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(54) **A HEAT EXCHANGER**

(57) A heat exchanger (100) for a motor vehicle is disclosed. The heat exchanger (100) comprises a first manifold (102), a second manifold (104), the first manifold (102) and the second manifold (104) being configured for circulating at least one of a first fluid and a second fluid, and a plurality of tubes (112, 114) fluidically connected between the first manifold (102) and the second

manifold (104). At least one of the first manifold (102) and the second manifold (104) comprises at least one of a first canal (106) and a second canal (108) for ingress of at least one of the first fluid and the second fluid, and at least one of a third canal (110) and a fourth canal (117) for egress of at least one of the first fluid and the second fluid.

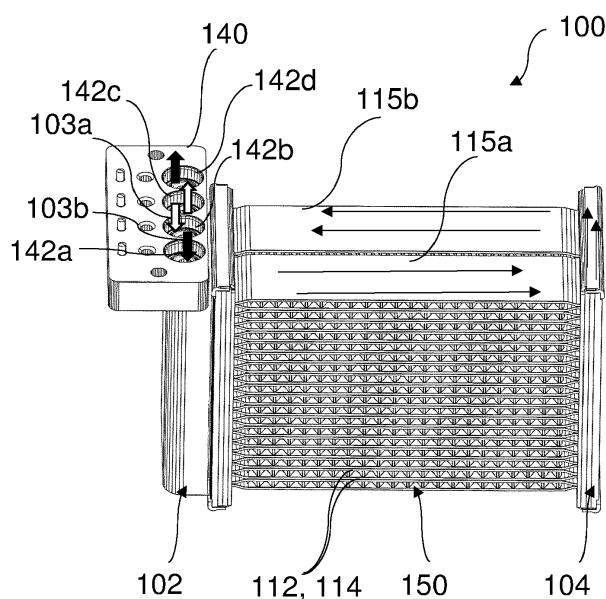


FIG. 1

Description

FIELD OF INVENTION

[0001] The present invention relates to a heat exchanger. More specifically, the present invention relates to an improved internal heat exchanger for a motor vehicle, which is able to withstand high fluid pressures.

BACKGROUND OF THE INVENTION

[0002] A vehicle is provided with several heat exchangers for example, an internal heat exchanger (IHx), an evaporator, a condenser, etc. The evaporator and the condenser are part of an air-conditioning (AC) loop or a part of HVAC system. These heat exchangers are used for heat exchange/transfer between two or more fluids/media. IHx is used to transfer heat between the low side pressure and the high pressure flow circuits. Its function is to improve system performance by further sub-cooling the refrigerant being supplied to the evaporator through the refrigerant control device.

[0003] A conventional heat exchanger typically includes a pair of manifolds, including a first manifold and a second manifold, configured at two opposite sides of the heat exchanger, and a heat exchanger core arranged between the pair of manifolds. The heat exchanger core is formed of a plurality of flat tubes (hereinafter, also referred to as tubes for simplicity) and fins arranged between outer surfaces of the adjacent tubes. Each tube has two opposite open ends which are inserted into respective tube insertion slots of a first header and a second header of the respective first manifold and the second manifold. Each of the first header and the second header in conjunction with a corresponding first tank and second tank define the first manifold and the second manifold for receiving and distributing the fluid/coolant to the tubes. One of the fluid/coolants flows from the first manifold to the second manifold through the plurality of tubes and the other fluid/air flows around and in a space between the tubes to enable heat exchange between the fluids.

[0004] It has been observed that when the fluid/coolant, which flow between the manifolds and in the tubes, is a high-pressure fluid, like R744 (CO₂) or R290 (propane), the heat exchanger has to be adapted accordingly. In particular, the high-pressure fluid imposes additional design constraints on the heat exchanger as the high pressure of the fluid necessitates higher mechanical resistance of heat exchanger components. Further, at the same time, efficiency requirements pose further demands on the heat exchanger. In addition, the existing heat exchangers are not capable to operate efficiently for the fluid/coolant operate at the high pressure, which can be up to 260 bar on the low-pressure side and up to 360 bar on the high-pressure side.

[0005] Therefore, there is a need of an efficient and cost-effective solution which can overcome abovementioned drawbacks of the conventional heat exchanger.

SUMMARY OF THE INVENTION

[0006] The present invention discloses a simple, efficient, light, and economical internal heat exchanger (hereinafter, also referred to as heat exchanger) for a motor vehicle, which is able to withstand high fluid pressures, which can be up to 260 bar on the low-pressure side and up to 360 bar on the high-pressure side, for high-pressure cooling system. The proposed high-pressure heat exchanger offers efficient operation without sacrificing its mechanical resistance, and which thus is safe to operate.

[0007] In accordance with an embodiment of the present invention, the disclosed heat exchanger includes a first manifold, a second manifold configured spaced apart from the first manifold, the first manifold and the second manifold being configured for circulating at least one of a first fluid and a second fluid, and a plurality of tubes fluidically connected between the first manifold and the second manifold. At least one of the first manifold and the second manifold comprises at least one of a first canal and a second canal for ingress of at least one of the first fluid and the second fluid. In addition, at least one of the first manifold and the second manifold comprises at least one of a third canal and a fourth canal for egress of at least one of the first fluid and the second fluid.

[0008] At least one of the first canal and the second canal, and at least one of the third canal and the fourth canal are configured such that at least one of the first fluid and the second fluid follow U-path through the heat exchanger.

[0009] At least one of the first manifold and the second manifold can include one or more first openings to fluidically connect the first canal to one or more tubes of the plurality of tubes, and one or more second openings to fluidically connect the second canal to one or more tubes of the plurality of tubes.

[0010] In addition, at least one of the first manifold and the second manifold can include one or more third openings to fluidically connect the third canal to one or more tubes of the plurality of tubes, and one or more fourth openings to fluidically connect the fourth canal to one or more tubes of the plurality of tubes.

[0011] The plurality of tubes are arranged in two adjacent tube rows between the first manifold and the second manifold. Each of the tube rows of tubes comprises at least one set of first tubes and at least one set of second tubes.

[0012] Each of at least one set of first tubes and at least one set of second tubes comprises at least two tubes. In addition, each tube of the plurality of tubes comprises an intermediate flat tube section, two opposite tube end sections, and two tube bend sections between the intermediate flat tube section and the two opposite tube end sections.

[0013] Further, the two tubes of each of at least one set of first tubes and at least one set of second tubes are configured such that the intermediate tube sections of

the two tubes extend substantially in a parallel and spaced manner to each other and the tube end sections are stacked on each other in a corresponding single tube slot of the corresponding manifold. Besides, spacers are provided in a gap between at least two tubes of each of at least one set of first tubes and at least one set of second tubes.

[0014] In addition, in each of the tube rows, at least one set of first tubes and at least one set of second tubes are arranged one above another in an alternate manner such that the intermediate flat tube sections of neighboring tubes of at least one set of first tubes and at least one set of second tubes abut with each other.

[0015] A first fluid circuit is defined through the first manifold, the second manifold, and the sets of first tubes arranged in the two adjacent tube rows.

[0016] A second fluid circuit is defined through the first manifold, the second manifold, and the sets of second tubes arranged in the two adjacent tube rows.

[0017] The first manifold can include a first header plate, a first cover, and one or more first internal plates with first slots configured between the first header plate and the first cover.

[0018] The second manifold can include a second header plate, a second cover, and one or more second internal plates with second slots configured between the second header plate and the second cover.

[0019] Furthermore, the disclosed heat exchanger comprises at least one connection block connected to at least one of the first manifold and the second manifold. At least one connection block comprises one or more ports.

[0020] In the present description, some elements or parameters may be indexed, such as a first element and a second element. In this case, unless stated otherwise, this indexation is only meant to differentiate and name elements which are similar but not identical. No idea of priority should be inferred from such indexation, as these terms may be switched without betraying the invention. Additionally, this indexation does not imply any order in mounting or use of the elements of the invention.

BRIEF DESCRIPTION OF DRAWINGS

[0021] Other characteristics, details and advantages of the invention may be inferred from the description of the invention hereunder. A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying figures, wherein:

FIG. 1 illustrates an isometric view of a heat exchanger with two U-flow passages where fluids are flowing in co-flow, in accordance with an embodiment of the present invention;

FIG. 2 illustrates a core of the heat exchanger of FIG. 1;

FIG. 3 illustrates a tube of the heat exchanger of FIG. 1;

FIG. 4 illustrates a set of tubes of the heat exchanger of FIG. 1;

FIG. 5 illustrates an arrangement of a set of first tubes and a set of second tubes of the heat exchanger of FIG. 1;

FIG. 6 illustrates an isometric view of a first manifold with a connecting block of the heat exchanger of FIG. 1;

FIG. 7 illustrates an exploded view of a first manifold with a connecting block of the heat exchanger of FIG. 1;

FIG. 8 illustrates an isometric view of a second manifold of the heat exchanger of FIG. 1;

FIG. 9 illustrates an exploded view of a second manifold of the heat exchanger of FIG. 1; and

FIG. 10 illustrates an isometric view of a heat exchanger with two U-flow passages where fluids are flowing in counter flow, in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0022] It must be noted that the figures disclose the invention in a detailed enough way to be implemented, said figures helping to better define the invention if needs be. The invention should however not be limited to the embodiment disclosed in the description.

[0023] The present invention is explained in the forthcoming description and the accompanying drawings with an example of internal heat exchanger for an air conditioning system and/or a cooling system of a motor vehicle. More specifically, the present invention discloses a simple, light, and cost efficient internal heat exchanger that is able to withstand high fluid pressures, which can be up to 260 bar on the low-pressure side and up to 360 bar on the high-pressure side, for high-pressure cooling systems. In addition, the heat exchanger is adapted to exchange heat between refrigerants from low pressure side and high pressure side of a cooling loop to increase efficiency of the cooling loop of the air conditioning system and/or cooling system.

[0024] It is to be appreciated that the concept of the present invention is applicable for any other application in vehicular and non-vehicular environment, where it is required to provide a heat exchanger that can withstand high coolant/fluid pressures flow and perform efficiently.

[0025] Referring to FIG. 1 and FIG. 2, in accordance with an embodiment, the present invention discloses an internal heat exchanger 100 that includes a first manifold 102, a second manifold 104 configured spaced apart on two opposite sides of a heat exchanger core 150 which fluidically connects the first manifold 102 and the second manifold 104. The heat exchanger core 150 includes a plurality of tubes 112 and 114 fluidically connected between the first manifold 102 and the second manifold 104 to enable circulation of at least one of a first fluid and a second fluid between the first manifold 102 and the second manifold 104. For instance, the first fluid and/or the second fluid can be a natural refrigerant such as, but not limited to, R744 (CO₂) or R290 (propane). To receive and/or distribute at least one of the first fluid and the second fluid through the plurality of tubes 112 and 114, at least one of the first manifold 102 and the second manifold 104 comprises at least one of a first canal 106 and a second canal 108 for ingress of at least one of the first fluid and the second fluid, and at least one of a third canal 110 and a fourth canal 117 for egress of at least one of the first fluid and the second fluid.

[0026] In addition, the plurality of tubes 112 and 114 of the heat exchanger core 150 are arranged in two adjacent tube rows 115a and 115b between the first manifold 102 and the second manifold 104. Each of the tube rows 115a and 115b comprises at least one set of first tubes 112 and at least one set of second tubes 114. In each of the tube rows 115a and 115b, the sets of first tubes 112 and the sets of second tubes 114 are arranged one above another in an alternate manner, as shown in FIG. 2. Besides, each of at least one set of first tubes 112 and at least one set of second tubes 114 comprises at least two tubes. In addition, spacers 118 are provided in a gap between the two tubes of each sets of tubes 112/114. The spacers/fillers 118 between tubes of each set of tubes 112/114 are adapted to ensure contact between the tubes 112/114. The spacers/fillers 118 between each set of tubes 112/114 can reinforce the corresponding set of tubes 112/114. The spacers 118 can be of different shapes such as but not limited to corrugated, rectangular, triangular, trapezoidal, and the like. In addition, the spacers 118 can disrupt the air flowing across the core 150 in order to improve the heat exchange of air with the first and/or the second fluids flowing through the tubes 112 and 114.

[0027] In an embodiment, the plurality of tubes 112 and 114 can be extruded tubes with micro ports, i.e., the plurality of tubes 112 and 114 can include micro channels extending along lengths of the tubes. For instance, a material of the plurality of tubes 112 and 114 and the spacers 118 can be aluminum, aluminum alloy or any other suitable alloy.

[0028] In an embodiment, extreme upper and lower tubes 112/114, i.e. external tubes, of the core 150 can be blind tubes to avoid transfer of fluid through the tubes which are not in contact with another tube of adjacent set of tubes.

[0029] Besides, the first canal 106, the second canal 108, the third canal 110, and the fourth canal 117 can be configured such that at least one of the first fluid and the second fluid follow U-path through the core 150 or the heat exchanger 100.

[0030] In an embodiment, the first canal 106, the second canal 108, the third canal 110, and the fourth canal 117 can be provided in the first manifold 102.

[0031] In another embodiment, the first canal 106, the second canal 108, the third canal 110, and the fourth canal 117 can be provided in the second manifold 104.

[0032] In another embodiment, the first canal 106 and the third canal 110 can be provided in the first manifold 102, and the second canal 108 and the fourth canal 117 can be provided in the second manifold 104.

[0033] In another embodiment, the first canal 106 and the third canal 110 can be provided in the second manifold 104, and the second canal 108 and the fourth canal 117 can be provided in the first manifold 102.

[0034] In addition, referring to FIG. 2 to FIG. 5, each tube of the plurality of tubes 112 and 114, i.e., each of the first tubes 112 and the second tubes 114, comprises an intermediate flat tube section 116a, two opposite tube end sections 116c, and two tube bend sections 116b between the intermediate flat tube section 116a and the two opposite tube end sections 116c. Each of the tube bend sections 116b comprises two opposite turns connected to the respective end of the intermediate flat tube section 116a and the tube end section 116c, which enable offset arrangement of the intermediate flat tube section 116a with respect to the tube end sections 116c.

[0035] Further, when the two tubes 112/114 of each of sets of first tubes 112 and the sets of second tubes 114 are configured with concavities of the tubes 112/114 facing each other the intermediate flat tube sections 116a of the two tubes 112/114 extend substantially in a parallel and spaced manner to each other and the tube end sections 116c are stacked on each other. Opposite tube end sections 116c of the two tubes 112/114 of each of the sets of first tubes 112 and the sets of second tubes 114 are configured to be received in the corresponding single tube slot 126 of the manifold/ 102/104. Furthermore, this arrangement of the tubes end sections 116c of the two tube in single tube slot 126 of the respective manifold 102/104 help to mechanically strengthen the proposed heat exchanger 100 by reducing the number of required tube slots 126 in the manifolds 102 and 104 and increases a gap between two adjacent tube slots 126 along the length of the respective manifold 102/104 in comparison to number of slots required and a gap between two adjacent slots in the conventional heat exchanger with same number of flat tubes.

[0036] In addition, in area between the tubes 112/114 connected to the same tube slot 126 of the manifold 102/104, due to geometry of the tubes 112 /114, free space is created between the intermediate flat tube sections 116a, which can be filled by the spacers 118 to make assembly and brazing process easier. The spacers

118 can be a component help in increasing heat exchange with air and the fluids flowing through the tubes 112 and 114.

[0037] In an embodiment, in each tube row 115a/ 115b, the set of first tubes 112 and set of second tubes 114 are arranged one above another in an alternate manner such that the intermediate flat tube sections 116a of neighboring tubes of the set of first tubes 112 and the set of second tubes 114 abut with each other. This contact between the intermediate flat tube sections 116a of neighboring tubes of the sets of first tubes 112 and the sets of second tubes 114 allows heat exchange between the fluids, such as the first fluid and/or the second fluid, flowing through the sets of first tubes 112 and the sets of second tubes 114.

[0038] In an embodiment, the first fluid and the second fluid can be same refrigerant fluid.

[0039] In another embodiment, the first fluid and the second fluid can be different refrigerant fluids.

[0040] For instance, the sets of first tubes 112 can be connected to odd number of tube slots 126 of the manifolds 102 and 104, and the sets of second tubes 114 can be connected to even number of tube slots 126 of the manifolds 102 and 104, or vice versa.

[0041] In addition, the first fluid can circulate through the sets of first tubes 112 and the second fluid can circulate through the sets of second tubes 114, or vice versa.

[0042] Further, a first fluid circuit can be defined through the first manifold 102, the second manifold 104, the sets of first tubes 112 arranged in the two adjacent tube rows 115a and 115b. In addition, a second fluid circuit can be defined through the first manifold 102, the second manifold 104, and the sets of second tubes 114 arranged in the two adjacent tube rows 115a and 115b.

[0043] In an exemplary embodiment, the disclosed heat exchanger 100 can be implemented between a low-pressure side, e.g. evaporator, and a high-pressure side, e.g. gas cooler, of a cooling loop of a vehicle. For instance, for the heat exchanger with two U-flow passages, as shown in FIG. 1 and FIG. 10, any of the low pressure side and the high pressure side of the cooling loop can be connected on any of the U-flow passages/ fluid circuits of the heat exchanger 100 to receive the low pressure refrigerant and the high pressure refrigerant, wherein during the flow in the core 150, the heat exchange occurs between the low pressure refrigerant and the high pressure refrigerant as the temperature of the high pressure refrigerant is more than the temperature of the low pressure refrigerant.

[0044] In another embodiment, the spacers 118 or metallic foils, such as aluminum foils, can be provided between the two adjacent sets of tubes, such as between the set of first tubes 112 and the set of second tubes 114. In this case, the neighboring tubes 112 and 114 of the set of first tubes 112 and the set of second tubes 114 can be in contact with each other through the spacers 118 or metallic foils indirectly to exchange heat between the fluids flowing through the set of first tubes 112 and

the set of second tubes 114.

[0045] In an embodiment, referring to FIG. 6 and FIG. 7, the first manifold 102 can include a first header plate 120, a first cover 124, and one or more first internal plates 122 configured between the first header plate 120 and the first cover 124. The first header plate 120 can include two rows of adjacent tube slots 126 configured along length of the first header plate 120. The first internal plates 122 can also include two rows of adjacent first slots 123 corresponding to the tube slots 126 of the first header plate 120. The first cover 124 can include the first canal 106 and the second canal 108, on an outer side and extending along length of the first cover 124, for ingress of at least one of the first fluid and the second fluid. In addition, the first cover 124 can also include a third canal 110 and a fourth canal 117, on an outer side and extending along length of the first cover 124, for egress of at least one of the first fluid and the second fluid.

[0046] Further, the first cover 124 can include one or more first openings, such as openings 107 on a side, i.e. inner side, which is opposite to the outer side and configured along the length of the first cover 124 with a gap between the adjacent first openings 107, and one or more second openings, such as openings 109, on the inner side and configured along the length of the first cover 124 with a gap between the adjacent second openings 109. The first openings 107 and second openings 109 of the first cover 124 are offset from each other. In an embodiment, the first openings 107 are adapted to fluidically connect the first canal 106 with the sets of tubes 112/114, in the tube row 115a, fitted to even number of tube slots 126 of the first header plate 120, whereas the second openings 109 are adapted to fluidically connect the canal 108 with the tubes 112/114, in the tube row 115a, fitted to odd number of tube slots 126 of the first header plate 120. For instance, the first openings 107 can be configured to fluidically connect the first canal 106 to the sets of second tubes 114 arranged in the tube row 115a through the slots 123 and 126 of the internal plates 122 and the first header plate 120, whereas the second openings 109 can be configured to fluidically connect the second canal 108 to the sets of first tubes 112 arranged in the tube row 115a through the slots 123 and 126 of the internal plates 122 and the header plate 120.

[0047] Furthermore, the first cover 124 can include one or more third openings, such as openings 111, on the inner side and configured along the length of the first cover 124 with a gap between the adjacent third openings 111, and one or more fourth openings, such as openings 113, on the inner side and configured along the length of the first cover 124 with a gap between the adjacent fourth openings 113. The third openings 111 and the fourth openings 113 are offset from each other. In an embodiment, the third openings 111 are adapted to fluidically connect the third canal 110 with the sets of tubes 112/114, in the tube row 115b, fitted to even number of tube slots 126 of the first header plate 120, whereas the fourth openings 113, are adapted to fluidically connect

the fourth canal 117 with the sets of tubes 112/114, in the tube row 115b, fitted to odd number of tube slots 126 of the first header plate 120. For instance, the third openings can be configured to fluidically connect the third canal 110 to the sets of second tubes 114 arranged in the tube row 115b through the slots 123 and 126 of the internal plates 122 and the header plate 120, whereas the fourth openings 113 can be configured to fluidically connect the fourth canal 117 to the sets of first tubes 112 arranged in the tube row 115b through the slots 123 and 126 of the internal plates 122 and the header plate 120.

[0048] In another embodiment, the first openings 107 and the third openings 111 can be arranged adjacent to each other, and the second openings 109 and the fourth openings 113 can be arranged adjacent to each other.

[0049] In an embodiment, numbers of the first openings 107, second openings 109, third openings 111 and the fourth openings 113 can be same or different, based on requirement.

[0050] In an embodiment, the second manifold 104 can include a second header plate 130, a second cover 134, and one or more second internal plates 132 configured between the second header plate 130 and the second cover 134, as shown in FIG. 8 and FIG. 9. The second header plate 130 includes two rows of adjacent tube slots 126 configured along length of the first header plate 120. The second internal plates 132 can also include second slots 133 configured along length of the second inner plates 133.

[0051] In another embodiment, the first cover 124 and the first internal plates 122 can be a single integral part, and the openings 107, 109, 111 and 113, and the slots 123 can be formed on the first cover 124 through machining process. Further, the machined first cover can be connected directly to the first header plate 120. Similarly, the second cover 134 and the second internal plates 132 can be a single integral part, and the slots 133 can be formed on the second cover 134 through machining process. Further, the machined second cover can be connected directly to the second header plate 130.

[0052] In addition, for instance, all canals 106, 108, 110, and 117 are provided on same side or on single manifold 102, and the second manifold 104 is simple in construction, which can be easily manufactured. For instance, the first manifold 102 need to be made from extrusion process and machining process, the second manifold 104 can be made from stamped plates, which may reduce the manufacturing of the heat exchanger 100.

[0053] In another embodiment, as shown in FIG. 1 and FIG. 10, a connection block 140 is connected to the first manifold 102. The connection block 140 can include ports 142a, 142b, 142c, and 142d fluidically connected to the canals 106, 108, 110 and 117 of the first cover 124.

[0054] In an embodiment, the connection block 140 can be made of same material, such as but not limited to aluminum or aluminum alloy, of the first cover 124.

[0055] In another embodiment, the heat exchanger 100 may comprise more than one connection blocks, for

instance two, or three, or four connection blocks with ports, which can be connected on one or both top and bottom sides, and/or even on lateral sides, of the respective manifold 102/104.

[0056] In an embodiment, the components, such as the tubes 112 and 114, manifolds 102 and 104, and spacers 118, connection block 140, and other elements of the heat exchanger can be joined to each other through one or more joining processes selected from a group of processes including brazing, welding, gluing and the like.

[0057] In an embodiment, as shown in FIG. 1, the first fluid (indicated by arrow 103a) enters through the port 142b of the connection block 140 into the first manifold 102, travel through the sets of first tubes 112 arranged in the tube row 115a, reach the second manifold 104 and then return through the sets of first tubes 112 arranged in other tube row 115b to the first manifold 102, and further the first fluid egress the heat exchanger 100 through the port 142c of the connection block 140 connected to the first manifold 102. Whereas the second fluid (indicated by arrow 103b) enters through the port 142a of the connection block 140 into the first manifold 102, travel through the sets of second tubes 114 arranged in the tube row 115a, reach the second manifold 104 and then return through the sets of second tubes 114 arranged in other tube row 115b to the first manifold 102, and further the second fluid egress the heat exchanger 100 through the port 142d of the connection block 140 connected to the first manifold 102. Thus, the first fluid and the second fluid can travel through the heat exchanger 100 in co-flow. In addition, in this case, heat exchange between the first fluid and the second fluid also occurs in the first manifold 102 in addition to heat exchange in the core 150.

[0058] In an embodiment, as shown in FIG. 10, the first fluid (indicated by arrow 103a) enters through the port 142c of the connection block 140 into the first manifold 102, travel through the sets of first tubes 112 arranged in the tube row 115b, reach the second manifold 104 and then return through the sets of first tubes 112 arranged in other tube row 115a to the first manifold 102, and further the first fluid egress the heat exchanger 100 through the port 142b of the connection block 140 connected to the first manifold 102. Whereas the second fluid (indicated by arrow 103b) enters through the port 142a of the connection block 140 into the first manifold 102, travel through the sets of second tubes 114 arranged in the tube row 115a, reach the second manifold 104 and then return through the sets of second tubes 114 arranged in other tube row 115b to the first manifold 102, and further the second fluid egress the heat exchanger 100 through the port 142d of the connection block 140 connected to the first manifold 102. Thus, the first fluid and the second fluid can travel through the heat exchanger 100 in counter flow. In addition, in this case, heat exchange between the first fluid and the second fluid also occurs in the first manifold 102 in addition to heat exchange in the core 150.

[0059] In any case, the invention cannot and should not be limited to the embodiments specifically described

in this document, as other embodiments might exist. The invention shall spread to any equivalent means and any technically operating combination of means.

Claims

1. A heat exchanger (100) for a motor vehicle comprising:

a first manifold (102);
 a second manifold (104) configured spaced apart from the first manifold (102), the first manifold (102) and the second manifold (104) being configured for circulating at least one of a first fluid and a second fluid; and
 a plurality of tubes (112, 114) fluidically connected between the first manifold (102) and the second manifold (104);
characterized in that at least one of the first manifold (102) and the second manifold (104) comprises:

at least one of a first canal (106) and a second canal (108) for ingress of at least one of the first fluid and the second fluid; and
 at least one of a third canal (110) and a fourth canal (117) for egress of at least one of the first fluid and the second fluid.

2. The heat exchanger (100) as claimed in the previous claim, wherein at least one of the first canal (106) and the second canal (108), and at least one of the third canal (110) and the fourth canal (117) are configured such that at least one of the first fluid and the second fluid follow U-path through the heat exchanger (100).
3. The heat exchanger (100) as claimed in any of the previous claims, wherein at least one of the first manifold (102) and the second manifold (104) comprises one or more first openings (107) to fluidically connect the first canal (106) to one or more tubes of the plurality of tubes (112, 114), and one or more second openings (109) to fluidically connect the second canal (108) to one or more tubes of the plurality of tubes (112, 114).
4. The heat exchanger (100) as claimed in any of the previous claims, wherein at least one of the first manifold (102) and the second manifold (104) comprises one or more third openings (111) to fluidically connect the third canal (110) to one or more tubes of the plurality of tubes (112, 114), and one or more fourth openings (113) to fluidically connect the fourth canal (117) to one or more tubes of the plurality of tubes (112, 114).

5. The heat exchanger (100) as claimed in any of the previous claims, wherein the plurality of tubes (112, 114) are arranged in two adjacent tube rows (115a, 115b) between the first manifold (102) and the second manifold (104), wherein each of the tube rows (115a, 115b) comprises at least one set of first tubes (112) and at least one set of second tubes (114).
6. The heat exchanger (100) as claimed in any of the previous claims, wherein each of at least one set of first tubes (112) and at least one set of second tubes (114) comprises at least two tubes.
7. The heat exchanger (100) as claimed in any of the previous claims, wherein each tube of the plurality of tubes (112, 114) comprises an intermediate flat tube section (116a), two opposite tube end sections (116c), and two tube bend sections (116b) between the intermediate flat tube section (116a) and the two opposite tube end sections (116c).
8. The heat exchanger (100) as claimed in any of the previous claims, wherein at least two tubes of each of at least one set of first tubes (112) and at least one set of second tubes (114) are configured such that the intermediate flat tube sections (116a) of at least two tubes extend substantially in a parallel and spaced manner to each other and the tube end sections (116c) are stacked on each other in a corresponding single tube slot (126) of the corresponding manifold (102, 104).
9. The heat exchanger (100) as claimed in any of the previous claims, wherein spacers (118) are provided in a gap between at least two tubes of each of at least one set of first tubes (112) and at least one set of second tubes (114).
10. The heat exchanger (100) as claimed in any of the previous claims, wherein, in each of the tube rows (115a, 115b), at least one set of first tubes (112) and at least one set of second tubes (114) are arranged one above another in an alternate manner such that the intermediate flat tube sections (116a) of neighboring tubes of at least one set of first tubes (112) and at least one set of second tubes (114) abut with each other.
11. The heat exchanger (100) as claimed in any of the previous claims, wherein a first fluid circuit is defined through the first manifold (102), the second manifold (104), and the sets of first tubes (112) arranged in the two adjacent tube rows (115a, 115b).
12. The heat exchanger (100) as claimed in any of the previous claims, wherein a second fluid circuit is defined through the first manifold (102), the second manifold (104), and the sets of second tubes (114).

arranged in the two adjacent tube rows (115a, 115b).

13. The heat exchanger (100) as claimed in any of the previous claims, wherein the first manifold (102) includes a first header plate (120), a first cover (124), and one or more first internal plates (122) with first slots (123) configured between the first header plate (120) and the first cover (124). 5
14. The heat exchanger (100) as claimed in any of the previous claims, wherein the second manifold (104) includes a second header plate (130), a second cover (134), and one or more second internal plates (132) with second slots (133) configured between the second header plate (130) and the second cover (134). 10 15
15. The heat exchanger (100) as claimed in any of the previous claims, further comprises at least one connection block (140) connected to at least one of the first manifold (102) and the second manifold (104), wherein at least one connection block (140) comprises one or more ports (142a, 142b, 142c, 142d). 20

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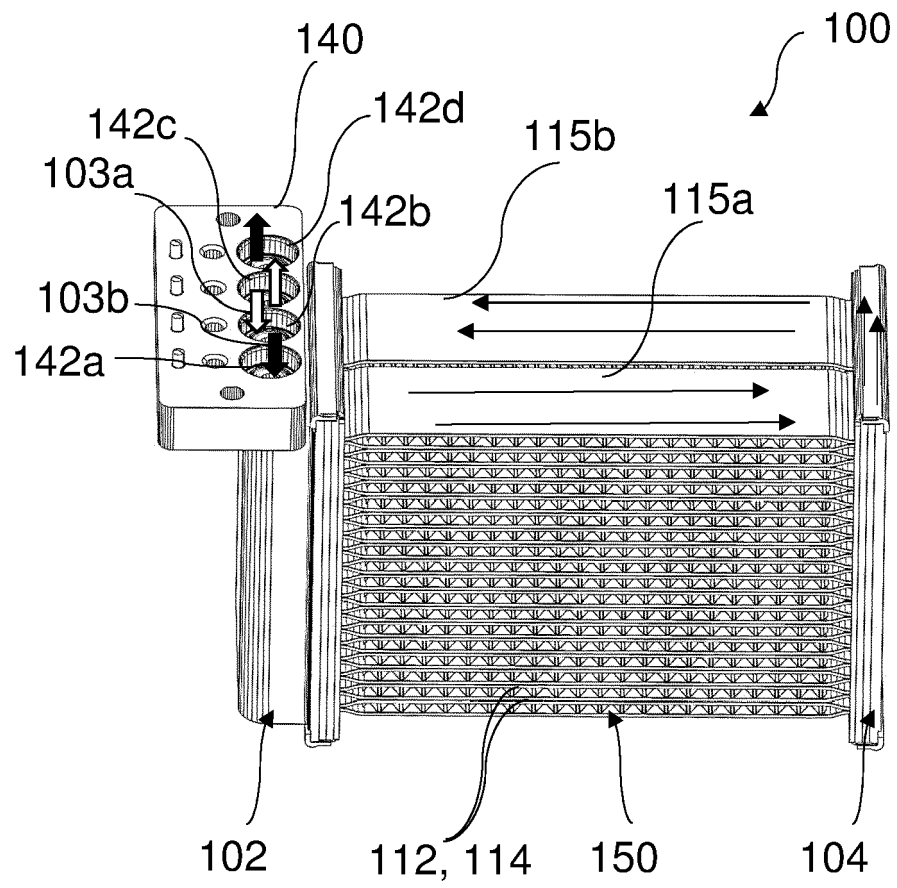


FIG. 1

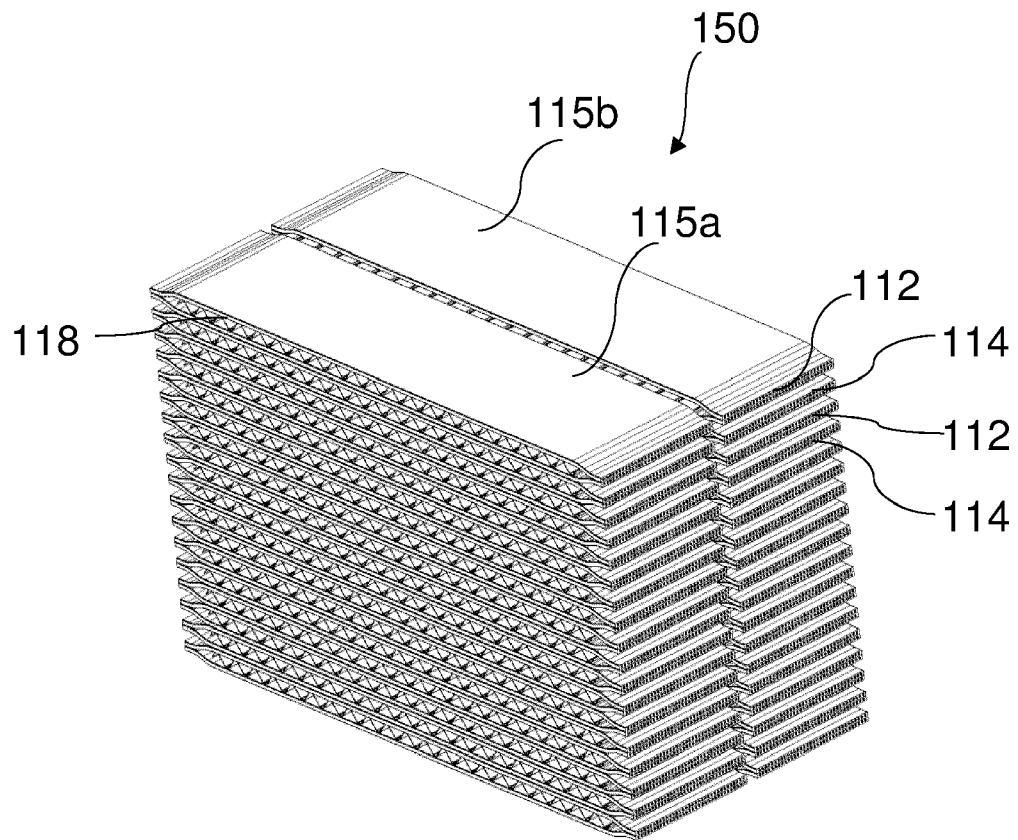


FIG. 2

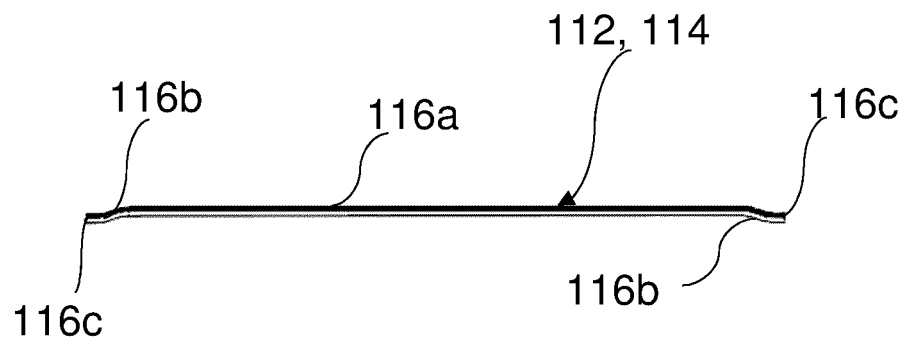


FIG. 3

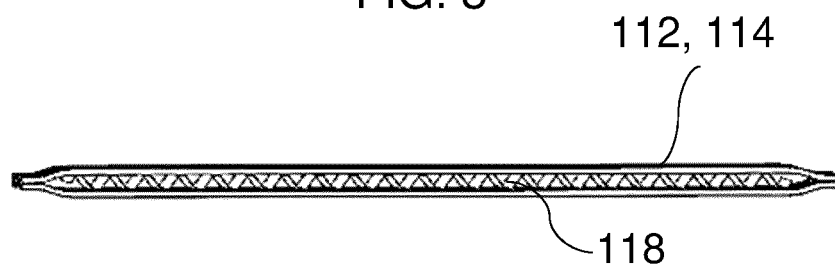


FIG. 4

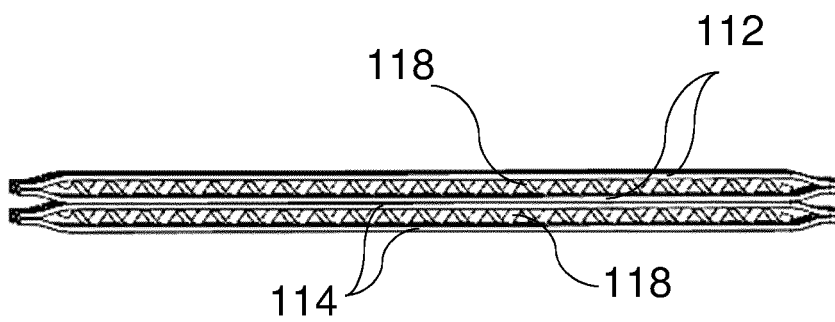


FIG. 5

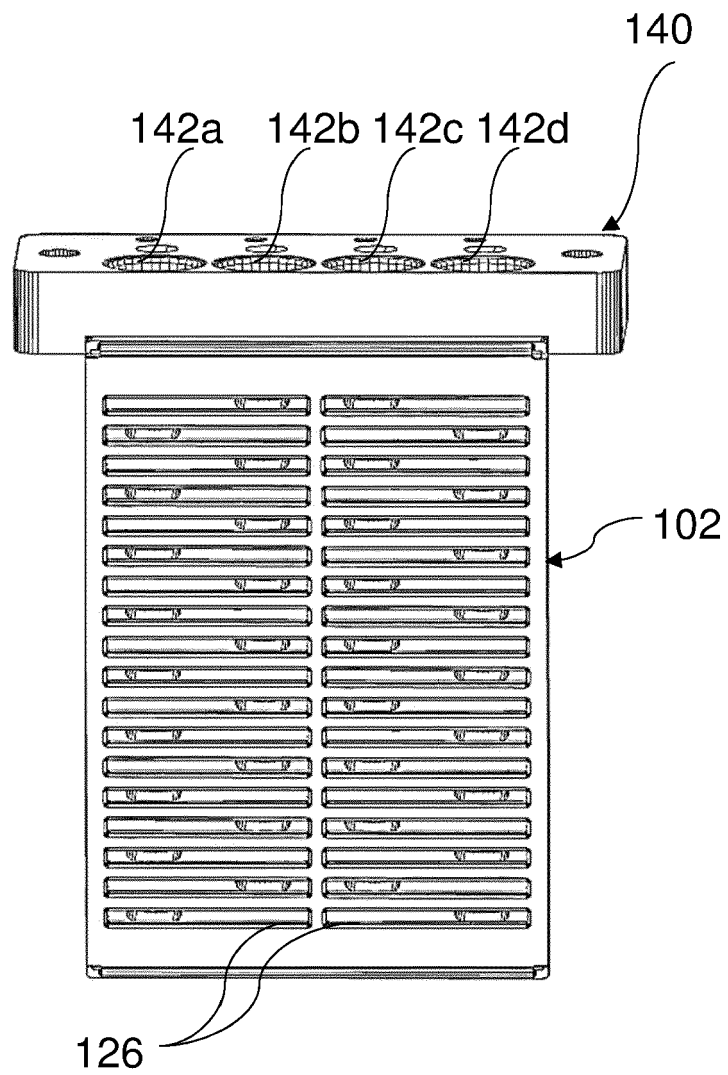


FIG. 6

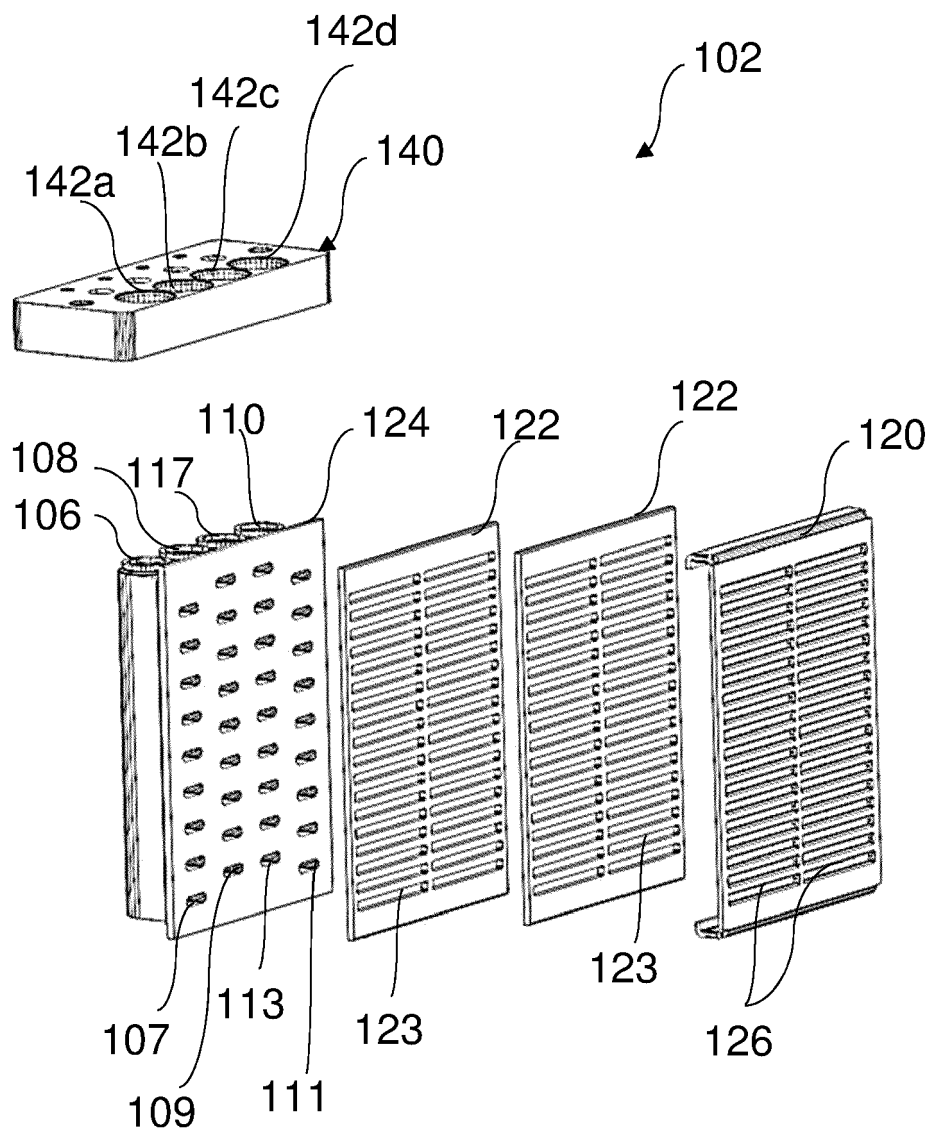


FIG. 7

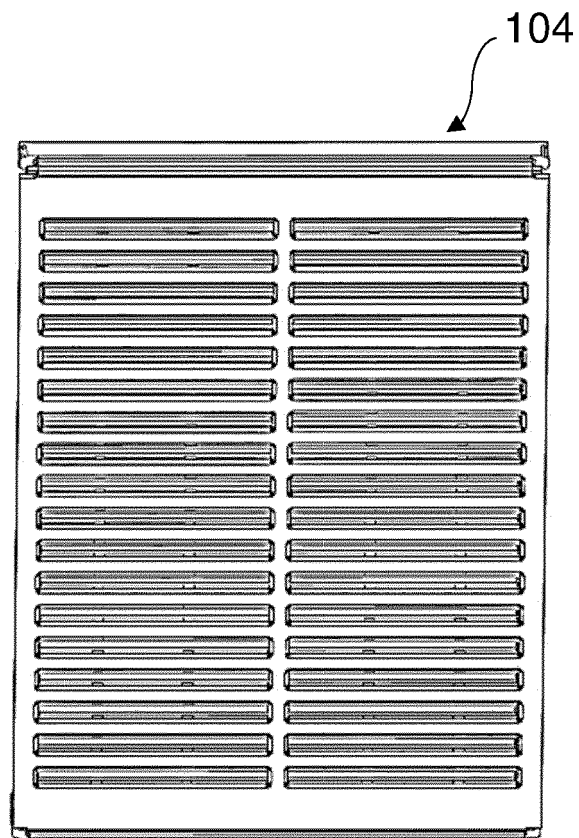


FIG. 8

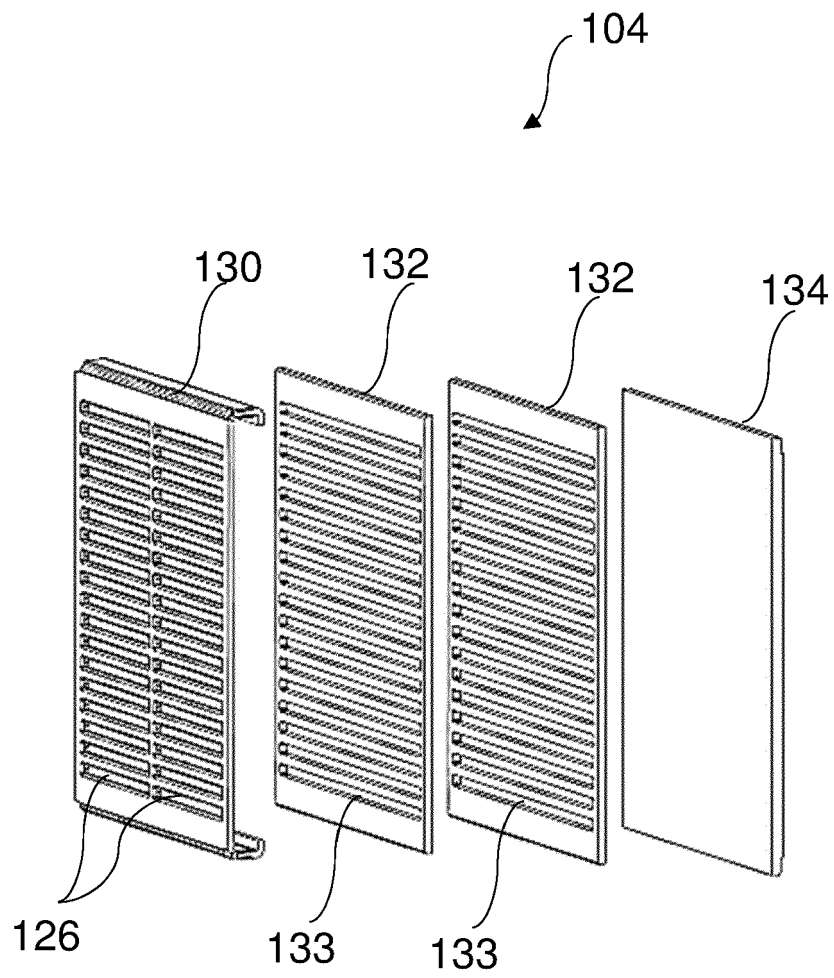


FIG. 9

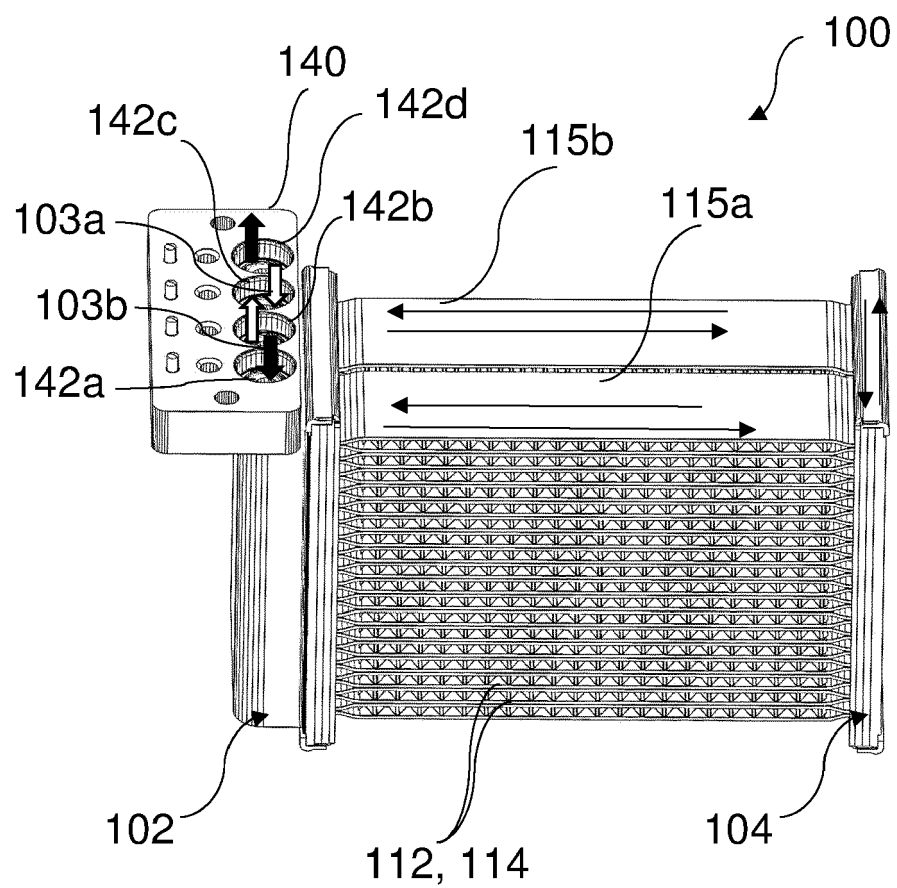


FIG. 10



EUROPEAN SEARCH REPORT

Application Number

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2014/245777 A1 (KATOH YOSHIKI [JP] ET AL) 4 September 2014 (2014-09-04)	1-6, 9-15	INV.
Y	* figures 4-6, 20-28 *	7, 8	F28D1/04
	-----		F28D1/053
X	US 9 995 534 B2 (DENSO CORP [JP]) 12 June 2018 (2018-06-12)	1-6, 9-15	
Y	* figures 18-22 *	7	

X	US 9 989 317 B2 (DENSO CORP [JP]) 5 June 2018 (2018-06-05)	1-6, 9-14	
	* figures 4-6 *		

X	US 7 337 832 B2 (VALEO INC [US]) 4 March 2008 (2008-03-04)	1-6, 9-14	
	* figures 3-7 *		

Y	US 2014/174703 A1 (YOSHIOKA SHUN [JP] ET AL) 26 June 2014 (2014-06-26)	7, 8	
	* figure 14 *		

			TECHNICAL FIELDS SEARCHED (IPC)
			F28D
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		18 October 2023	Vassoille, Bruno
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EP 23 17 4122

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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 The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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50

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2014245777 A1	04-09-2014	CN 103459968 A	18-12-2013
		EP 2696158 A1	12-02-2014
		JP 5772672 B2	02-09-2015
		JP 2012225634 A	15-11-2012
		JP 2012225638 A	15-11-2012
		KR 20140002774 A	08-01-2014
		US 2014245777 A1	04-09-2014
US 9995534 B2	12-06-2018	WO 2012137487 A1	11-10-2012
		-----	-----
		CN 103959003 A	30-07-2014
		DE 112012005002 T5	21-08-2014
		JP 5796563 B2	21-10-2015
		JP 2013137182 A	11-07-2013
		US 2014318749 A1	30-10-2014
US 9989317 B2	05-06-2018	WO 2013080532 A1	06-06-2013
		-----	-----
		CN 104884892 A	02-09-2015
		DE 112013006239 T5	08-10-2015
		JP 5853948 B2	09-02-2016
		JP 2014126339 A	07-07-2014
		US 2015338173 A1	26-11-2015
US 7337832 B2	04-03-2008	WO 2014103189 A1	03-07-2014
		-----	-----
		US 2004216863 A1	04-11-2004
		US 2005016716 A1	27-01-2005
		WO 2004099695 A1	18-11-2004
		-----	-----
		US 2014174703 A1	26-06-2014
US 2014174703 A1	26-06-2014	CN 103717989 A	09-04-2014
		EP 2738507 A1	04-06-2014
		ES 2731727 T3	18-11-2019
		JP 5287949 B2	11-09-2013
		JP 2013029244 A	07-02-2013
		TR 201909098 T4	22-07-2019
		US 2014174703 A1	26-06-2014
		WO 2013015186 A1	31-01-2013
		-----	-----