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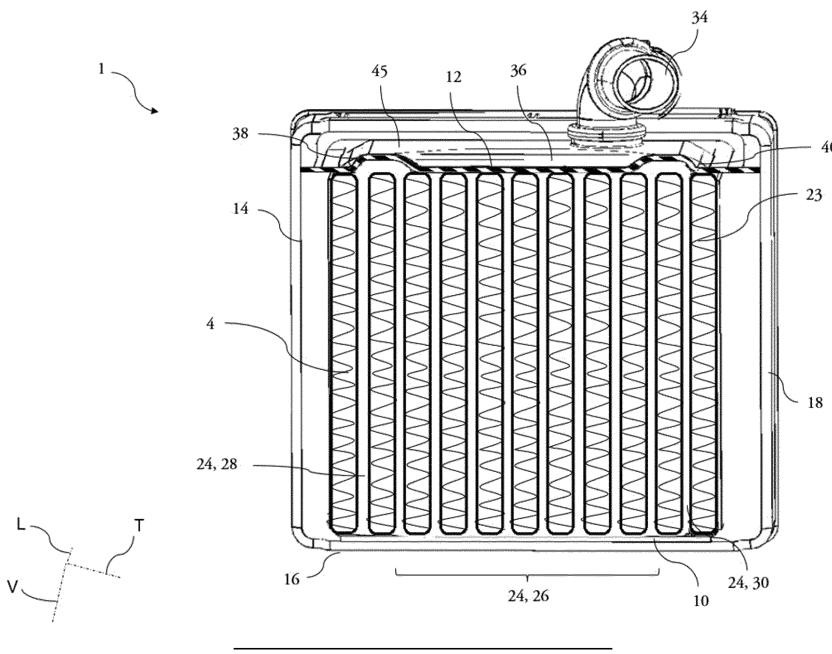
(54) HEAT EXCHANGER FOR AIR COOLING

(57) The present invention relates to a heat exchanger (1) configured to cool an air flow, comprising a heat core (2) comprising air flow channels (4) defining liquid passes (24, 26, 28, 30) in between at least two air flow channels (4), said heat core (2) comprising a group of central liquid passes (26) and two lateral liquid passes (28, 30), said heat core (2) comprising a plurality of plates (12, 14, 16, 18), at least one of the plates (12) having a plane portion and a projection defining a liquid chamber (36) in liquid communication with the liquid passes (24, 26, 28, 30), the liquid chamber (36) having a first section covering at least one of the lateral liquid passes (28, 30) which is bigger than a second section covering at least one of the central liquid passes (26).



Description

[0001] The invention relates to heat exchangers and more particularly to heat exchangers designed to cool an air flow using a coolant liquid.

[0002] These heat exchangers may be used in vehicles in order to cool inlet gases of a turbocharged internal combustion engine with a coolant liquid, for instance a water-based coolant liquid.

[0003] Such heat exchangers usually comprise a casing inside which there are channels dedicated to the circulation of the gases as well as passes for the coolant liquid to circulate inside the heat exchanger. The channels and the passes are arranged so that the gases and the coolant liquid can exchange calories, resulting in a drop of temperature for the gases.

[0004] More specifically, the channels can extend from one end of the heat exchanger bearing an air inlet to another end bearing an air outlet, the air circulating inside the heat exchanger from the air inlet to the air outlet. The channels are usually stacked horizontally, i.e. one next to the other in a direction perpendicular to that of the air flow. The liquid coolant can circulate in passes located in between the channels, from a liquid inlet to a liquid outlet. Due to this disposition of the liquid inlet and outlet relative to that of the passes, there can however be a risk of local boiling in the vicinity of the liquid outlet for the passes which are the farthest from the centre of the heat exchanger. These passes are indeed at risk of not being cooled enough by the coolant liquid. As such, there is a need for heat exchangers inside of which the coolant liquid flow is improved.

[0005] The present invention fits into this context by providing a heat exchanger with a liquid chamber designed to improve the flow of the coolant liquid, thus allowing to avoid local boiling in the passes located at a distance from the centre of the heat exchanger.

[0006] In this context, the present invention is directed to a heat exchanger configured to cool an air flow with a coolant liquid, comprising a heat core, a first air flow duct located at a first longitudinal end of said heat core and a second air flow duct located at a second longitudinal end of said heat core, the heat core comprising a plurality of air flow channels defining liquid passes in between at least two air flow channels, said heat core comprising a group of central liquid passes and two lateral liquid passes bordering said group of central liquid passes, said heat core comprising a plurality of plates enveloping the air flow channels and the liquid passes, at least one of the plates having a plane portion and a projection defining a liquid chamber which is in liquid communication with the liquid passes, the liquid chamber having a first section covering at least one of the lateral liquid passes which is bigger than a second section covering at least one of the central liquid passes.

[0007] The heat exchanger according to the invention requires a coolant liquid in order to cool the air. This air flows in the heat exchanger, and more precisely in its heat core, from the first air duct or air inlet located at its first longitudinal end, to the second air duct or air outlet located at its second longitudinal end which is opposed to the first longitudinal end.

[0008] The plurality of plates of the heat core, for instance four plates, define an internal housing for the air and the coolant liquid to circulate inside the heat core. More precisely, when circulating inside the heat core the air is contained in air flow channels whereas the coolant liquid can circulate in the spaces between these air flow channels, which form liquid passes. Two of the plates are used to delimit the liquid passes vertically, by closing a volume inside of which the coolant liquid can circulate. One of these two plates bears the projection defining the liquid chamber, wherein the coolant liquid can circulate as well. The projection of the plate making up the liquid chamber extends opposite of the internal housing.

[0009] The liquid may be a water-based coolant liquid, e.g., a mix of water and glycol, which is designed to exchange calories with the air flowing inside the air flow channels. Each air flow channel is furthermore equipped with an air flow disrupter, which helps distribute the air inside the heat core.

[0010] The first section and second section of the liquid chamber are measured according to the direction in which the air flow channels mainly extend, which is a longitudinal direction from the first longitudinal end to the second longitudinal end or conversely. The first section is bigger than the second section, i.e. its dimension measured according to the longitudinal direction is greater than that of the second section. Such disposition of the liquid chamber helps improve the coolant liquid flow in the lateral liquid passes, thus preventing local boiling in these lateral liquid passes.

[0011] The projection comprises at least one front side and at least one back side opposite to the front side. The liquid chamber is located closer to one of the longitudinal end of the heat core. The front side of this projection is closer to this particular end of the heat core, whereas the back side faces the opposite longitudinal end. For instance, if the liquid chamber is located closer to the air outlet than to the air inlet, the front side will face the longitudinal end of the heat core bearing the air outlet while the back side will be facing towards the air inlet.

[0012] As an option of the invention, the front side is straight and the back side comprises at least a curved part.

[0013] These sides extend mainly perpendicularly to the longitudinal direction of the heat core. According to another option, the back side has a convex shape when seen from the opposite front side.

[0014] Alternatively, the back side has a W-shape when seen from the opposite front side.

[0015] The convex shape corresponds to a first embodiment of the liquid chamber, whereas the W-shape is a second embodiment. This W-shape includes an increased section of the liquid chamber covering the most central liquid pass among the plurality of central liquid passes.

[0016] According to an optional characteristic of the invention, the back side is continuous from one lateral liquid pass to the other lateral liquid pass.

[0017] According to an optional characteristic, the front side and the back side are joined by two lateral sides, these two sides extending mainly parallel to the air flow channels.

[0018] Each of the lateral sides thus extends alongside a transverse end of the plate having the liquid chamber, these transverse ends also extending parallel to the air flow channels. The two lateral sides may consequently be perpendicular or substantially perpendicular to the front side.

[0019] In some embodiments, a section of one of the lateral sides is longer than a section of the other lateral side, such sections being measured according to a longitudinal direction of the heat core parallel to the air flow channels.

[0020] Such discrepancy is the dimension of the aforementioned sections results in a dissymmetry of the lateral sides of the liquid chamber, which allows a modulation of the coolant liquid flow.

[0021] According to another optional characteristic, the heat core comprises at least a coolant inlet and a coolant outlet, the projection defining the liquid chamber bearing one of them.

[0022] The coolant liquid enters the heat core via the coolant inlet and exits it via the coolant outlet. Either the coolant inlet or the coolant outlet is located on the projection. In other words, either the coolant inlet is located on the liquid chamber or the coolant outlet is located on the liquid chamber.

[0023] In particular embodiments, there can be two projections for two liquid chambers, one bearing the coolant inlet and the other bearing the coolant outlet.

[0024] According to another optional characteristic of the invention, the coolant inlet and the coolant outlet are located on opposite plates of the heat core.

[0025] Such arrangement of the coolant inlet and outlet ensures a satisfactory flow of coolant in the heat core, so that all the air flow channels are adequately cooled.

[0026] According to another optional characteristic of the invention, the coolant outlet is located closer to the first longitudinal end of the heat core whereas the coolant inlet is located closer to the second longitudinal end of the heat core.

[0027] Likewise, this arrangement of the coolant inlet and of the coolant outlet contributes to a satisfactory distribution of coolant liquid in the heat core.

[0028] Other characteristics, details and advantages of the invention will become clearer on reading the following description, on the one hand, and several examples of realisation given as an indication and without limitation with reference to the schematic drawings annexed, on the other hand, on which:

[Fig. 1] is a perspective view of a heat exchanger according to the invention;

[Fig. 2] is another perspective view of the heat exchanger of figure 1 with one of its plates having been removed, the heat exchanger being shown upside down compared to figure 1;

[Fig. 3] is a cross-section of the heat exchanger of figure 1;

[Fig. 4] is a schematic representation of one of the plates of the heat exchanger;

[Fig. 5] is a cross-section of the plate of figure 4.

[0029] The characteristics, variants and different modes of realization of the invention may be associated with each other in various combinations, in so far as they are not incompatible or exclusive with each other. In particular, variants of the invention comprising only a selection of features subsequently described in from the other features described may be imagined, if this selection of features is enough to confer a technical advantage and/or to differentiate the invention from prior art.

[0030] Like numbers refer to like elements throughout drawings.

[0031] In the following description, the designations "longitudinal", "transversal" and "vertical" refer to the orientation of the heat exchanger according to the invention. A longitudinal direction corresponds to a direction in which the air flow channels of the heat exchanger mainly extend, this longitudinal direction being parallel to a longitudinal axis L of a coordinate system L, V, T shown in the figures. A transversal direction corresponds to a direction in which the liquid passes slot in between the air flow channels, this transversal direction being parallel to a transverse axis T of the coordinate system L, V, T, and perpendicular to the longitudinal axis L. Finally, a vertical direction corresponds to a vertical axis V of the coordinate system L, V, T, the vertical axis V being perpendicular to the longitudinal axis L and the transversal axis T.

[0032] Figure 1 and figure 2 are perspective views of a heat exchanger 1 according to the invention, such heat exchanger 1 being destined to cool an air flow. The heat exchanger 1 can for example be installed in a vehicle such as an automobile vehicle in order to cool its inlet gases.

[0033] The heat exchanger 1 comprises a heat core 2, which makes up its central portion. The heat core 2 is furthermore the part of the heat exchanger 1 where calorie exchanges occur, these calorie exchanges being essential to the cooling of the air flow. To this end, the heat core 2 comprises air flow channels 4 within which the air needing to be cooled can circulate. Such air flow channels 4 are particularly visible on figure 2, as well as on figure 3 which is a cross-section view. These air flow channels 4 extend from one side of the heat core 2 to the other according to a longitudinal direction, more particularly from a first longitudinal end 6 of the heat core to its second longitudinal end 8. The air flow channels 4 are contained in an internal housing 10 of the heat core 2, which is made of plates such as aluminium plates. As represented here, the heat core 2 comprises four rectangular plates, among which a first plate 12, a second plate 14, a third plate 16 and a fourth plate 18. The first plate 12 and the third plate 16 face each other and extend mainly according to a longitudinal-transversal plane, whereas the second plate 14 and the fourth plate 18 face each other and extend mainly according to a longitudinal-vertical plane.

[0034] The air flow thus circulates in the internal housing 10 and more precisely in the air flow channels 4 from the second longitudinal end 8 to its first longitudinal end 6. More specifically, the air flow may enter the heat exchanger 1 via an air inlet 20 located at the second longitudinal end 8 and may exit it via an air outlet 22 located at the first longitudinal end 6 of the heat core 2. Both the air inlet 20 and the air outlet 22 are air flow ducts, and they may for instance be made of polyvinyl chloride.

[0035] Each air flow channel 4 is equipped with an air flow disrupter 23, which helps distribute the air flow more homogeneously within the heat core 2. These air flow disrupters are particularly visible on figure 3. They snake inside their respective air flow channels 4 from one of their lateral ends in the vicinity of the first plate 12 to an opposite lateral end of the air flow channels 4 close to the third plate 16, forming winglets in the air flow channels 4 so as to deviate the air flowing inside them.

[0036] The air flow channels 4 are stacked one next to the other according to a transverse direction, perpendicular to the longitudinal direction. The spaces between two contiguous air flow channels 4 define liquid passes 24, within which a coolant liquid may circulate. This coolant liquid can be water-based; it can for instance be a mix of 50 % water and 50 % glycol. In addition to the liquid passes 24, the coolant liquid may also circulate in the spaces between the air flow channels 4 and the first plate 12 on the one hand and between these air flow channels 4 and the third plate 16. Among the liquid passes 24, the heat core 2 comprises a group of central liquid passes 26 as well as two lateral liquid passes 28, 30 bordering said group of central liquid passes 26, among which a first lateral liquid pass 28 and a second lateral liquid pass 30. The first lateral liquid pass 28 faces the second plate 14 whereas the second lateral liquid pass 30 faces the fourth plate 18, although there may be an air flow channel 4 in between each of these first and second lateral liquid passes 28, 30 and the plate 14, 18 they respectively face. In any case, every air flow channel 4 and every liquid pass 24 is contained within the internal housing 10 of the heat core 2 of the heat exchanger 1. In other words, this internal housing 10 participates in delimiting a volume for both the air flow and the coolant liquid to circulate inside of.

[0037] The heat exchanger 1 according to the invention is configured to receive the coolant liquid via a coolant inlet 32 and to evacuate the coolant liquid via a coolant outlet 34. Similarly to the air inlet 20 and the air outlet 22, the coolant inlet 32 and the coolant outlet 34 are ducts and can be made of polyvinyl chloride. As shown on figures 1 and 2, the coolant inlet 32 and the coolant outlet 34 may be located on opposite plates of the heat core 2, with here the coolant outlet 34 located on the first plate 12 and the coolant inlet 32 located on the third plate 16. This ensures the coolant liquid can flow through the heat core 2 from the first plate 12 to the third plate 16, which means from one of its lateral end to the other, and cool the air flowing in the air flow channels 4 adequately. To this end, the coolant outlet 34 may in addition be located in the vicinity of the first longitudinal end 6 of the heat core 2 while the coolant inlet 32 is closer to its second longitudinal end 8, thus reinforcing the spreading of the coolant liquid within the heat core 2.

[0038] The first, second, third and fourth plates 12, 14, 16, 18 making up the heat core 2 are mostly plane. However, according to the invention at least one of these plates, here the first plate 12, has a projection in addition to its plane portion. Such projection defines a liquid chamber 36 which is in liquid communication with the liquid passes 24, so that the coolant liquid can circulate through it. This liquid chamber 36 is particularly visible on figures 4 and 5. The height H of the projection, which corresponds to its dimension measured according to the vertical direction, can for example be of the order of 3,5 mm. The liquid chamber is made of four sides 38, 40, 42, 44 extending from the first plate 12 and opposite to the internal housing 10. These four sides 38, 40, 42, 44 are joined by a back wall 45, which is pierced with a hole 47 to which either the coolant inlet 32 or the coolant outlet 34 can be connected. The back wall 45 is mainly parallel to the plane portion of the first plate 12.

[0039] Out of these four sides, two delimit the liquid chamber 36 according to the transverse direction, namely a first lateral side 38 and a second lateral side 40 which are particularly visible on figure 4. These lateral sides 38, 40 extend along the longitudinal direction, that is to say mainly parallel to the air flow channels 4 and to the liquid passes 24.

[0040] In some particular embodiments, not shown on the figures, either the first lateral side 38 is longer than the second lateral side 40 or conversely the second lateral side 40 is longer than the first lateral side 38. More precisely, a section of one of these lateral sides 38, 40 is longer than the other, such section being measured according to the longitudinal direction. The resulting shape of the liquid chamber 36 allows a different repartition of the cooling liquid within the heat core 2, thus enabling an increase of the cooling phenomenon on one side of the heat core 2 and more particularly for a chosen lateral liquid pass 28, 30.

[0041] The first and second lateral sides 38, 40 are joined by at least one front side 42, which faces the first longitudinal end 6 of the heat core 2, and at least one back side 44 opposite the front side 42. The front side

42 and the back side 44 forming the projection of the liquid chamber 36 may exhibit varying shapes depending on the embodiments. As shown on the figures, the front side 42 is straight and extends mainly perpendicularly to the longitudinal direction of the heat core 2, along the first longitudinal end 6, whereas the back side 44 is curved. According to the invention, the liquid chamber 36 thus has a first section 46 covering at least one of the lateral liquid passes 28, 30 which is bigger than a second section 48 covering at least one of the central liquid passes 26. This first section 46 and second section 48 are measured according to the longitudinal direction, and it is understood that by "bigger" it is meant that the first section 46 has a greater dimension than the second section 48 when they are measured according to this longitudinal direction. Such first section 46 and second section 48 can be seen on figures 4 and 5. As an example, the first section can be about 45 mm long whereas the second section 48 can be about 30 mm long.

[0042] There can be a third section 50, covering the lateral liquid pass 28, 30 which is not covered by the first section 46. For instance, the first section 46 may cover the first lateral liquid pass 28 while the third section covers the second lateral liquid pass 30, the second section 48 covering any or a plurality of the central liquid passes 26. Such shape of the liquid chamber 36 ensures that the coolant liquid is distributed adequately within the heat core 2, and particularly in direction of the lateral liquid passes 28, 30 which may be subject to local boiling if they are not sufficiently cooled.

[0043] The back side 44 is continuous from the first lateral side 38 to the second lateral side 40, as well as from the first lateral liquid pass 28 to the second lateral liquid pass 30. It may have a convex shape when seen from the front side 42. Alternatively and although not illustrated on the figures, the back side 44 may have a W-shape when seen from this front side 42. Both embodiments help improve the flow of coolant liquid within the heat core 2. When the back side 44 is of the W-shape, one section covering the central liquid pass 26 located in the middle of the heat core 2 according to the transverse direction has an increased dimension compared to that of the second section 48. In other terms, this particular section covering the central liquid pass 26 located in the middle may have the same dimension than that of the first section 46 or the second section 48 when measured according to the longitudinal direction. In some other embodiments not shown on the figures, the front side 42 of the liquid chamber 36 is curved, or is of the W-shape, whereas the back side is curved or straight.

[0044] As mentioned before, the back wall 45 of the projection of the liquid chamber 36 is pierced with a hole 47, to which either the coolant inlet 32 or the coolant outlet 34 can be connected. This means that the liquid chamber 36 bears the coolant inlet 32 or the coolant outlet 34. However, in particular embodiments there can be two liquid chambers, with the liquid chamber 36 of the first plate 12 corresponding to a first liquid chamber bearing the coolant inlet 32 and a second liquid chamber located on the third plate 16 bearing the coolant outlet 34, or conversely the liquid chamber 36 bearing the coolant outlet 34 and the other liquid chamber bearing the coolant inlet 32. These particular embodiments further help distributing the coolant fluid adequately within the heat core 2, thus preventing local boiling in the lateral liquid passes 28, 30.

[0045] The present invention thus covers a heat exchanger configured to improve its internal repartition of coolant fluid, in order to ensure that each of its liquid passes is adequately cooled.

[0046] Many modifications and other embodiments of the invention set forth herein will come to mind to one skilled in the art to which the invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

Claims

1. A heat exchanger (1) configured to cool an air flow with a coolant liquid, comprising a heat core (2), a first air flow duct located at a first longitudinal end (6) of said heat core (2) and a second air flow duct located at a second longitudinal end (8) of said heat core (2), the heat core (2) comprising a plurality of air flow channels (4) defining liquid passes (24, 26, 28, 30) in between at least two air flow channels (4), said heat core (2) comprising a group of central liquid passes (26) and two lateral liquid passes (28, 30) bordering said group of central liquid passes (26), said heat core (2) comprising a plurality of plates (12, 14, 16, 18) enveloping the air flow channels (4) and the liquid passes (24, 26, 28, 30), at least one of the plates (12) having a plane portion and a projection defining a liquid chamber (36) which is in liquid communication with the liquid passes (24, 26, 28, 30), the liquid chamber (36) having a first section (46) covering at least one of the lateral liquid passes (28, 30) which is bigger than a second section (48) covering at least one of the central liquid passes (26).

2. A heat exchanger (1) according to the preceding claim, wherein the projection comprises at least one front side (42) and at least one back side (44) opposite to the front side (42).

3. A heat exchanger (1) according to the preceding claim, wherein the front side (42) is straight and the back side (44) comprises at least a curved part.

4. A heat exchanger (1) according to the preceding claim, wherein the back side (44) has a convex shape when seen from the opposite front side (42).

5. A heat exchanger (1) according to claim 2, wherein the back side (44) has a W-shape when seen from the opposite front side (42).

6. A heat exchanger (1) according to any one of the claims 2 to 5, wherein the back side (44) is continuous from one lateral liquid pass (28) to the other lateral liquid pass (30).

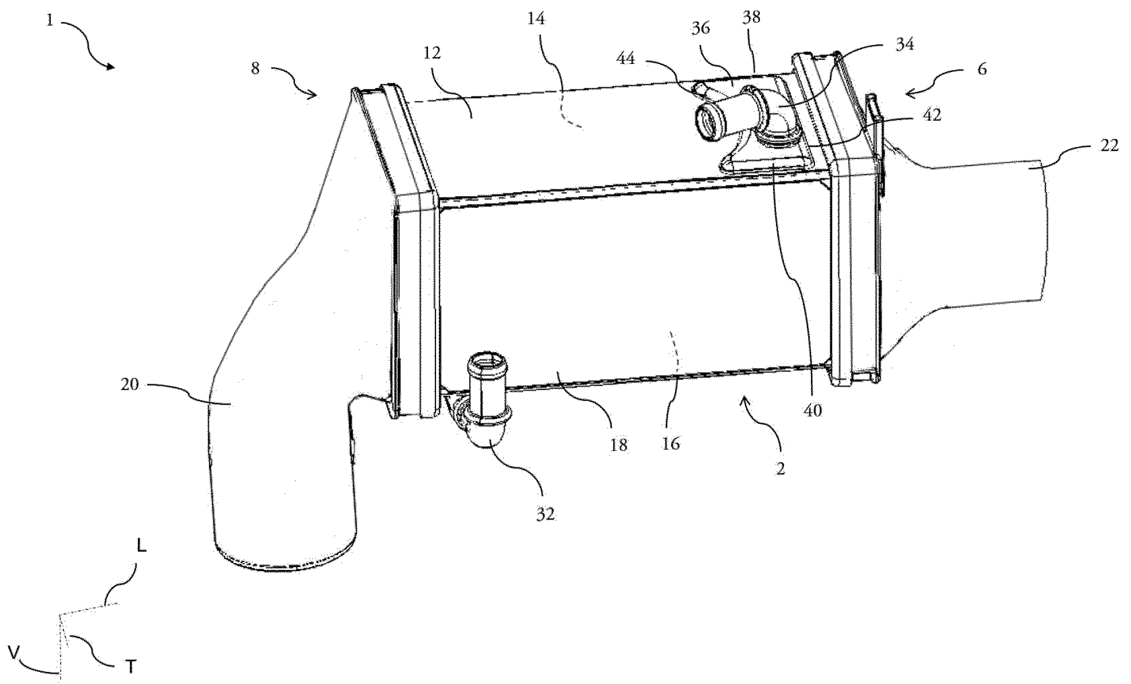
7. A heat exchanger (1) according to any one of the claims 2 to 6, wherein the front side (42) and the back side (44) are joined by two lateral sides (38, 40), these two sides (38, 40) extending mainly parallel to the air flow channels (4).

8. A heat exchanger (1) according to the preceding claim, wherein a section (46) of one of the lateral sides (28, 30) is longer than a section (50) of the other lateral side (28, 30), such sections (46, 50) being measured according to a longitudinal direction of the heat core (2) parallel to the air flow channels (4).

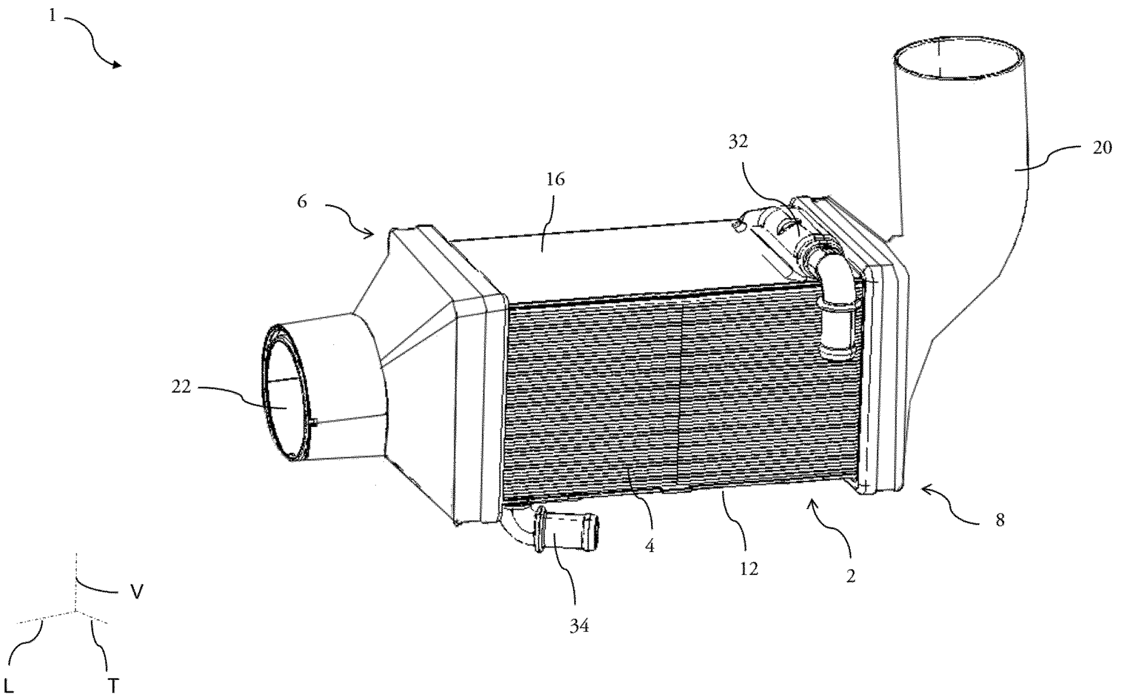
9. A heat exchanger (1) according to any one of the preceding claims, wherein the heat core (2) comprises at least a coolant inlet (32) and a coolant outlet (34), the projection defining the liquid chamber (36) bearing one of them.

10. A heat exchanger (1) according to the preceding claim, wherein the coolant inlet (32) and the coolant outlet (34) are located on opposite plates (12, 16) of the heat core (2).

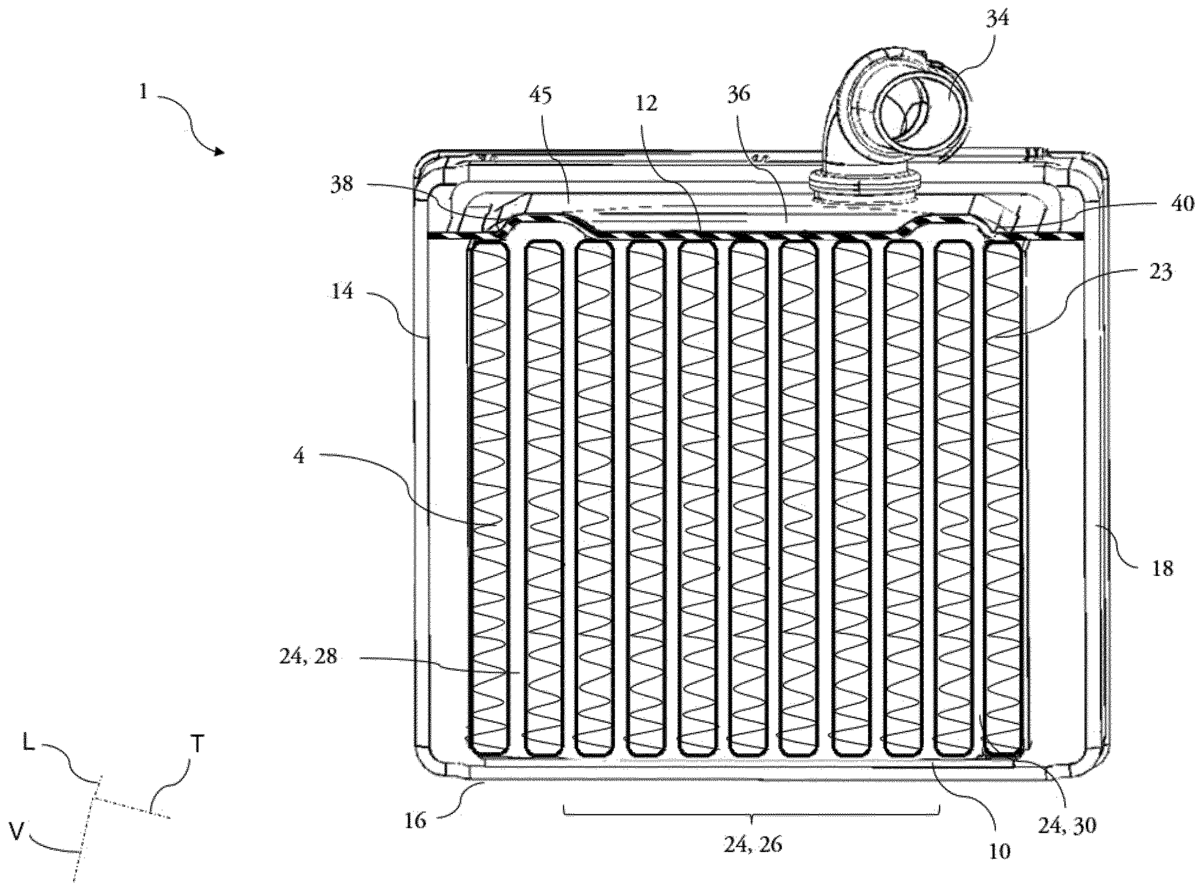
[Fig. 1]



[Fig. 2]



[Fig. 3]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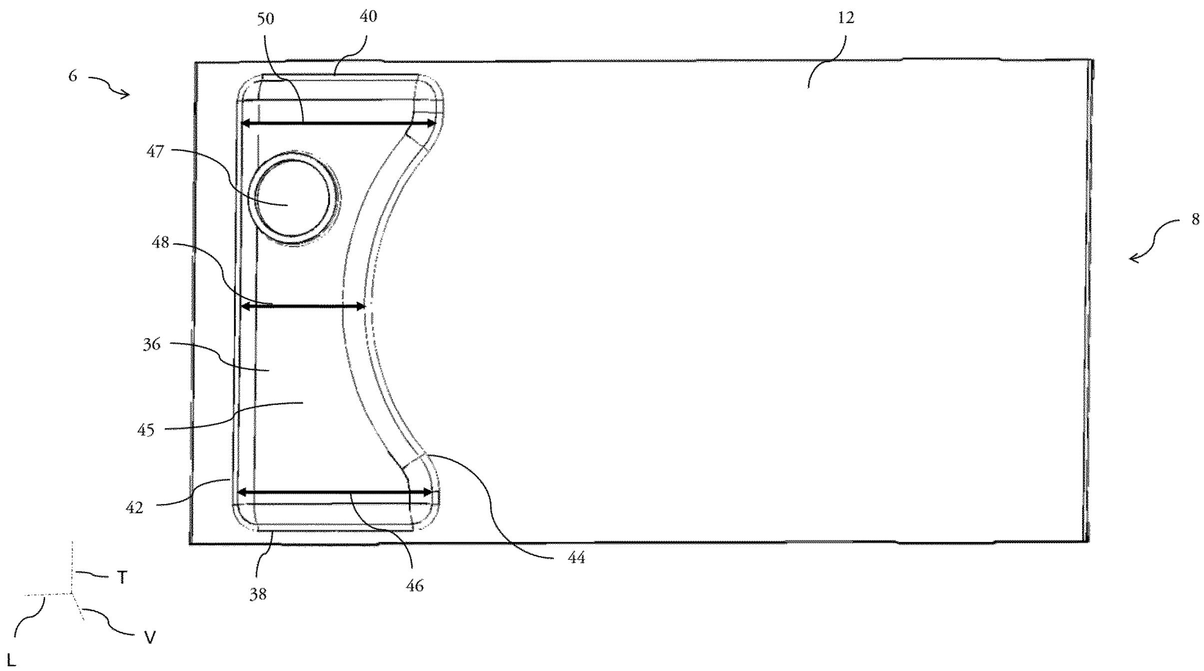
[Fig. 4]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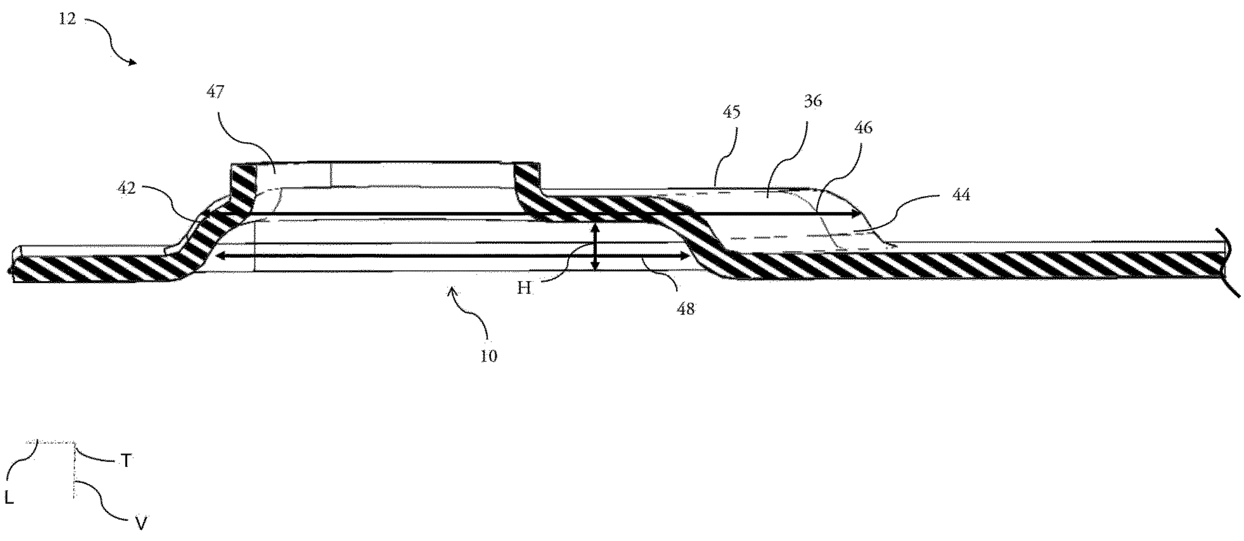
[Fig. 5]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EUROPEAN SEARCH REPORT

Application Number
EP 22 15 1647

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TECHNICAL FIELDS SEARCHED (IPC)

F28F
F28D
F02B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	6 June 2022	Mellado Ramirez, J

CATEGORY OF CITED DOCUMENTS

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