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(54) A HEAT EXCHANGER

(57) A heat exchanger for a heat exchange between a first fluid and at least one second fluid is disclosed. The heat exchanger comprises a first manifold, a second manifold and a plurality of tubes configured to provide a fluidal communication between the manifolds for flow of the first fluid. The plurality of tubes comprise a first stack of tubes and a second stack of tubes arranged in parallel to the first stack of tubes. The first manifold comprises at least two inlet channels and at least two outlet channels. The inlet channels and outlet channels are in fluid communication with a desired set of tubes in the first stack of tubes and the second stack of tubes, respectively. This arrangement achieves uniform distribution of the first fluid, provide a longer flow path for the first fluid and increase heat exchanger rate between the first fluid and the second fluid.

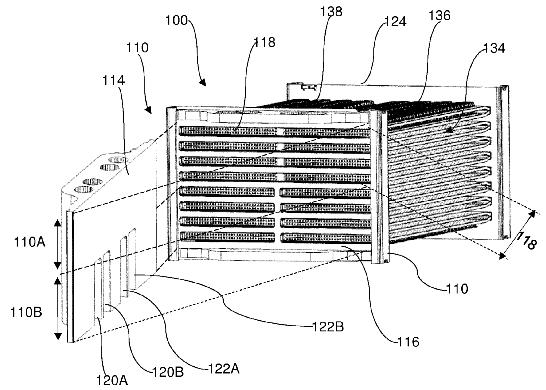

FIG. 4

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Description

[0001] The present invention relates to a heat exchanger. In particular, the present invention relates to a heat exchanger for a motor vehicle.

[0002] Generally, heat exchangers are used in many applications to exchange heat between two or more fluids. The fluid circuits can be adapted for the fluids, for example, a refrigerant and a coolant, respectively. The refrigerant flow path may be defined through the heat exchange elements provided in the heat exchanger. The heat exchangers comprising, for example, a two-pass structure or a multi-pass structure are preferred because the heat exchange fluid has more time to flow across heat exchange tubes. As a result, the rate of heat exchange and thermal efficiency of the heat exchanger are increased. Although the rate of heat exchange and thermal efficiency are increased in multi-pass type heat exchangers, the heat exchangers experience some problems, such as non-uniform distribution of the heat exchange fluid across the heat exchange tubes.

[0003] The multi-pass heat exchanger includes a plurality of flow paths provided by a plurality of tubes connected between two manifolds. The manifold incudes one refrigerant inlet channel and one refrigerant outlet channel. The refrigerant inlet channel receives refrigerant from the refrigerant circuit and distributes among the tubes. Each tube has small cross sectional flow area. Together, the plurality of tubes forms a large number of small cross sectional flow area for refrigerant flow. Thus obtaining a better flow distribution amongst the plurality of tubes using the single inlet and outlet channel is difficult. Particularly, single inlet channel and single outlet channel may not be sufficient for a heat exchanger core employing wide multi-port extrusion tubes. Further, changing the design or size of the channels without increasing the size of the heat exchanger may be advantageous to fit the heat exchanger into a given area for the application, however due to limited space required by customers, the resistance to pressure is a major factor limiting diameter of single channel.

[0004] Further, non-uniform distribution of the heat exchange fluid across the heat exchange tubes of the heat exchanger reduces thermal efficiency and leads to thermal shock in some of the heat exchange tubes. As a result, service life of the heat exchanger is reduced.

[0005] Accordingly, there is a need for an improved heat exchanger to achieve uniform distribution of heat exchange fluid at a heat exchanger core. Further, there is another need for a heat exchanger that enables uniform distribution of the heat exchange fluid in the heat exchange tubes without affecting cost and size of the heat exchanger.

[0006] 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.

[0007] In view of forgoing, the present invention relates to a heat exchanger for a heat exchange between a first fluid and at least one second fluid. The heat exchanger may comprise a first manifold and a second manifold spaced apart from the first manifold. A plurality of tubes may be configured to provide a fluidal communication between the first manifold and the second manifold for flow of the first fluid. The heat exchanger further comprises a connector block in fluid communication with the first manifold. The connector block includes a first inlet port and a second inlet port. The connector block is disposed at a housing enclosing a heat exchanger core. The plurality of tubes, the first manifold and the second manifold defines the heat exchanger core.

[0008] The plurality of tubes may comprise a first stack of tubes and a second stack of tubes arranged in parallel to the first stack of tubes. The first stack of tubes comprises a first set of tubes providing the first fluid flow between a first inlet port and the second manifold in a first direction defining a first flow path. The first stack of tubes further comprises a second set of tubes providing the first fluid flow between the second manifold and the first manifold in a second direction defining a second flow path. The second flow path is in fluid communication with the first flow path through the second manifold.

[0009] The second stack of tubes comprises a third set of tubes providing the first fluid flow between the first manifold and the second manifold in the first direction defining a third flow path. The third flow path is in fluid communication with the second flow path through the first manifold.

[0010] The second stack of tubes further comprises a fourth set of tubes providing the first fluid flow between the second manifold and a first outlet port in the second direction to define a fourth flow path. The fourth flow path is in fluid communication with the third flow path through the first manifold. The first manifold comprises at least two inlet channels and at least two outlet channels. The inlet channels are fluidly connected with the first set of tubes and the first inlet port. The outlet channels are fluidly connected with the fourth set of tubes and the first outlet port.

[0011] The heat exchanger further comprises a first diverter plate arranged between a first header plate and a first cover of the first manifold. The first diverter plate comprises a plurality of horizontal orifices for directing fluid between the second flow path and the third flow path. The heat exchanger further comprises a second diverter plate arranged between a second header plate and a second cover of the second manifold. The second diverter plate comprises plurality of longitudinal orifices for directing fluid between the first flow path and the second flow path, and between the third flow path and the fourth flow path. The inlet channels and outlet channels are defined by the first cover of the first manifold.

[0012] The first flow path and the second flow path form a first U- flow. The second flow path and the third flow path form a second U-flow. The third flow path and the fourth flow path form a third U-flow. In one embodiment, at least two inlet channels and at least two outlet channels comprises a same cross-section. In another embodiment, at least two inlet channels comprises a different cross-section than the at least two outlet channels. In yet another embodiment, at least two inlet channels and at least two outlet channels comprises a variable cross-sectional area. In yet another embodiment, at least two inlet channels and at least two outlet channels comprises a cross section successively diminishing along a downstream side of the first fluid entering through the inlet channels. In yet another embodiment, at least two inlet channels and at least two outlet channels comprises a cross section successively increasing along a downstream side of the first fluid entering through the inlet channels.

[0013] Other characteristics, details and advantages of the invention can 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 exemplarily illustrates a perspective view of a heat exchanger, according to an embodiment of the present invention;

FIG. 2 exemplarily illustrates another perspective view of the heat exchanger of FIG. 1 without a housing and a connector block;

FIG. 3 exemplarily illustrates another perspective view of arrangement of plurality of heat exchange tubes of the heat exchanger of FIG. 1;

FIG. 4 exemplarily illustrates an exploded view of a first manifold of the heat exchanger of FIG. 1;

FIG. 5 exemplarily illustrates at least two inlet and outlet channels defined by the first manifold of the heat exchanger of FIG. 1;

FIG. 6 exemplarily illustrates a second diverter plate of a second manifold and the heat exchanger core of the heat exchanger of FIG. 1;

FIG. 7 exemplarily illustrates the heat exchanger core and an exploded view of a second manifold of the heat exchanger of FIG. 1; and

FIG. 8 exemplarily illustrates a flow of refrigerant in a first fluid flow circuit of the heat exchanger of FIG. 1.

[0014] 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.

[0015] The present invention discloses an improved heat exchanger to achieve uniform distribution of a heat exchange fluid at a heat exchanger core. The heat exchanger is provided with at least one manifold having multiples channels for distribution of heat exchange fluid. The multiple channels may be connected to desired tubes or a desired zone of the heat exchanger core to achieve optimal distribution of heat exchange fluid. The heat exchanger may adopt a multi-pass structure and provide a longer flow path for the flow of the heat exchange fluid, for example refrigerant, to increase the heat transfer.

[0016] FIG. 1shows a perspective view of a heat exchanger 100 according to an embodiment of the present invention. FIG. 2 shows a perspective view of a heat exchanger 100 of FIG. 1 without a housing 102 and a connector block 104. Referring to FIG. 1 and FIG. 2, the heat exchanger 100 comprises a heat exchanger core including at least two manifolds 110, 124, a plurality of flow tubes 134 connected between the manifolds 110, 124 and at least one connector block 104. The connector block 104 includes a first inlet port 106A and a first outlet port 106B adapted to connect with a first external circuit supplying a first fluid. In one embodiment, the first fluid is a refrigerant. The manifolds 110, 124 may include a first manifold 110 and a second manifold 124. The first manifold 110 may comprise at least two inlet channels 120A, 120B and at least two outlet channels 122A, 122B. The inlet channels 120A, 120B may be in fluid communication with the first inlet port 106A and the outlet channels 122A, 122B may be in fluid communication with the first outlet port 106B.

[0017] The first manifold 110 may comprise a first header plate 112 and a first cover 114, and the second manifold 124 may comprise a second header plate 132 and a second cover 126. The plurality of heat exchange tubes 134 may comprise a first end and an opposing second end. The first end of each heat exchange tube 134 is received into corresponding tube holes of a first header plate 112 of the first manifold 110. The opposing second end of the heat exchange tubes 134 are received into the corresponding tube holes of a second header plate 132 of the second manifold 124. Here, the term the heat exchange tubes 134 or tubes 134 are interchangeably used in the document.

[0018] The heat exchanger 100 may further comprise a housing 102 and at least one connector block 104. The housing 102 may comprise at least one opening to receive the connector block 104 of the heat exchanger core so that the connector block 104 extends outside the housing 102. The housing 102 includes a second inlet port 108A and a second outlet port 108B adapted to connect with a second external circuit supplying at least one second fluid. In one embodiment, the second fluid is a coolant.

[0019] The first fluid may flow from the first inlet port 106A to the inlet channels 120A, 120B of the first manifold 110. From the inlet channels 120A, 120B, the first fluid circulates between the manifolds 110, 124 and within the heat exchange tubes 134, and reaches the outlet channels 122A, 122B, which define a first fluid flow circuit. The first fluid flow circuit is explained in detail in further paragraphs. The second fluid flows around the heat exchange tubes 134 from the second inlet port 108A and reaches the second outlet port 108B, which defines the second fluid flow circuit. The refrigerant flow and the coolant flow in and around the heat exchange core enables heat exchange between the coolant and refrigerant. In one embodiment, the heat exchange tubes 134 are flat tubes. In another embodiment, the heat exchange tubes 134 may be multi-channel tubes containing several flow channels or paths. In one embodiment, fins 160 are located between the heat exchange tubes 134 to promote the transfer of heat between the refrigerant within the tubes 134 and the coolant passing over the tubes 134. According to an exemplary embodiment, the fins 160 are constructed of aluminium, brazed or otherwise joined to the tubes 134, and disposed generally perpendicular to the flow of refrigerant. However, according to other exemplary embodiments, the fins 160 may be made of other materials that facilitate heat transfer and may extend in parallel or at varying angles with respect to the flow of the refrigerant. The fins 160 may be louvered fins, corrugated fins, or any other suitable type of fin.

[0020] All components of the heat exchanger 100 mentioned above can be made of materials suitable for brazing, for example aluminium, steel and their alloys. In order to obtain the proper fluid tightness of the assembly all components thereof are connected to each other by brazing or any another suitable means.

[0021] Referring to FIG. 3, the plurality of heat exchange tubes 134 are arranged as two parallel stack of heat exchange tubes 136, 138 including a first stack of tubes 136 and a second stack of tubes 138. The first stack of tubes 136 and the second stack of tubes 138 are fluidically isolated from each other at the second manifold 124, so that the refrigerant does not pass from the first stack of tubes 136 to the second stack of tubes 138 through the second manifold 124. The first stack of tubes 136 includes a first set of tubes 136A and a second of tubes 136B. The second stack of tubes 138 includes a third set of tubes 138A and a fourth set of tubes 138B. The first set of tubes 136A is in fluid communication with the at least two inlet channels 120A, 120B. The second set of tubes 136B are in fluid communication with the first set of tubes 136A through the second manifold 124. The third set of tubes 138A are in fluid communication with the second set of tubes 136B through the first manifold 110. The fourth set of tubes 138B are in fluid communication with the third set of tubes 138A through the second manifold 124. The fourth set of tubes 138B is in fluid communication with the at least two outlet channels 122A, 122B.

[0022] Referring to FIG. 3, the refrigerant flows from inlet channels 120A, 120B (shown in FIG. 2) to the second manifold 124 through the first set of tubes 136A, which defines a first pass or first flow path 140 (shown in FIG. 8). From the second manifold 124, the refrigerant flows to the first manifold 110 through the second set of tubes 136B, which defines a second pass or a second flow path 142 (shown in FIG. 8). As the first set of tubes 136A is in the fluidic communication with the second set of tubes 136B at the second manifold 124, first flow path 140 is in fluidic communication with the second flow path 142. From the first manifold 110, the refrigerant flows to the second manifold 124 through the third set of tubes 138A, which defines a third pass or a third flow path 144 (shown in FIG. 8). As the second set of tubes 136B is in fluid communication with the third set of tubes 138A at the first manifold 110, the second flow path 142 is in fluidic communication with the third flow path 144. From the second manifold 124, the refrigerant reaches the at least two outlet channels 122a, 122B through the fourth set of tubes 138B, which defines a fourth pass or a fourth flow path 146 (shown in FIG. 8). As the third set of tubes 138A is in fluid communication with the fourth set of tubes 138B, at the second manifold 124, the third flow path 144 is in fluidic communication with the fourth flow path 146. Thereby, the heat exchanger 100 adopts a four-pass configuration.

[0023] In an example, the first set of tubes 136A may be one half of the heat exchange tubes 134 among the first stack of tubes 136 and the second set of tubes 136B may be another half of the heat exchange tubes 134 among the first stack of tubes 136. In one example, the third set of tubes 138A may be one of half of heat exchange tubes 134 among the second stack of tubes 138 and the fourth set of tubes 138B may be another half of the heat exchange tubes 134 among the second stack of tubes 138. The first set of tubes 136A, the second set of tubes 136B, the third set of tubes 138A, and the fourth set of tubes 138B may include any number heat exchange tubes. In this example, the first set of tubes 136A may be a lower half of tubes of the first stack of tubes 136. The second set of tubes 136B may be an upper half of tubes of the first stack of tubes 136. The third set of tubes 138A may be an upper half of tubes of the second stack of tubes 138. The fourth set of tubes 138B may be a lower half of tubes of the second stack of tubes 138.

[0024] Referring to FIG. 4, the first manifold 110 may be fluidically communicated with the first open ends of the first set of tubes 136A, the second set of tubes 136B, the third set of tubes 138A and the fourth set of tubes 138B. The first manifold 110 includes a first portion 110A and a second portion 110B. The first portion 110A communicates with a first open ends of the second set of tubes 136B and third set of tubes 138A. Further, the first open ends of the second set of tubes 136B are fluidically connected with the first open ends of the third set of tubes

138A though a second intermediate passage 148 (shown in FIG. 8) at the first manifold 110. Further, a first diverter plate 116 disposed between the first header plate 112 and the first cover 114 of the first manifold 110. The first diverter plate 116 fluidically connects the first open ends of the second set of tubes 136B and the third set of tubes 138A. The first diverter plate 116 includes plurality of horizontal orifices 118 extending across the first open ends of the second set of tubes 136B and the third set of tubes 138A. The second portion 110B includes the at least inlet channels 120A, 120B and the at least two outlet channels 122A, 122B. The first open ends of the first set of tubes 136A may be fluidically connected with the inlet channels 120A, 120B and the first open ends of the fourth set of tubes 138B fluidically connects with the outlet channels 122A, 122B.

[0025] In this example, the first portion 110A may be an upper portion of the first manifold 110 and the second portion 110B may be a lower portion of the first manifold 110. In another embodiment, the first portion 110A may be a lower portion of the first manifold 110 and the second portion 110B may be the upper portion of the first manifold 110. The first portion 110A and the second portion 110B are fluidly insulated from each other. The first diverter plate 116 is provided to partition the first portion 110A and the second portion 110B at substantial centres thereof.

[0026] FIG. 5 illustrates a cross-section of the first cover 114 of the first manifold 110 showing the inlet channels 120A, 120B and the outlet channels 122A, 122B. The inlet channels 120A, 120B and the outlet channels 122A, 122B may extend along a length of the first cover 114. The length is a measure of length between opposing edges 114a, 114b of first cover 114, shown in FIG. 4 and 5. The inlet channels 120A, 120B include a first inlet channel 120A and a second inlet channel 120B. The inlet channels 120A, 120B run at least a portion of length of the first cover 114 of the first manifold 110. In this example, the inlet channels 120A, 120B run along the entire length of the first cover 114 of the first manifold 110. Further, in this example, the first inlet channel 120A and the second inlet channel 120B are formed separately from one another. In another example, the first inlet channel 120A may be in fluid communication with the second inlet channel 120B. In yet another example, the first inlet channel 120A may be fluidly insulated from the second inlet channel 120B. Further, in one example, the first inlet channel 120A and the second inlet channel 120B may have the same cross section. In another example, the first inlet channel 120A may have different cross section than the second inlet channel 120B. In yet another example, the first inlet channel 120A and second inlet channel 120B may have the variable cross-sectional area. In yet another example, the first inlet channel 120A and the second inlet channel 120B may have a cross section successively diminishing along a downstream side of the first fluid entering through the inlet channels 120A, 120B. In yet another example, the first inlet channel 120A and the second inlet channel 120B may have a cross section successively increasing along a downstream side of the first fluid entering through the inlet channels 120A, 120B.

[0027] Still referring to FIG. 5, the outlet channels 122A, 122B run at least a portion of length of the first cover 114 of the first manifold 110. In this example, the outlet channels 122A, 122B runs along the entire length of the first cover 114 of the first manifold 110. Further, in this example, the first outlet channel 122A and the second outlet channel 122B are formed separately from one another. In another example, the first outlet channel 122A may be in fluid communication with the second outlet channel 122B. In yet another example, the first outlet channel 122A may be fluidly insulated from the second outlet channel 122B. Further, in one example, the first outlet channel 122A and the second outlet channel 122B may have the same cross section. In another example, the first outlet channel 122A may have different cross section than the second outlet channel 122B. In yet another example, the first outlet channel 122A and second outlet channel 122B may have variable cross-sectional area. In yet another example, the first outlet channel 122A and the second outlet channel 122B may have the cross section successively diminishing along an upstream side of the first fluid leaving through the outlet channels 120A, 120B. In yet another example, the first outlet channel 122A and the second outlet channel 122B may have the cross section successively increasing along the upstream side of the first fluid leaving through the outlet channels 120A, 120B.

[0028] Referring to FIG. 6 and FIG. 7, the second manifold 124 fluidly communicates with an opposing second open ends of the first set of tubes 136A, second set of tubes 136B, a third set of tubes 138A and the fourth set of tubes 138B. The second manifold 124 may comprise a second diverting passage 150 (shown in FIG. 8) fluidly connecting the second open ends of the first set of tubes 136A to the second ends of the second set of tubes 136B. The second manifold 124 may further comprise a third diverting passage 152 (shown in FIG. 8) fluidically connecting the second open ends of the third set of tubes 138A and the fourth set of tubes 138B. The second manifold 124 may comprise a second diverter plate 128 having a plurality of longitudinal orifices 130. The plurality of longitudinal orifices 130 includes a first set of longitudinal orifices 130A extending across and fluidically connects the second ends of the first set of tubes 136A and second set of tubes 136B. The plurality of longitudinal orifices 130 further comprises a second set of longitudinal orifices 130B extending across and fluidically connects the second ends of the third set of tubes 138A and the fourth set of tubes 138B. Thereby, the first set of longitudinal orifices 130A may define the second diverting passage 150 and the second set of longitudinal orifices 130B may define the third diverting passage 152.

[0029] Referring to FIG. 8, the refrigerant provided though the first inlet port 106A passes through the inlet channels 120A, 120B. From the inlet channels 120A, 120B, the refrigerant flows through the first set of tubes 136A, in a first direction A, represented by arrow A, from the inlet channels 120A, 120B towards the second manifold 124, which defines the first pass or the first fluid path 140. From the second manifold 124, the refrigerant flows through the second set of tubes 136B, in a second direction B, represented by arrow B, from the second manifold 124 to the first manifold 110. The first diverting passage 148 at the second manifold 124 defined by the first set of longitudinal orifices 130A directs the refrigerant from the first set of tubes 136A to the second set of tubes 136B. Further, the first set of longitudinal orifices 130A uniformly distributes refrigerant in the second set of tubes 136B.

[0030] From the first manifold 110, the refrigerant flows through the third set of tubes 138A, in the first direction A, from the second manifold 124 to the first manifold 110, which defines third pass or the third flow path 144. The second diverting passage 150 at the first manifold 110 defined by the set of horizontal orifices 118 of the first diverter plate 116 directs the refrigerant from the second set of tubes 136B to the third set of tubes 138A. Further, the set of horizontal orifices 118 of the first diverter plate 116 uniformly distributes refrigerant in the third set of tubes 138A.

[0031] From the second manifold 124, the refrigerant flows through the fourth set of tubes 138B in the second direction B from the second manifold 124 to the first manifold 110, which defines the fourth pass or the fourth flow path 146. The third diverting passage 152 at the second manifold 124 defined by the second set of longitudinal orifices 130B directs the fluid from the third set of tubes 138A to the fourth set of tubes 138B. Further, the refrigerant reach the first outlet port 106B via the outlet channels 122A, 122B in communication with the fourth set of tubes 138B. Simultaneously, the coolant flows from the second inlet port 108A and flows around the heat exchange tubes 134 and exits via the second outlet port 108B. Further, the second set of longitudinal orifices 130B of the second diverter plate 128 uniformly distributes refrigerant in the fourth set of tubes 138B.

[0032] Referring to FIG. 8, the refrigerant is distributed through a four-pass flow inside the heat exchanger core, represented by structure 800. Namely, the first fluid, for example, the refrigerant flows from the inlet channels 120A, 120B to the outlet channels 122A, 122B passing through a series of the first flow path 140, the first diverting passage 148, the second flow path 142, the second diverting passage 150, the third flow path 144, the third diverting passage 152. The flow direction of the fluid in succeeding flow path 142, 144, 146 is reversed with respect to the preceding flow path 140, 142, 144. The second flow path 142, the third flow path 144 and the fourth flow path 146 are succeeding to the first flow path 140, the second flow path 142 and the third flow path 144, respectively.

[0033] Further, the first flow path 140 and the second flow path 142 together forms a first U - flow path, the second flow path 142 and the third flow path 144 together forms a second U-flow path and the third flow path 144 and the fourth flow path 146 together forms a third U-flow path. Thereby, the heat exchanger 100 provides at least three U-flow paths. Together, the three-U-flow paths provide a longer flow path for the flow of the refrigerant, which increases the time of the first fluid in heat exchange configuration with the second fluid and increases the heat transfer efficiency. Further, the two inlet channels 120A, 120B, the outlet channels 122A, 122B, the first diverter plate 116 and second diverter plate 128 uniformly distributes the refrigerant within the heat exchange tubes 134 and without increasing the pressure drop. As the refrigerant uniformly distributed across the heat exchange tubes 134, thermal efficiency of the heat exchanger 100 is increased.

[0034] 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 heat exchange between the first fluid and at least one second fluid, comprising:

a first manifold (110);
a second manifold (124) spaced apart from the first manifold (110), and a plurality of tubes (134) configured to provide a fluidal communication between the first manifold (110) and the second manifold (124) for flow of the first fluid, wherein the plurality of tubes (134) comprise a first stack of tubes (136) and a second stack of tubes (138) arranged in parallel to the first stack of tubes (136), wherein:

the first stack of tubes (136) comprises:

a first set of tubes (136A) providing the first fluid flow between a first inlet port (106A) and the second manifold (124) in a first direction defining a first flow path (140), and
a second set of tubes (136B) providing the first fluid flow between the second manifold (124) and the first manifold (110) in a second direction defining a second flow path (142), wherein the second flow path (142) is in fluid communication with the first flow path (140) through the second manifold (124), and

the second stack of tubes (138) comprising:

a third set of tubes (138A) providing the first fluid flow between the first manifold (110) and the second manifold (124) in the first direction defining a third flow path (144), wherein the third flow path (144) is in fluid communication with the second flow path (142) through the first manifold (110), and

a fourth set of tubes (138B) providing the first fluid flow between the second manifold (124) and a first outlet port (106B) in the second direction to define a fourth flow path (146), wherein the fourth flow path (146) is in fluid communication with the third flow path (144) through the first manifold (110) **characterised in that** the first manifold (110) comprises at least two inlet channels (120A, 120B) and at least two outlet channels (122A, 122) wherein the inlet channels (120A, 120B) are fluidly connected at least with the first set of tubes (136A) and outlet channels (122A, 122B) are fluidly connected at least with the fourth set of tubes (138B).

2. The heat exchanger (100) of claim 1, comprising a first diverter plate (116) arranged between a first header plate (112) and a first cover (114) of the first manifold (110), wherein the first diverter plate (116) comprises a plurality of horizontal orifices (118) for directing fluid between the second flow path (142) and the third flow path (144).

3. The heat exchanger (100) as claimed in any of the preceding claims, further comprises a second diverter plate (128) arranged between a second header plate (132) and a second cover (126) of the second manifold (124), wherein the second diverter plate (128) comprises plurality of longitudinal orifices (130) for directing fluid between the first flow path (140) and the second flow path (142), and between the third flow path (144) and the fourth flow path (146).

4. The heat exchanger (100) as claimed in any of the preceding claims, wherein at least two inlet channels (120A, 120B) and at least two outlet channels (122A, 122B) are defined by the first cover (114) of the first manifold (110).

5. The heat exchanger (100) of claim 1 and 3, wherein the first flow path (140) and the second flow path (142) form a first U- flow.

6. The heat exchanger (100) of claim 1 and 2, wherein the second flow path (142) and the third flow path (144) form a second U-flow.

7. The heat exchanger (100) of claim 1 and 3, wherein the third flow path (144) and the fourth flow path (146) form a third U-flow.

8. The heat exchanger (100) of claim 1, further comprises a connector block (104) disposed at a housing (102) enclosing a heat exchanger core, wherein the plurality of tubes (134), the first manifold (110) and the second manifold (124) defines the heat exchanger core.

9. The heat exchanger (100) of claim 1 and 8, wherein the first inlet port (106A) and first outlet port (106B) are formed on the connector block (104).

10. The heat exchanger (100) of claim 1 and 9, wherein at least two inlet channels (120A, 120B) fluidically connects the first inlet port (106A) with the first set of tubes (136A), and at least two outlet channels (122A, 122B) fluidically connects the first outlet port (106B) with the fourth set of tubes (138B).

11. The heat exchanger (100) of claim 1, wherein at least two inlet channels (120A, 120B) and at least two outlet channels (122A, 122B) comprises a same cross-section.

12. The heat exchanger (100) of claim 1, wherein at least two inlet channels (120A, 120B) comprises a different cross-section than the at least two outlet channels (122A, 122B).

13. The heat exchanger (100) of claim 1, wherein at least two inlet channels (120A, 120B) and at least two outlet channels (122A, 122B) comprises a variable cross-sectional area.

14. The heat exchanger (100) of claim 1, wherein at least two inlet channels (120A, 120B) and at least two outlet channels (122A, 122B) comprises a cross section successively diminishing along a downstream side of the first fluid entering through the inlet channels (120A, 120B).

15. The heat exchanger (100) of claim 1, wherein at least two inlet channels (120A, 120B) and at least two outlet channels (122A, 122B) comprises a cross section successively increasing along a downstream side of the first fluid entering through the inlet channels (120A, 120B).

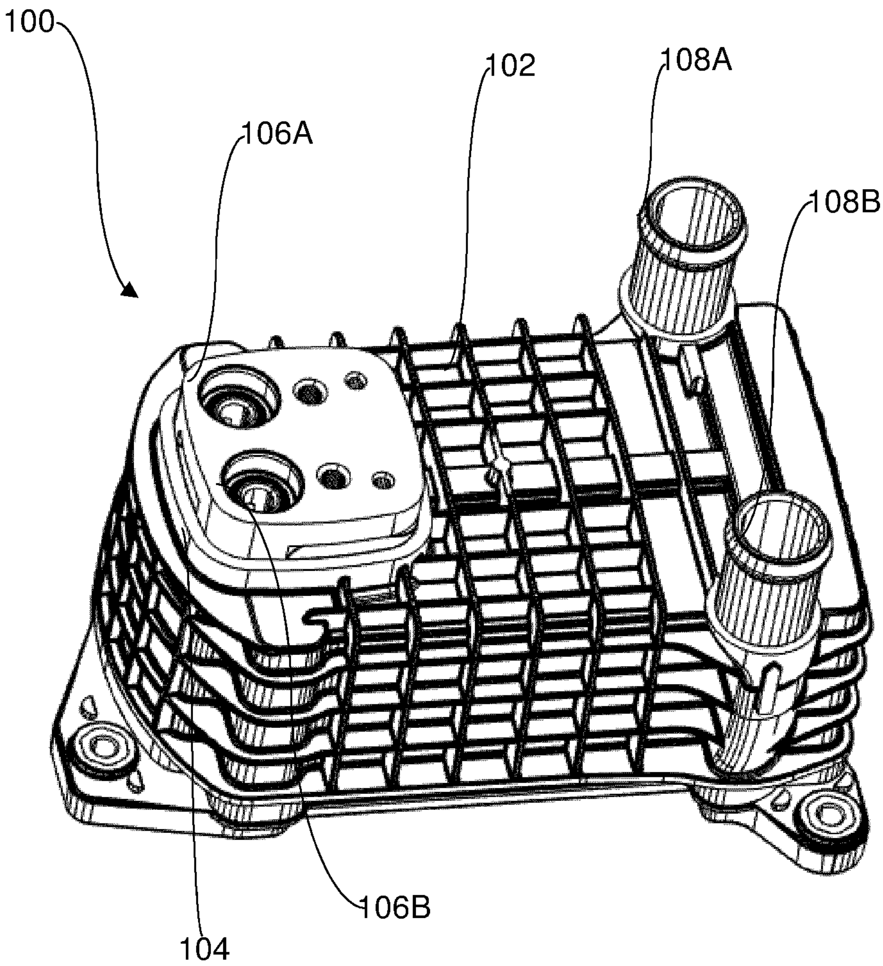

FIG. 1

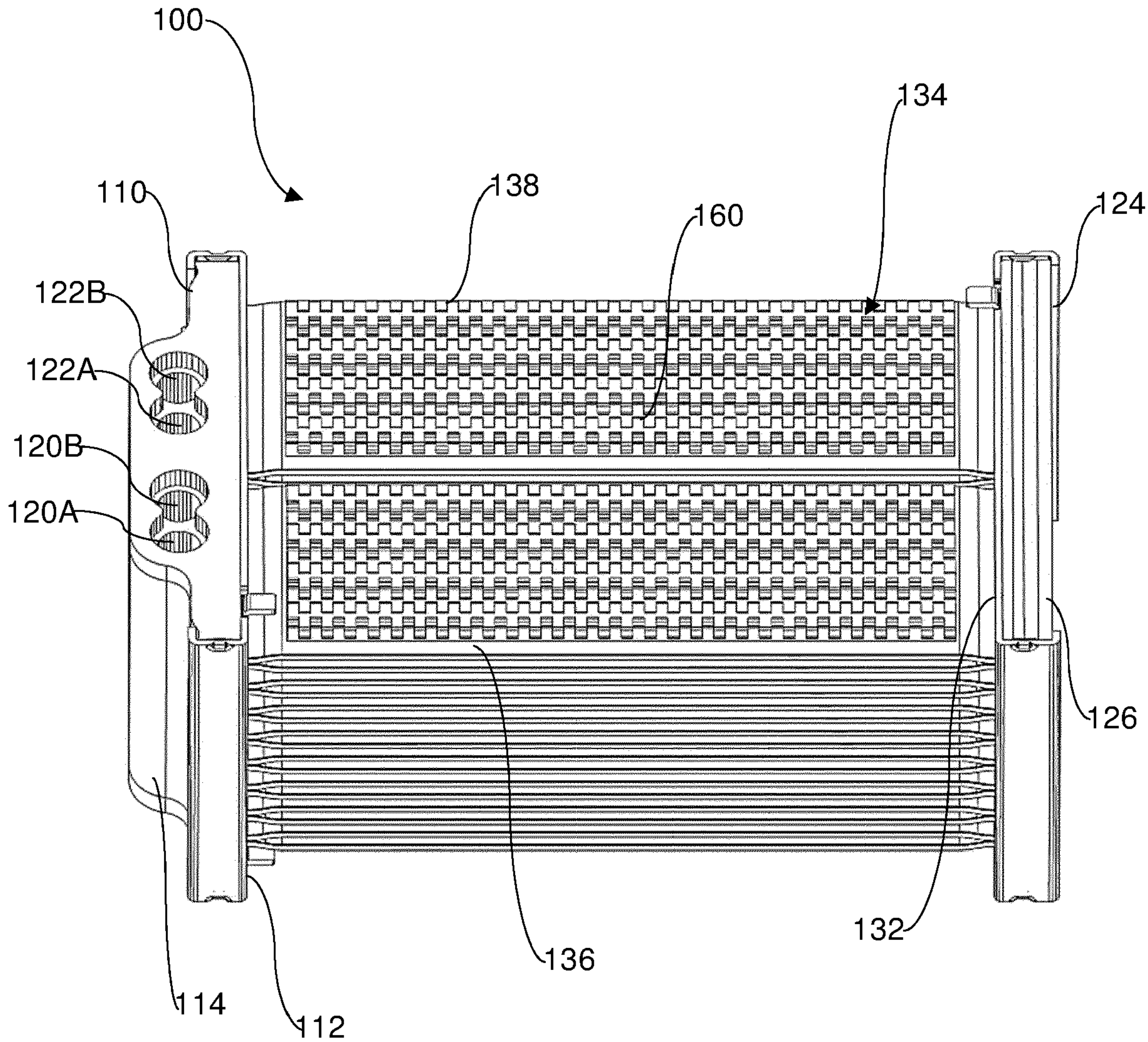

FIG. 2

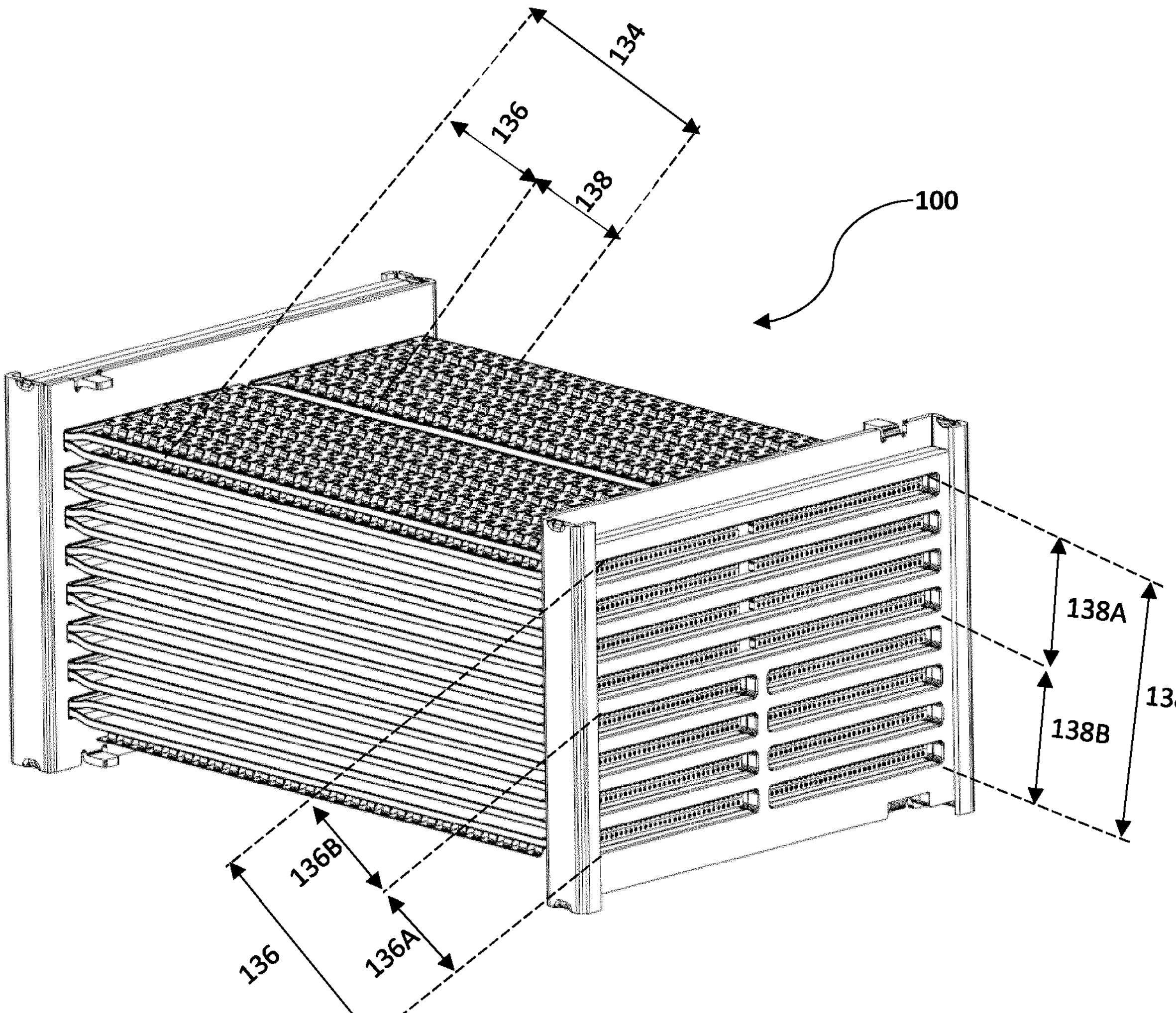

FIG. 3

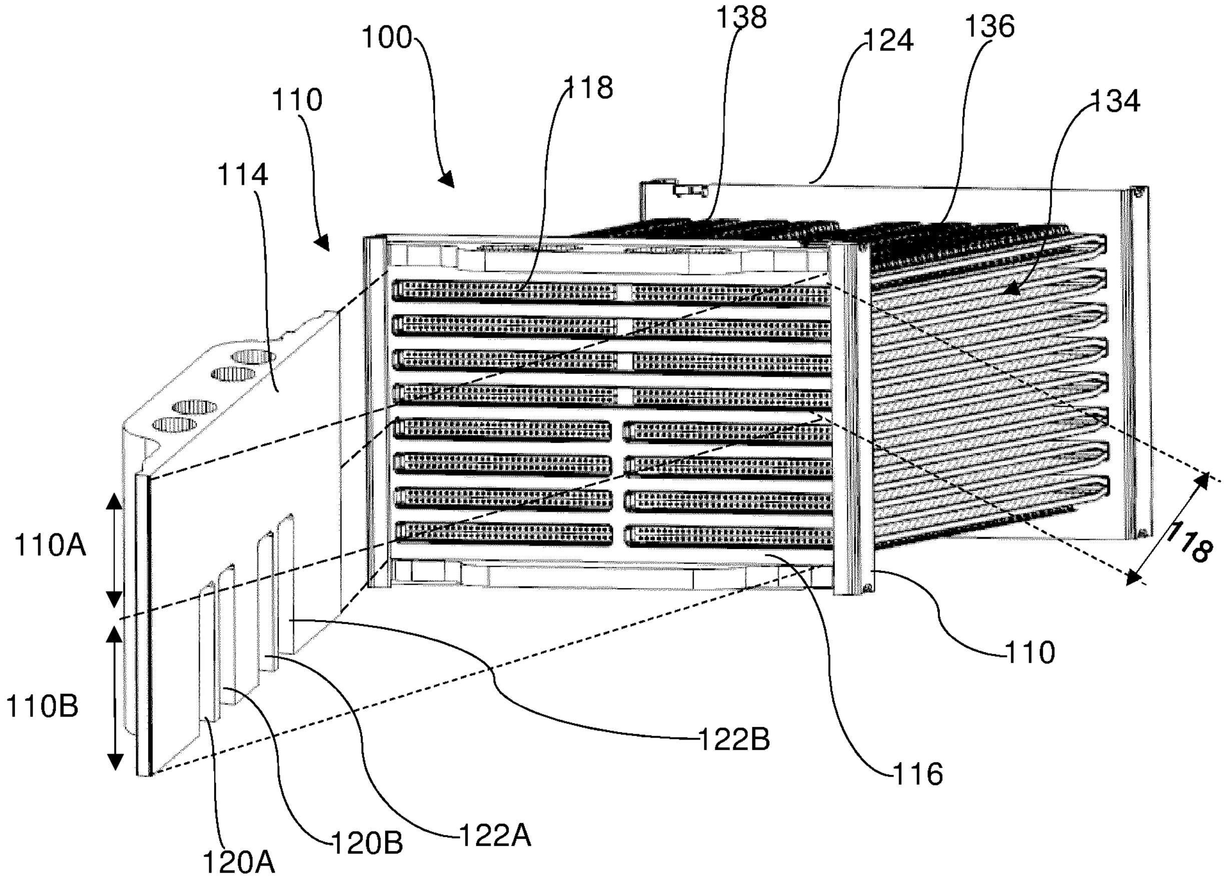
100
110
114
118
138
124
136
134
110A
110B
118
110
122B
116
120A
120B
122A

FIG. 4

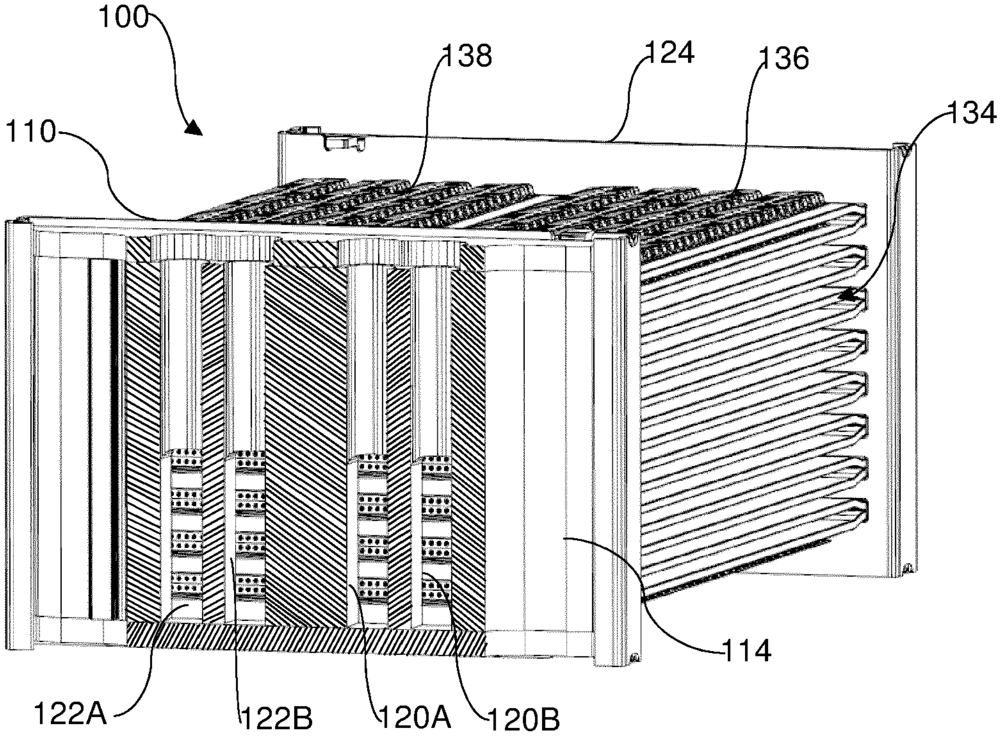
100
138
124
136
134
110
114
122A
122B
120A
120B

FIG. 5

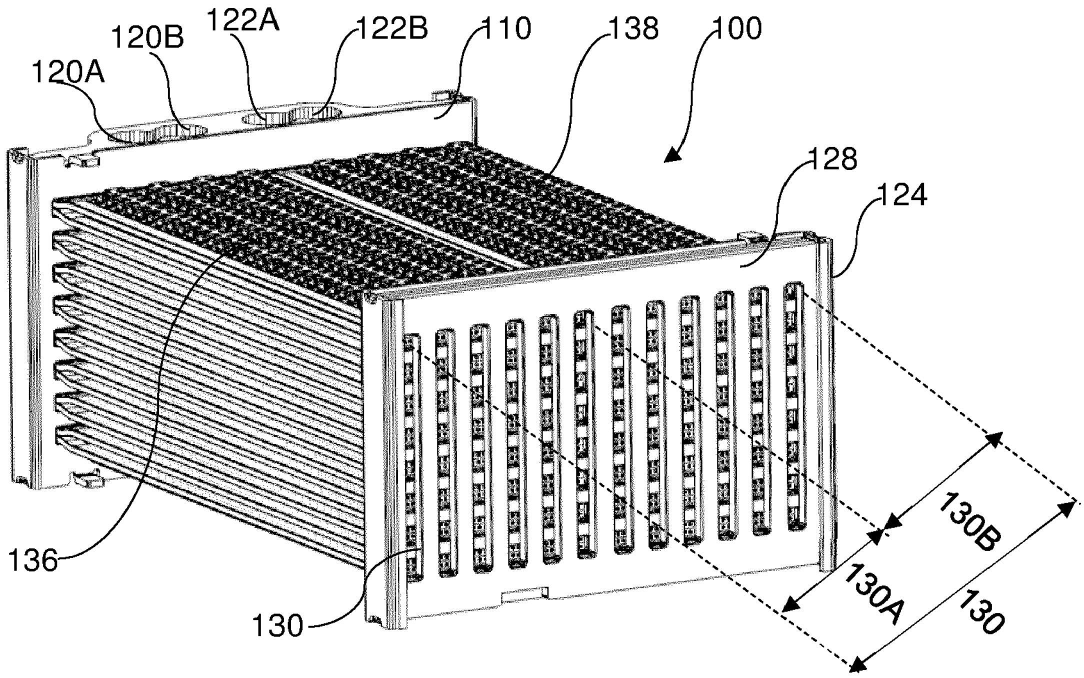
120A
120B
122A
122B
110
138
100
128
124
136
130
130B
130A
130

FIG. 6

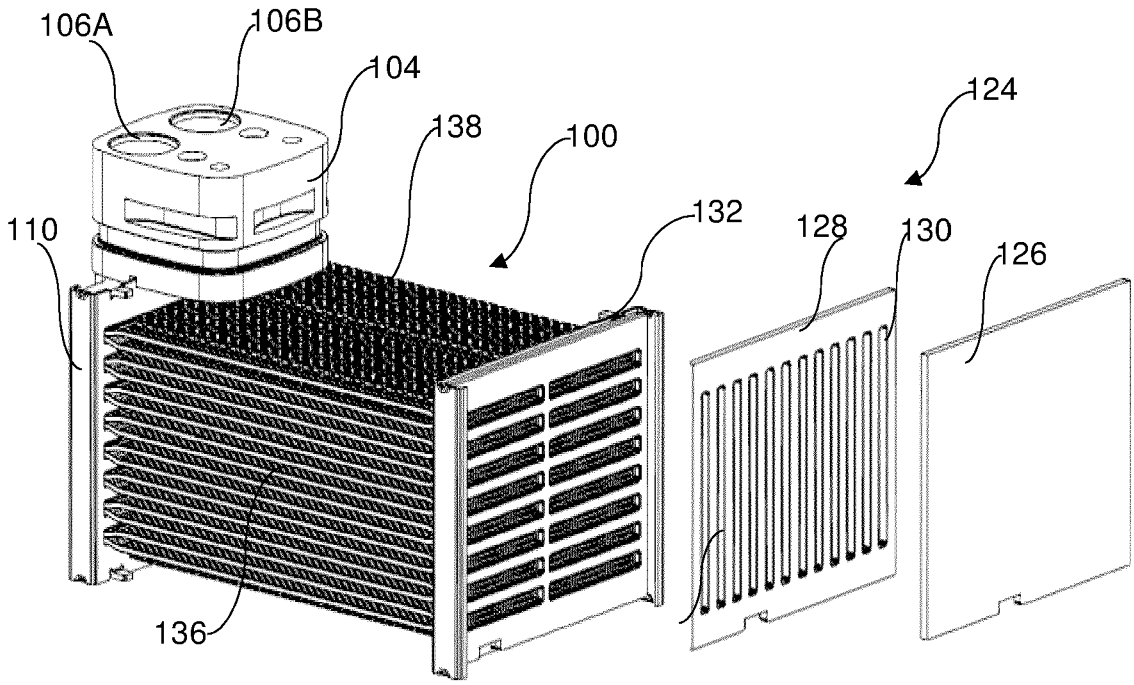
106A
106B
104
138
100
124
132
128
130
126
110
136

FIG. 7

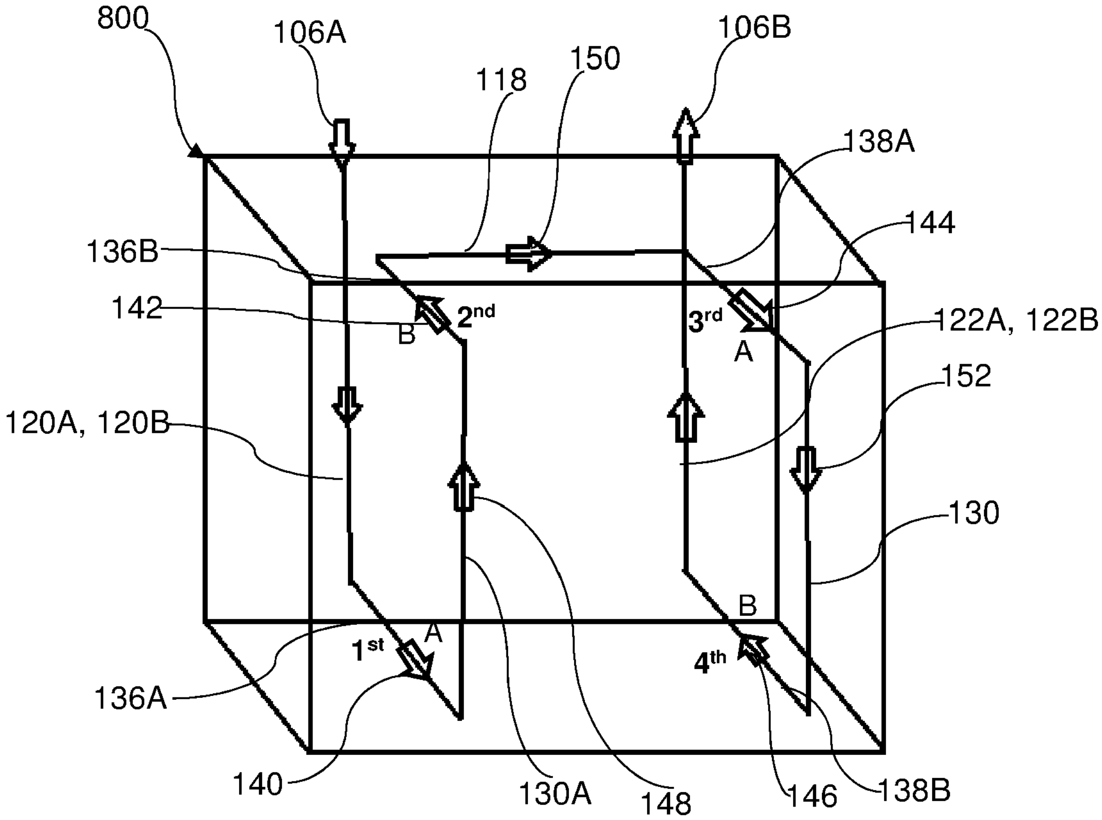
800
106A
106B
118
150
138A
144
136B
142
2nd
3rd
B
A
122A, 122B
120A, 120B
152
130
B
1st
A
4th
136A
140
130A
148
146
138B

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 21 21 3845

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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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F28F
F28D
F25B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	28 April 2022	Mellado Ramirez, J

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28-04-2022

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