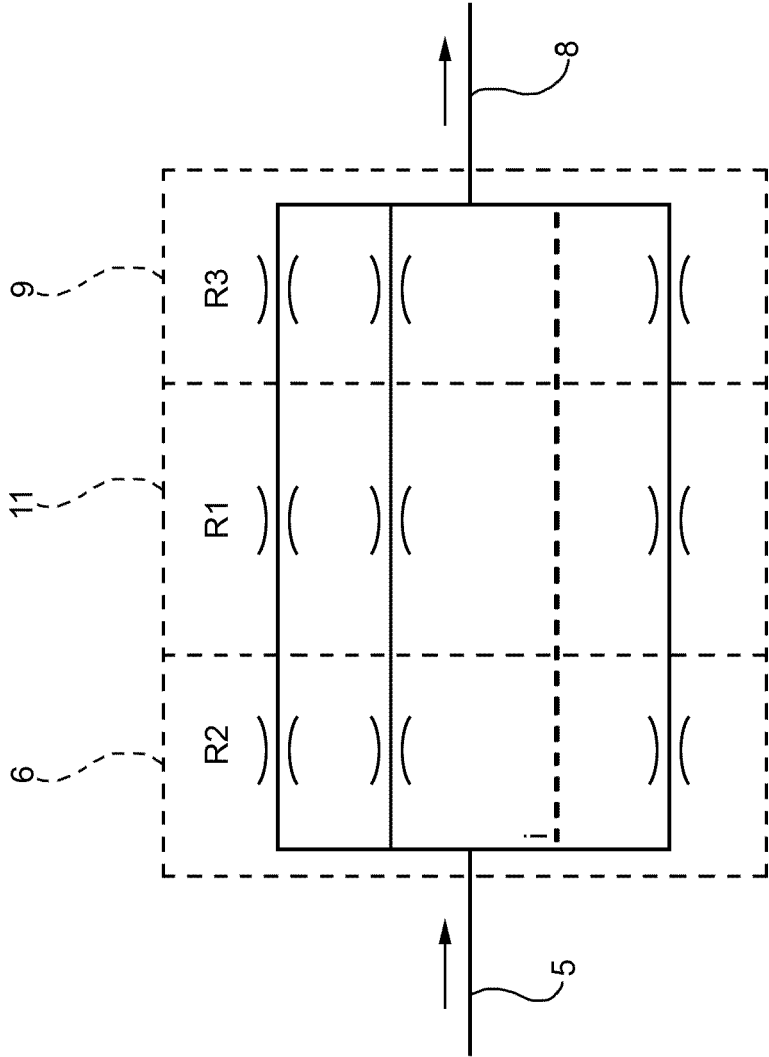


FIG. 3



EUROPEAN SEARCH REPORT

Application Number
EP 12 16 6612

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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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 25 July 2012	Examiner Bain, David
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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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 12 16 6612

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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