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(54) A HEAT EXCHANGER, IN PARTICULAR A CHILLER

(57) The present invention relates to a heat exchanger (1), in particular a chiller, comprising:
- a housing (2);
- a plurality of channel tubes (3) placed in the housing (2) and comprising inner channels (4), in particular inner micro-channels, configured to allow a circulation of a first heat transfer fluid within the inner channels;
- a fluid flow path (5) for a second heat transfer fluid, said fluid flow path being formed within the housing (2) and having a fluid inlet (8) and a fluid outlet (9) located on the housing (2), the fluid flow path (5) passing between the tubes (3) to enable heat exchange between the first heat transfer fluid and the second heat transfer fluid;
- a main return area (10) configured to enable a U turn on the fluid flow path (5);
- a local area (11, 12) configured to change a distribution of the second heat transfer fluid in the main return area (10).

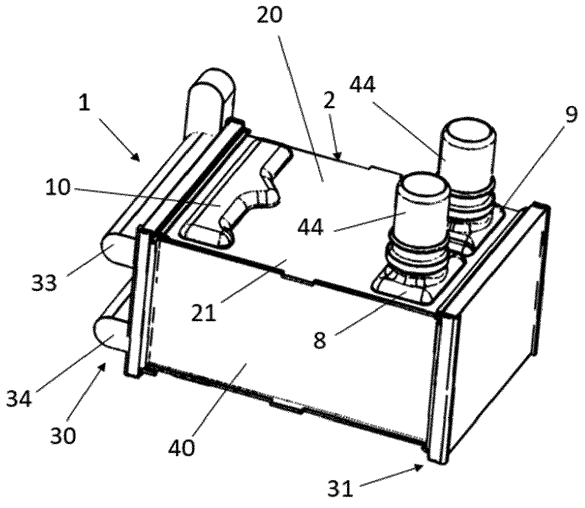

Figure 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to a vehicle heat exchanger, more particularly, the present invention relates to a water chiller for a use in a vehicular environment.

BACKGROUND

[0002] EP Patent application EP21175515 discloses a water chiller for exchanging heat between a first fluid and a second fluid. The heat exchanger comprises a plurality of heat exchange tubes fluidically connecting a first manifold and a second manifold for a first fluid flow there between. The first fluid flows between the manifolds through the tubes and a second fluid flows around the heat exchange tubes. For instance, the disclosed water chiller enables heat exchange between the water circulating around the tubes and the refrigerant flowing through these tubes, resulting in the cooling of the water.
[0003] The invention aims, in particular, to enhance the performance of such heat exchangers.

SUMMARY

[0004] The invention relates to a heat exchanger, in particular a chiller, comprising:

- a housing;
- a plurality of channel tubes placed in the housing and comprising inner channels, in particular inner microchannels, configured to allow a circulation of a first heat transfer fluid within the inner channels;
- a fluid flow path for a second heat transfer fluid, said fluid flow path being formed within the housing and having a fluid inlet and a fluid outlet located on the housing, the fluid flow path passing between the tubes to enable heat exchange between the first heat transfer fluid and the second heat transfer fluid;
- a main return area configured to enable a U turn on the fluid flow path;
- a local area configured to change a distribution of the second heat transfer fluid in the main return area.

[0005] According to an aspect of the invention, the fluid flow path for the second heat transfer fluid has an upstream pass that is upstream the main return area, and a downstream pass that is downstream the main return area.
[0006] For instance, the upstream pass corresponds to the fluid flow between the fluid inlet and the main return area, and the downstream pass corresponds to the fluid flow between the main return area and the fluid outlet.
[0007] The invention allows the second heat transfer fluid (for instance the coolant) to have a better flow which results in significantly lower pressure drops. Enhanced efficiency, reduced pressure drop, and improved flow in targeted areas contribute to overall improvements.
[0008] The invention may be used for a chiller, a water condenser or a water charged air cooler.
[0009] According to an aspect of the invention, the main return area extends across an entire transversal dimension of the fluid flow path.
[0010] The transversal dimension is measured perpendicularly to the channel tubes, and is in particular perpendicular to the upstream and downstream passes.
[0011] For instance, the main return area has a transversal dimension corresponding to the sum of the transversal dimension of the upstream pass and the transversal dimension of the downstream pass.
[0012] According to an aspect of the invention, the upstream and downstream passes have the same transversal dimension.
[0013] In another embodiment of the invention, the upstream and downstream passes have different transversal dimension.
[0014] According to an aspect of the invention, the local area has a transversal dimension that is smaller than the transversal dimension of the main return area.
[0015] According to an aspect of the invention, the transversal dimension of the local area is smaller than 50% of the transversal dimension of the main return area, in particular smaller than 40% or 30% or 20% of the transversal dimension of the main return area.
[0016] According to an aspect of the invention, the local area is connected to the main return area.
[0017] In this case, the main return area and the local area form a global unitary shape.
[0018] In a variant, the local area is separate from the main return area.
[0019] In this case, the main return area and the local area are defined as two distinct shapes.
[0020] According to an aspect of the invention, the main return area has a substantially rectangular shape.
[0021] According to an aspect of the invention, the fluid flow path is connected to the main return area so that the fluid flow path reaches the main return area in a first portion of the rectangular shape and the fluid flow leaves the main return area via a second portion of the rectangular shape.
[0022] According to an aspect of the invention, the first and second portions may be the two halves of the rectangular shape.
[0023] In a variant, the first portion of the rectangular shape may have a transversal dimension greater than the transversal dimension of second portion of the rectangular shape.
[0024] According to an aspect of the invention, the fluid U-turn takes place in the rectangular shape.
[0025] According to an aspect of the invention, the

transversal dimension of the main return area corresponds to the long side of the rectangular shape (length) of the main return area.

[0026] According to an aspect of the invention, the local area is configured to enlarge the cross section for the fluid in the main return area. In other words, thanks to the local area, an additional cross section for the second fluid is made available when the second fluid accomplishes the U-turn.

[0027] According to an aspect of the invention, the cross-section is bigger at the fluid outlet and/or at the middle of the U-turn to minimize the pressure drop of the second fluid.

[0028] In particular, the local area(s) are positioned where the velocity of the second fluid is higher, to increase the cross-section in the U-turn. It enables to decrease the pressure drop.

[0029] According to an aspect of the invention, if the local area connects the main return area, the local area may be defined as an extension of the main return area.

[0030] According to an aspect of the invention, the local area is located adjacent to the middle of the main return area.

[0031] According to an aspect of the invention, in case the main return area has a rectangular shape, the local area is placed adjacent to the middle of the long side of the rectangular shape.

[0032] According to an aspect of the invention, the main return area together with the local area define a global shape that is symmetrical in respect to a plane of symmetry of the heat exchanger.

[0033] For instance, this shape is a T-shape. The leg of the T is oriented towards the fluid inlet and outlet.

[0034] In another embodiment of the invention, the main return area together with the local area define a global shape that is asymmetrical.

[0035] For instance, the local area is closer to a lateral side (which may be a short side of a rectangle) than an opposite lateral side of the main return area.

[0036] In other words, the local area is not positioned at the middle of the main return area.

[0037] For instance, this shape is a L-shape. The smallest branch of the L is oriented towards the fluid inlet.

[0038] In an embodiment of the invention, only one local area is associated with the main return area.

[0039] In another embodiment of the invention, multiple local areas are associated with the main return area.

[0040] For instance, the main return area connects a first local area in its middle and a second local area on a lateral side of the main return area.

[0041] According to an aspect of the invention, at least two local areas are associated with the main return area, with a first local area placed in contact with the main return area and a second local area separate from the main return area.

[0042] According to an aspect of the invention, the local area is positioned closer to the fluid inlet than the fluid outlet of the second fluid.

[0043] According to an aspect of the invention, the local area has a rounded shape.

[0044] According to an aspect of the invention, the local area forms a rounded extension on the long side of the main return area.

[0045] According to an aspect of the invention, the main return area is an embossed area on a wall of the housing.

[0046] According to an aspect of the invention, the local area is an embossed area on a wall of the housing.

[0047] According to an aspect of the invention, the main return area and the local area have the same height.

[0048] According to an aspect of the invention, the main return area and the local area have different heights.

[0049] According to an aspect of the invention, the fluid inlet and outlet are positioned on one side of a wall of the housing and the main return area is positioned on an opposite side of the wall.

[0050] According to an aspect of the invention, the housing comprises a plate that defines a wall of the housing.

[0051] According to an aspect of the invention, the main return area and the local area are embossed areas on the plate.

[0052] According to an aspect of the invention, the main return area and the local area are formed by embossing or stamping the plate.

[0053] According to an aspect of the invention, the housing comprises two opposite walls formed by two plates.

[0054] According to an aspect of the invention, the channel tubes contact the housing walls along their longitudinal edges.

[0055] According to an aspect of the invention, the second fluid leaves the inter-tube space and accomplishes the U-turn in the volume of the main return area and the local area.

[0056] According to an aspect of the invention, a portion of length of the longitudinal edges of the channel tubes faces the main return area and the local area.

[0057] According to an aspect of the invention, both plates comprise a main return area.

[0058] In another embodiment of the invention, only one of the plates comprise the main return area and the local area and the other plate comprise a main return area without a local area.

[0059] The main return area is also called water box.

[0060] According to an aspect of the invention, the channel tubes are longitudinally positioned between the inlet and outlet on one side, and the main return area and the local area on the other side.

[0061] According to an aspect of the invention, the heat exchanger comprises two opposite end manifolds and the channel tubes are connected at their opposite sides to the end manifolds.

[0062] According to an aspect of the invention, the first heat transfer fluid is a refrigerant.

[0063] According to an aspect of the invention, the second heat transfer fluid is a coolant, in particular glycol water.

[0064] According to an aspect of the invention, the housing is made of plastics or metal.

[0065] Further advantages, features and details of the invention will be apparent from the following description of a preferred example embodiment and with the aid of the drawings, showing in:

- Figure 1 illustrates in perspective a heat exchanger according to an embodiment of the invention;
- Figure 2 illustrates in perspective the heat exchanger according to FIG. 1, from the bottom side;
- Figure 3 illustrates the channel tubes within the heat exchanger according to FIG. 1;
- Figure 4 illustrates, in a detailed view, a single channel tube of the heat exchanger according to FIG. 1;
- Figure 5 illustrates the top face of the heat exchanger according to FIG. 1;
- Figure 6 illustrates an internal side of the heat exchanger according to FIG. 1;
- Figure 7 shows a heat exchanger according to another embodiment of the invention.

[0066] Identical components or respectively components with the same function are provided with the same reference numbers in the figures.

[0067] FIG. 1 shows a heat exchanger 1 designed as a water chiller in accordance with an embodiment of the present invention.

[0068] The heat exchanger 1 comprises a housing 2 and a plurality of channel tubes 3 placed in the housing 2, as shown in FIG. 3.

[0069] Each channel tube 3 comprises inner channels, in particular inner micro-channels (see FIG. 4) configured to allow a circulation of a first heat transfer fluid within the inner channels 4. The first heat transfer fluid is a refrigerant.

[0070] A fluid flow path 5 for a second heat transfer fluid (which is water in this embodiment of the invention) is formed within the housing 2 and extends between a fluid inlet 8 and a fluid outlet 9 located on the housing 2. The fluid flow path 5 is illustrated with arrows F1, F2 and F3 (see FIG. 5 for instance).

[0071] The fluid flow path 5 passes between the tubes 3 to enable heat exchange between the first heat transfer fluid in the micro-channels 4 and the second heat transfer fluid around the tubes 3.

[0072] The heat exchanger 1 comprises a main return area 10 configured to enable a U turn (see arrow F2 on FIG. 5) on the fluid flow path 5 of the second heat transfer fluid.

[0073] Two local areas 11 and 12 are added adjacent to the main return area 10 to modify the distribution of the second heat transfer fluid in the main return area 10.

[0074] The fluid flow path 5 has an upstream pass 5a (arrow F1) that is upstream the main return area 10, and a downstream pass 5b (arrow F3) that is downstream the main return area 10.

[0075] The upstream pass 5a corresponds to the fluid flow between the fluid inlet 8 and the main return area 10, and the downstream pass 5b corresponds to the fluid flow between the main return area 10 and the fluid outlet 9.

[0076] The main return area 10 extends across substantially an entire transversal dimension Dtrans of the fluid flow path 5.

[0077] The transversal dimension Dtrans is measured perpendicularly to the channel tubes 3, and is in particular perpendicular to the upstream and downstream passes 5a and 5b.

[0078] The main return area 10 has a transversal dimension Dtrans corresponding to the sum of the transversal dimension of the upstream pass 5a and the transversal dimension of the downstream pass 5b.

[0079] The upstream and downstream passes 5a and 5b have the same transversal dimension.

[0080] In another embodiment of the invention, the upstream and downstream passes 5a and 5b have different transversal dimension.

[0081] The local areas 11 and 12 each have a transversal dimension, respectively Dt11 and Dt12, that is smaller than the transversal dimension Dtrans of the main return area 10.

[0082] Each transversal dimension Dt11, Dt12 of the local area 11 and 12 is smaller than 50% of the transversal dimension Dtrans of the main return area 10, in particular smaller than 40% or 30% or 20% of the transversal dimension Dtrans of the main return area 10.

[0083] The local areas 11 and 12 are connected to the main return area 10.

[0084] In this case, the main return area 10 and the local areas 11 and 12 form a global unitary shape.

[0085] In another embodiment of the invention as illustrated in FIG. 7, the local area 11 is separate from the main return area 10. In this case, the main return area 10 and the local area 11 are defined as two distinct shapes.

[0086] The main return area 10 has a substantially rectangular shape as illustrated in FIG. 5.

[0087] The fluid flow path 5 is connected to the main return area 10 so that the fluid flow path 5 reaches the main return area 10 in a first portion 15 of the rectangular shape and the fluid flow 5 leaves the main return area 10 via a second portion 16 of the rectangular shape.

[0088] The first and second portions 15 and 16 may be the two halves of the rectangular shape.

[0089] The fluid U-turn takes place in the rectangular shape.

[0090] The transversal dimension Dtrans of the main return area 10 corresponds to the long side of the rec-

tangular shape (length) of the main return area 10.

[0091] Each local area 11, 12 is configured to enlarge the cross section for the fluid in the main return area 10. In other words, thanks to the local areas 11 and 12, an additional cross section for the second fluid is made available when the second fluid accomplishes the U-turn.

[0092] The cross-section is bigger at the fluid outlet and/or at the middle of the U-turn to minimize the pressure drop of the second fluid (water).

[0093] In particular, the local area(s) 11, 12 are positioned where the velocity of the second fluid is higher, to increase the cross-section in the U-turn. It enables to decrease the pressure drop.

[0094] If the local areas 11, 12 connect the main return area 10, each local area 11, 12 may be defined as an extension of the main return area. 10

The local area 11 is located adjacent to the middle of the main return area 10.

[0095] In case the main return area 10 has a rectangular shape, the local area 11 is placed adjacent to the middle of the long side of the rectangular shape.

[0096] If the local area 12 is omitted, the main return area 10 together with the local area 11 define a global shape that is symmetrical in respect to a plane of symmetry PS of the heat exchanger 1.

[0097] For instance, this shape is a T-shape. The leg of the T is oriented towards the fluid inlet 8 and outlet 9.

[0098] If the local area 12 is present, the main return area 10 together with the local areas 11 and 12 define a global shape that is asymmetrical.

[0099] The local area 12 is closer to a lateral side (which is a short side of a rectangle) than an opposite lateral side of the main return area 10.

[0100] In other words, the local area 12 is not positioned at the middle of the main return area 10.

[0101] For instance, this shape (main return area 10 and local area 12) is a L-shape. The smallest branch of the L is oriented towards the fluid inlet 8.

[0102] In embodiment of FIG. 5, the main return area 10 connects a first local area 11 in its middle and a second local area 12 on a lateral side of the main return area 10.

[0103] The local area 12 is positioned closer to the fluid inlet 8 than the fluid outlet 9 of the second fluid (water).

[0104] Each local area 11, 12 has a rounded shape forming a rounded extension on the long side of the main return area 10.

[0105] The main return area 10 is an embossed area on a wall 20 of the housing 2. The local areas 11 and 12 are embossed areas on the wall 20 of the housing 2.

[0106] The main return area 10 and the local areas 11 and 12 have the same height.

[0107] The fluid inlet 8 and outlet 9 are positioned on one side of the wall 20 of the housing 2 and the main return area 10 is positioned on an opposite side of the wall 20.

[0108] The housing 2 comprises a plate 21 that defines a wall 20 of the housing 2.

[0109] The main return area 10 and the local areas 11 and 12 are embossed areas on the plate 21, by stamping the plate 21.

[0110] The housing 2 comprises two opposite walls 20 formed by two parallel plates 21, one serving as an upper wall and the other as a bottom wall.

[0111] Both plates 21 are provided with the main return area 10 and the local areas 11 and 12, as illustrated in FIG. 1 and FIG. 2.

[0112] The channel tubes 3 contact the housing opposite walls 20 along their longitudinal edges 24, as shown in FIG. 6.

[0113] The second fluid leaves the inter-tube space and accomplishes the U-turn in the volume of the main return area 10 and the local areas 11 and 12.

[0114] A portion of length of the longitudinal edges 24 of the channel tubes 3 faces the main return area 10 and the local areas 11 and 12.

[0115] In another embodiment of the invention, only one of the plates 21 comprise the main return area and the local area and the other plate comprise a main return area without a local area.

[0116] The main return area 10 is also called water box.

[0117] The channel tubes 3 are longitudinally positioned between the inlet 8 and outlet 9 on one side, and the main return area 10 and the local areas 11 and 12 on the opposite side.

[0118] The heat exchanger 1 comprises two opposite end manifolds 30 and 31 and the channel tubes 3 are connected at their opposite ends to the end manifolds 30 and 31.

[0119] Manifold 30 comprises a distribution column 33 configured to distribute the refrigerant in the tubes 3, and a collection column 34 configured to collect the refrigerant as it exits the tubes 3. The distribution column 33 distributes the refrigerant to a first set of channels 4 via slots on a guide plate (not shown).

[0120] Manifold 31, opposite to manifold 30, is configured to guide the refrigerant between different sets of the micro-channels 4 and to define the return pass.

[0121] The housing 2 further comprises side plates 40. The plates 21, 40 and manifolds 30, 31 could be brazed together to form together a sealed volume that accommodates the tubes 3 and is designed for glycol water flow within the sealed volume.

[0122] The fluid inlet 8 and the fluid outlet 9 each have a tubular fluid connector 44 to ensure a connection with an external coolant circuit.

[0123] The housing 2 is made of plastics or metal.

Claims

1. A heat exchanger (1), in particular a chiller, comprising:

    - a housing (2);
    - a plurality of channel tubes (3) placed in the housing (2) and comprising inner channels (4),

in particular inner micro-channels, configured to allow a circulation of a first heat transfer fluid within the inner channels;
- a fluid flow path (5) for a second heat transfer fluid, said fluid flow path being formed within the housing (2) and having a fluid inlet (8) and a fluid outlet (9) located on the housing (2), the fluid flow path (5) passing between the tubes (3) to enable heat exchange between the first heat transfer fluid and the second heat transfer fluid;
- a main return area (10) configured to enable a U turn on the fluid flow path (5);
- a local area (11, 12) configured to change a distribution of the second heat transfer fluid in the main return area (10).

2. A heat exchanger (1) according to claim 1, wherein the main return area (10) extends across an entire transversal dimension (Dtrans) of the fluid flow path (5).

3. A heat exchanger (1) according to claim 2, wherein the local area (11, 12) has a transversal dimension (Dt11, Dt12) that is smaller than the transversal dimension (Dtrans) of the main return area (10), in particular the transversal dimension of the local area (11, 12) is smaller than 50% of the transversal dimension of the main return area (10), in particular smaller than 40% or 30% or 20% of the transversal dimension of the main return area (10).

4. A heat exchanger (1) according to any of the preceding claims, wherein the local area (11, 12) is connected to the main return area (10).

5. A heat exchanger (1) according to any of claims 1 to 3, wherein the local area (11, 12) is separate from the main return area (10).

6. A heat exchanger (1) according to claims 4 and 5, wherein at least two local areas are associated with the main return area, with a first local area placed in contact with the main return area and a second local area separate from the main return area.

7. A heat exchanger (1) according to any of the preceding claims, wherein the main return area (10) has a substantially rectangular shape, and in particular the fluid flow path (5) is connected to the main return area (10) so that the fluid flow path (5) reaches the main return area (10) in a first portion (15) of the rectangular shape and the fluid flow leaves the main return area (10) via a second portion (16) of the rectangular shape.

8. A heat exchanger (1) according to any of the preceding claims, wherein the main return area (10) together with the local area (11, 12) define a global shape that is symmetrical in respect to a plane of symmetry (PS) of the heat exchanger (1).

9. A heat exchanger (1) according to any of claims 1 to 7, wherein the main return area (10) together with the local area (11, 12) define a global shape that is asymmetrical.

10. A heat exchanger (1) according to any of the preceding claims, wherein the local area (11, 12) is positioned closer to the fluid inlet (8) than the fluid outlet (9) of the second fluid.

11. A heat exchanger (1) according to any of the preceding claims, wherein the local area (11, 12) is an embossed area on a wall (20) of the housing (2).

12. A heat exchanger (1) according to any of the preceding claims, wherein the fluid inlet (8) and outlet (9) are positioned on one side of a wall (20) of the housing (2) and the main return area (10) is positioned on an opposite side of the wall (20).

13. A heat exchanger (1) according to any of the preceding claims, wherein the channel tubes (3) are longitudinally positioned between the inlet (8) and outlet (9) on one side, and the main return area (10) and the local area (11, 12) on the other side.

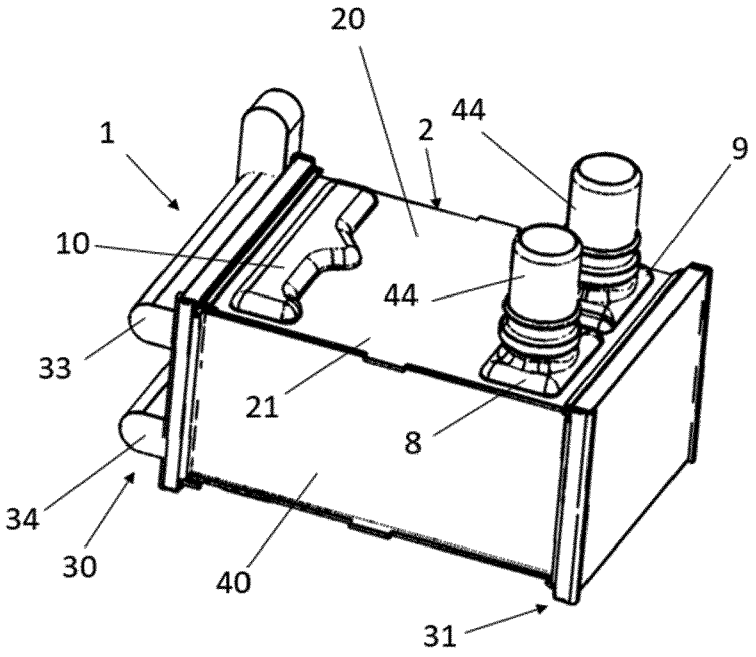

Figure 1

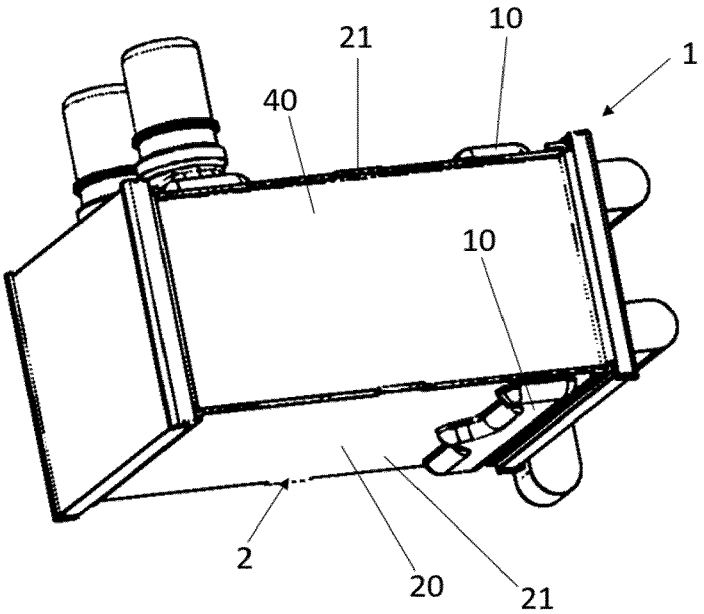

Figure 2

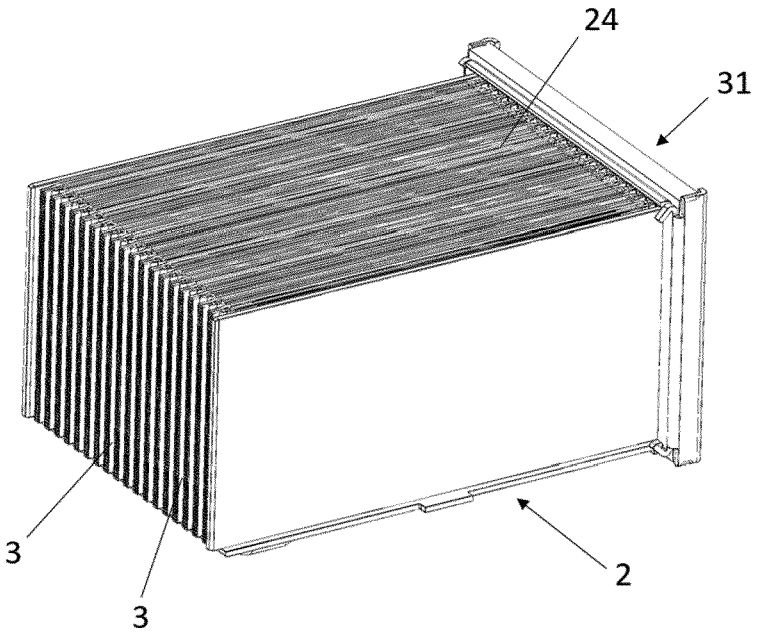

Figure 3

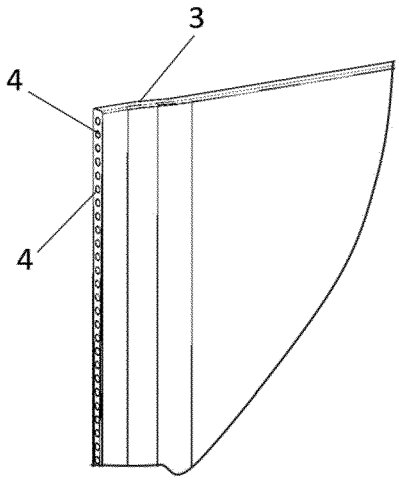

Figure 4

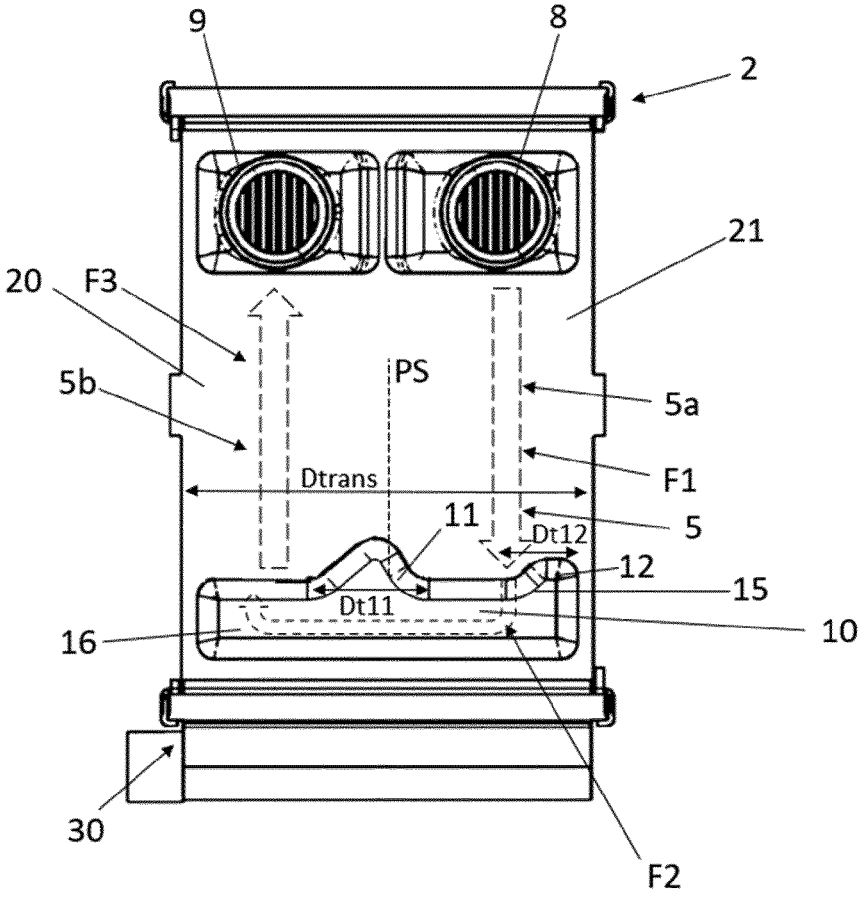

Figure 5

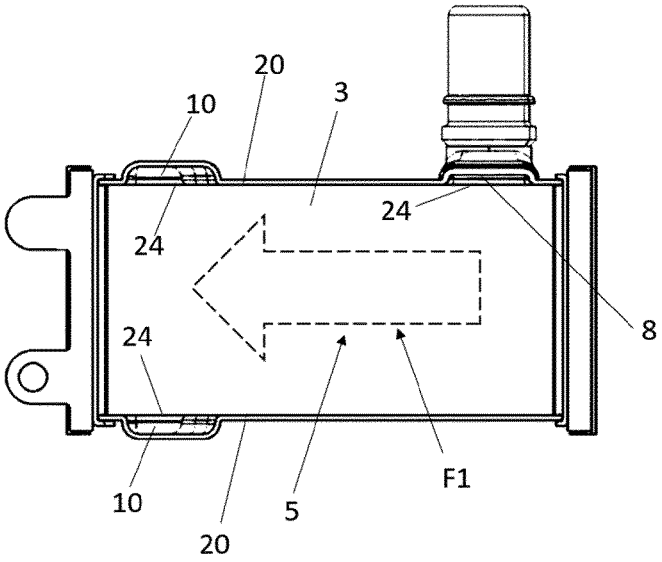

Figure 6

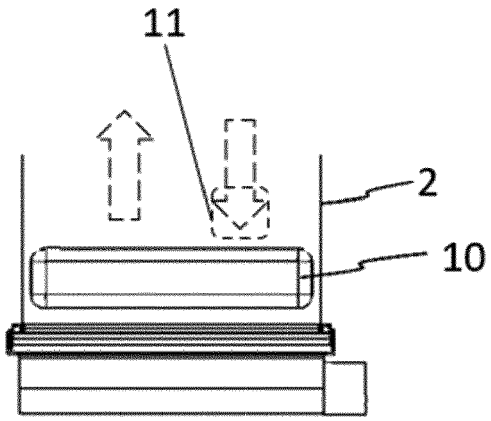

Figure 7

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EUROPEAN SEARCH REPORT

Application Number
EP 23 21 5172

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2014/190673 A1 (DAY ALAN [FR]) 10 July 2014 (2014-07-10) * figures 1-3 *	1-13	INV. F28D7/16 F28F9/02
A	US 2021/325118 A1 (SHEN QIE [CN] ET AL) 21 October 2021 (2021-10-21) * figures 13-18 *	1-13	ADD. F28F1/02
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A	GB 468 013 A (CHARLES HAROLD LEACH) 28 June 1937 (1937-06-28) * the whole document *	1-13	

TECHNICAL FIELDS SEARCHED (IPC)

F28D
F28F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 April 2024	Vassoille, Bruno

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 21 5172

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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29-04-2024

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