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(54) **A HEAT EXCHANGER**

(57) The present invention discloses a heat exchanger (100) includes a first header tank assembly (10) and a second header tank assembly (20) comprising at least one distribution plate (14, 24) formed with openings (14a, 24a) and intermediate ribs (14b, 24b) and at least one collecting plate (12, 22) formed with apertures (12a, 22a) and intermediate webs (12b, 22b) and at least one cover plate (16, 26) configuring at least one of distribution channel, collection channel and bypass channels with respect to the corresponding distribution plate (14, 24) that are arranged sequentially with respect to each other and collectively define at least one u-flow of a heat exchange fluid through at least one of first extruded tube (15a) and the corresponding second extruded tube (15b) and at least one u-flow between first and second extruded tube (15a, 15b).

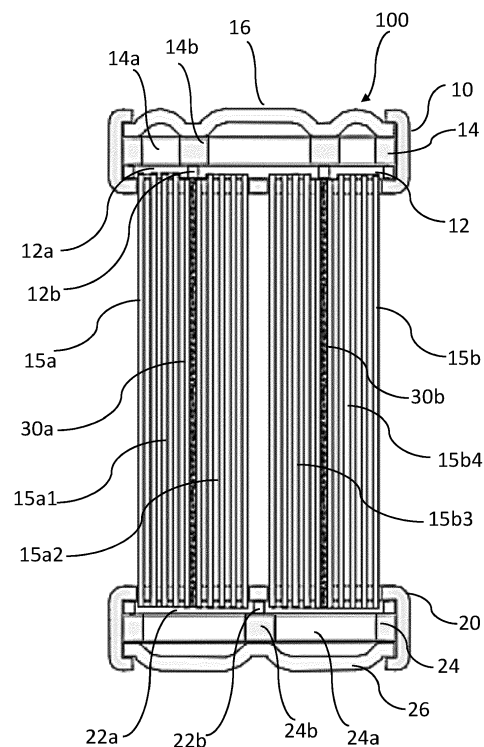


FIG. 1

Description

FIELD OF INVENTION

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

BACKGROUND OF THE INVENTION

[0002] The present invention relates to the field of heat exchanger and in particular to heat exchangers through which a refrigerant fluid flows under high pressure. In this regard, the invention relates more particularly to air conditioning gas coolers, inner gas coolers or evaporators through which a refrigerant fluid in the supercritical state, such as for example, carbon dioxide, also known as CO₂ or R744 flows. It should be noted that such heat exchanger may also be suitable for other types of refrigerant fluids like R290 and alike, including mixture thereof. Such heat exchangers find particular application in motor vehicles.

[0003] A conventional heat exchanger includes a heat exchanger core with a plurality of flow passages, which is formed by arranging a plurality of heat exchanger tubes parallelly with respect to each other to reduce the pressure loss of the refrigerant fluid, which flows through the said heat exchanger tubes. Such heat exchanger also includes a first manifold and a second manifold in fluid communication with the heat exchanger tubes. The heat exchanger tubes are configured to allow the refrigerant fluid to transverse between the first and second manifolds. The heat exchange tubes also configured to allow a thermal exchange between the refrigerant fluid, flowing inside said heat exchange tubes, and air flowing outside the heat exchanger, thus extracting heat from the air flowing across the heat exchanger core.

[0004] However, in case of conventional heat exchangers the heat exchanging tubes in which the refrigerant fluid is traversing between first and second manifold does not maintain a thermal communication which results in low thermal conductivity between the refrigerant fluid passing through adjacent heat exchanging tubes.

[0005] Further, even though a distribution plate is arranged in the manifolds intended to distribute the refrigerant fluid to the heat exchanger tubes the presence of the distribution plate may not ensure the homogenous distribution of the refrigerant fluid especially in the heat exchanger tubes in the middle of the exchanger core and the heat exchanger tubes disposed close to the end of the distribution channel, which causes non-homogenous temperature spread across the heat exchanger active area. In addition, in case of multi-phase refrigerant fluids with phase change during the circulation of the fluid in the heat exchanger the fluid heat exchange coefficient and the fluid density vary widely depending on the fluid phase such as liquid, gaseous or the mixture of both. Therefore maintaining the optimal fluid flow distribution is difficult.

[0006] Accordingly, there is a need for an improved heat exchanger that can achieve homogeneous distribution of the refrigerant fluid across the heat exchanger. More specifically, there is a need for an improved heat exchanger to achieve optimal functioning in a complex architecture, working under a high delta temperature.

SUMMARY OF THE INVENTION

[0007] The present invention discloses a heat exchanger for a motor vehicle includes a first header tank assembly and a second header tank assembly disposed opposite to and spaced apart from the first header tank assembly. The heat exchanger further includes a first set of parallel tubes and a corresponding second set of parallel tubes interposed in parallel between the first header tank assembly and the second header tank assembly, characterized in that the at least one of the first header tank assembly and the second header tank assembly comprising at least one distribution plate formed with openings and intermediate ribs and at least one collecting plate formed with apertures and intermediate webs and at least one cover plate, configuring at least one of distribution channel, collection channel and bypass channels with respect to the corresponding distribution plate, that are arranged sequentially with respect to each other and collectively define at least one u-flow of a first fluid through at least one of first extruded tube and the corresponding second extruded tube and at least one u-flow between first and second extruded tube.

[0008] Advantageously, at least one of the first openings is extending along length of the distribution plate and adapted to distribute the first heat exchange fluid with respect to at least one of the corresponding first apertures.

[0009] Advantageously, at least one of the first openings is extending along length of the distribution plate and adapted to collect the first heat exchange fluid with respect to at least one of the corresponding first apertures.

[0010] Advantageously, at least one of the first openings disposed centrally and adapted to collect and distribute the first heat exchange fluid with respect to at least one of the corresponding first apertures.

[0011] Advantageously, at least one of the second openings adapted to collect and distribute the first heat exchange fluid with respect to at least one of the corresponding second apertures.

[0012] Advantageously, at least one of the first apertures adapted to either one of distribute and collect the first heat exchange fluid with respect to the channels of the first and second extruded tube.

[0013] Advantageously, at least one of the first apertures adapted to distribute and collect the first heat exchange fluid with respect to the channels of the first extruded tube to configure fluid communication between channels of first and second extruded tubes.

[0014] Advantageously, at least one of the second apertures adapted to either one of collect and distribute

the first heat exchange fluid with respect to the channels of the corresponding first and second extruded tube.

[0015] Advantageously, at least one of the second apertures adapted to collect and distribute the first heat exchange fluid with respect to the channels of the corresponding first and second extruded tube to configure fluid communication between channels of first and second extruded tubes.

[0016] Advantageously, the each first extruded tube comprising a first set of channels and a second set of channels. Each second extruded tube comprising a third set of channels and a fourth set of channels.

[0017] Advantageously, the intermediate webs in the collecting plate is adapted to block at least one channel in the first extruded tube to configure a separation between the first set of channels and the second set of channels.

[0018] Advantageously, the intermediate webs in the collecting plate is adapted to block at least one channel in the second extruded tube to configure a separation between the third set of channels and the fourth set of channels.

[0019] Advantageously, at least one of the first side openings and the first side apertures adapted to distribute the first heat exchange fluid to the first set of channels of the first extruded tube.

[0020] Advantageously, the second openings and the second apertures adapted to configure fluid communication between the first set of channels and the second set of channels to define first u-flow passage within the first extruded tube.

[0021] Advantageously, the first central openings and the first central apertures adapted to configure fluid communication between the second set of channels and the third set of channels to define second u-flow passage between the first extruded tube and the second extruded tube.

[0022] Advantageously, the second openings and the second apertures adapted to configure fluid communication between the third and the fourth set of channels to define third u-flow passage within the second extruded tube.

[0023] Advantageously, the first side openings and the first apertures adapted to collect the first heat exchange fluid from the fourth channels.

[0024] Advantageously, the first intermediate ribs, the first intermediate webs and at least one of first and second dummy tubes are aligned to fluidically isolate the first set of channels from second set of channels and the third channel from fourth channels at a first header tank assembly.

[0025] Advantageously, the second intermediate ribs, the second intermediate webs are aligned to fluidically isolate the channels of the first and the second extruded tubes with respect to each other at the second header tank assembly.

[0026] Advantageously, at least one of the first apertures adapted to collect and distribute the first heat exchange fluid with respect to the corresponding the first

openings to configure fluid communication between channels of first and second extruded tubes.

[0027] Advantageously, the distribution channel distributes heat exchange fluid to a first extruded tube of each pair of corresponding extruded tubes.

[0028] Advantageously, the collection channel collects heat exchange fluid from a second extruded tube of each pair of corresponding extruded tubes.

[0029] Advantageously, the bypass channels are adapted to configure u-flow within at least one of the first extruded tube and the corresponding second extruded tube.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] Other characteristics, details and advantages of the invention may be inferred from the description of the invention hereunder. A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying figures, wherein:

FIG. 1 illustrates a schematic diagram of a heat exchanger for a motor vehicle in accordance with an embodiment of the present invention.

FIG. 2 illustrates a schematic diagram of a first collecting plate and a second collecting plate.

FIG. 3 shows a schematic diagram of a first distribution plate and a second distribution plate.

FIG. 4 shows a schematic diagram of a first cover and a second cover.

DETAILED DESCRIPTION OF THE INVENTION

[0031] 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.

[0032] FIG. 1 of the accompanying drawings illustrates a schematic diagram of a heat exchanger 100 for a motor vehicle in accordance with an embodiment of the present invention. The heat exchanger 100 includes a first header tank assembly 10 (hereinafter also referred to as first header tank) and a second header tank assembly 20 (hereinafter also referred to as second header tank) disposed opposite to and spaced apart from the first header tank assembly 10. The heat exchanger 100 further includes a first set of parallel tubes 15a (hereinafter also referred as first set of extruded tubes or first extruded tubes) and a corresponding second set of parallel tubes 15b (hereinafter also referred as second set of extruded tubes or second extruded tubes) interposed in

parallel between the first header tank assembly 10 and the second header tank assembly 10. Each tube in the first set of parallel tubes 15a and the second set of parallel tubes 15b is formed with multiple channels (also known as capillaries). However, the present invention is not limited to any particular number for the channels in the tubes 15a, 15b.

[0033] The first header tank assembly 10 includes a first collecting plate 12 elongating along the axis of elongation of the first header tank assembly 10. The first collecting plate 12 comprising a first set of apertures 12a adapted to configure fluid communication between the first header tank 10 and the first set of parallel tubes 15a and second set of parallel tubes 15b. In accordance with an embodiment of the present invention, the first collecting plate 12 includes three rows of first set of apertures 12a, wherein at least one of the first set of apertures 12a is adapted either to distribute or collect the heat exchange fluid with respect to the channels of the first extruded tube 15a and the second extruded tube 15b. However, the present invention is not limited to any number of rows of first set of apertures 12a. The first collecting plate 12 further includes first webs 12b disposed between the rows of first set of apertures 12a. The first header tank 10 further includes at least one first distribution plate 14 comprising a first set of openings 14a corresponding to first set of apertures 12a and at least one first distribution plate 14 adapted to receive heat exchange fluid thereon from an inlet. In accordance with an embodiment of the present invention the first distribution plate 14 includes three rows of first set of openings 14a, wherein at least one of the first set of openings 14a is adapted either to collect or distribute the heat exchange fluid with respect to at least one of the corresponding first set of apertures 12a. However, the present invention is not limited to any number of rows of first set of openings 14a. The first distribution plate 14 further includes first ribs 14b disposed between the rows of first set of openings 14a. In addition the first header tank 10 includes a first cover 16 adapted to be fixed to the first header tank 10, wherein the first cover 16 is configured with at least one distribution channel 16a, 16b associated with the corresponding first distribution plate 14. Preferably the first distribution plate 14 is disposed between the first collecting plate 12 and the first cover 16. However, the present invention is not limited to any particular configuration and sequence of connections between the first collecting plate 12, first distribution plate 14 and the first cover 16.

[0034] The second header tank assembly 20 includes a second collecting plate 22 elongating along the axis of elongation of the second header tank assembly 20. The second collecting plate 22 comprising a second set of apertures 22a may be adapted to configure fluid communication between the second header tank 20 and the first set of parallel tubes 15a and second set of parallel tubes 15b. In accordance with an embodiment of the present invention the second collecting plate 22 may

comprise two rows of second set of apertures 22a, wherein at least one of the second set of apertures 22a adapted to either one of collect and distribute the heat exchange fluid with respect to the channels of the corresponding first extruded tube 15a and the second extruded tube 15b. However, the present invention is not limited to any number of rows of second set of apertures 22a. The second collecting plate 22 further comprises second webs 22b disposed between the rows of second set of apertures 22a. The second header tank 20 further includes a second distribution plate 24 comprising a second set of openings 24a corresponding to second set of apertures 22a. In accordance with an embodiment of the present invention the second distribution plate 24 may comprise two rows of second set of openings 24a, wherein at least one of the second set of openings 24a adapted to either one of collect and distribute the heat exchange fluid with respect to at least one of the corresponding second set apertures 22a. However, the present invention is not limited to any number of rows of second set of openings 24a. The second distribution plate 24 further includes second ribs 24b disposed between the rows of second set of openings 24a. In addition the second header tank 20 includes a second cover 26 adapted to be fixed to the second header tank 20, wherein the second cover 26 is configured with at least one distribution channel 26a, 26b, collection channel and bypass channels with respect to the corresponding second distribution plate 24. Preferably the second distribution plate 24 is disposed between the second collecting plate 22 and the second cover 26. However, the present invention is not limited to any particular configuration and sequence of connections between the second collecting plate 22, second distribution plate 24 and the second cover 26.

[0035] Advantageously, the each first extruded tube 15a comprising a first set of channels 15a1 and a second set of channels 15a2 and each second extruded tube 15b comprising a third set of channels 15b3 and a fourth set of channels 15b4. The intermediate webs 12b, 22b in the collecting plate 12, 22 are adapted to block at least one channel in the first extruded tube 15a to configure a separation between the first set of channels 15a1 and the second set of channels 15a2. Further, the intermediate webs 12b, 22b in the collecting plate 12, 22 are adapted to block at least one channel in the second extruded tube 15b to configure a separation between the third set of channels 15b3 and the fourth set of channels 15b4.

[0036] Advantageously, the first intermediate ribs 14b, the first intermediate webs 12b and at least one of first and second dummy tubes 30a, 30b are aligned to fluidically isolate the first set of channels 15a1 from the second set of channels 15a2 and the third set of channels 15b3 from the fourth set of channels 15b4 at a first header tank assembly.

[0037] Advantageously, the second intermediate ribs 24b, the second intermediate webs 22b and at least one

of first and second dummy tubes 30a, 30b are aligned to fluidically isolate the first set of channels 15a1 from the second set of channels 15a2 and the third set of channels 15b3 from the fourth set of channels 15b4 at a second header tank assembly.

[0038] FIG. 2 illustrates a schematic diagram of first collecting plate 12 and the second collecting plate 22, wherein the first collecting plate 12 is disposed in the first header tank 10 and the second collecting plate 22 is disposed in the second header tank 20. Advantageously, the first collecting plate may comprise a first set of apertures 12a disposed in three rows across the longitudinal axis of the first collecting plate 12. The first side apertures 12a1 are adapted to distribute the heat exchange fluid with respect to the channels of the first extruded tube 15a and the second extruded tube 15b. The first central apertures 12a2 are adapted to collect and distribute the heat exchange fluid to configure fluid communication between channels of the first extruded tubes 15a and second extruded tubes 15b. The first side apertures 12a3 are adapted to collect the heat exchange fluid with respect to the channels of the first extruded tube 15a and second extruded tube 15b.

[0039] In accordance with an embodiment of the present invention the second collecting plate 22 may comprise a second set of apertures 22a disposed in two rows across the longitudinal length of the second collecting plate 22. The first row and the second row of second set apertures 22a1, 22a2 are adapted to collect and distribute the heat exchange fluid with respect to the channels of the corresponding first extruded tube 15a and second extruded tube 15b to configure fluid communication between channels of the first extruded tubes 15a and second extruded tubes 15b.

[0040] FIG. 3 illustrates a schematic diagram of first distribution plate 14 and the second distribution plate 24, wherein the first distribution plate 14 is disposed in the first header tank 10 and the second distribution plate 24 is disposed in the second header tank 20. The first side opening 14a1 is disposed at the side of the first distribution plate 14 is extending along the length of the distribution plate 14 and adapted to distribute the heat exchange fluid with respect to at least one of the corresponding first apertures 12a. The first side opening 14a3 is disposed at the other side of the first distribution plate 14 is extending along the length of the distribution plate 14 and adapted to collect the heat exchange fluid with respect to at least one of the corresponding first apertures 12a. Such extended openings in the distribution plate 14 leads to achieve uniform flow rate of heat exchange fluid across the length of the distribution plate 14. The first central openings 14a2 disposed between the first side openings 14a1, 14a3 are adapted to collect and distribute the heat exchange fluid with respect to at least one of the corresponding first apertures 12a.

[0041] Advantageously, the second distribution plate 24 includes a second set of openings 24a disposed in two rows across the longitudinal length of the second dis-

tribution plate 24. The first row and the second row of second set of openings 24a1, 24a2 are adapted to collect and distribute the heat exchange fluid with respect to at least one of the corresponding second apertures 22a.

[0042] FIG. 4 shows a schematic diagram of the first cover 16 and the second cover 26. The first and the second cover 16, 26 includes one or more channels adapted to distribute or collect the heat exchange fluid with respect to the first extruded tube 15a and the second extruded tube 15b.

[0043] Advantageously, at least one of the first side openings 14a1 and the first side apertures 12a1 adapted to distribute the heat exchange fluid to the first set of channels 15a1 of the first extruded tube 15a. The first row of second set openings 24a1 and the first row of second set apertures 22a1 adapted to collect and distribute the heat exchange fluid and configure fluid communication between the first set of channels 15a1 and the second set of channels 15a2 to define first u-flow passage. Further, the first central openings 14a2 and the first central apertures 12a2 adapted to collect and distribute the heat exchange fluid and configure fluid communication between the second set of channels 15a2 and the third set of channels 15b3 to define second u-flow passage. Furthermore, the second row of second set of openings 24a2 and second row of second set apertures 22a2 adapted to configure fluid communication between the third set of channels 15b3 and the fourth set of channels 15b4 to define third u-flow passage. Finally, the first side openings 14a3 and the second side apertures 12a3 adapted to collect the heat exchange fluid from the fourth set of channels 15b4. Such configuration of fluid communication between the channels in the first extruded tube 15a and second extruded tube 15b to define u-flow of the heat exchange fluid increases the heat transfer.

Claims

1. A heat exchanger (100) comprising :

- a first header tank assembly (10);
- a second header tank assembly (20);
- a first set of extruded tubes (15a) and a corresponding second set of extruded tubes (15b) parallelly interposed between the first header tank assembly (10) and the second header tank assembly (20);

wherein the at least one of the first header tank assembly (10) and the second header tank assembly (20) comprises:

- at least one collecting plate (12, 22) formed with apertures (12a, 22a) and intermediate webs (12b, 22b);
- at least one distribution plate (14, 24) formed with openings (14a 24a) and intermediate ribs

- (14b, 24b);
 at least one cover plate (16, 26), configuring at least one of distribution channel, collection channel and bypass channels with respect to the corresponding distribution plate (14, 24), wherein the collecting plate (12, 22), the distribution plate (14, 24) and the cover plate (16, 26) are arranged sequentially with respect to each other and collectively define at least one u-flow of a heat exchange fluid through at least one of first extruded tube (15a) and the corresponding second extruded tube (15b) and at least one u-flow between first and second extruded tube (15a, 15b).
2. The heat exchanger (100) as claimed in any of the previous claims, wherein at least one of the first openings (14a) is extending along length of the distribution plate (14) and adapted to distribute the heat exchange fluid with respect to at least one of the corresponding first apertures (12a).
 3. The heat exchanger (100) as claimed in any of the preceding claims, wherein at least one of the first openings (14a) is extending along length of the distribution plate (14) and is adapted to collect the heat exchange fluid with respect to at least one of the corresponding first apertures (12a).
 4. The heat exchanger (100) as claimed in any of the preceding claims, wherein at least one of the first openings (14a) disposed centrally and adapted to collect and distribute the heat exchange fluid with respect to at least one of the corresponding first apertures (12a).
 5. The heat exchanger (100) as claimed in any of the preceding claims, wherein at least one of the second openings (24a) is adapted to collect and distribute the heat exchange fluid with respect to at least one of the corresponding second apertures (22a).
 6. The heat exchanger (100) as claimed in any of the preceding claims, wherein at least one of the first apertures (12a) is adapted to either one of distribute and collect the heat exchange fluid with respect to the channels of the first and second extruded tube (15a, 15b).
 7. The heat exchanger (100) as claimed in any of the preceding claims, wherein at least one of the first apertures (12a) is adapted to distribute and collect the heat exchange fluid with respect to the channels of the first extruded tube (15a) to configure fluid communication between channels of first and second extruded tubes (15a, 15b).
 8. The heat exchanger (100) as claimed in any of the preceding claims, wherein at least one of the second apertures (22a) is adapted to either one of collect and distribute the heat exchange fluid with respect to the channels of the corresponding first and second extruded tube (15a, 15b).
 9. The heat exchanger (100) as claimed in any of the preceding claims, wherein at least one of the second apertures is (22a) adapted to collect and distribute the heat exchange fluid with respect to the channels of the corresponding first and second extruded tube (15a, 15b) to configure fluid communication between channels of first and second extruded tubes (15a), and (15b).
 10. The heat exchanger (100) as claimed in any of the preceding claim, wherein the first extruded tube (15a) comprises:
 - a first set of channels (15a1);
 - a second set of channels (15a2); disposed parallel to the first set of channels (15a1).
 11. The heat exchanger (100) as claimed in any of the preceding claims, each second extruded tube (15b) comprising:
 - a third set of channels (15b3);
 - a fourth set of channels (15b4); disposed parallel to the third set of channels (15a3).
 12. The heat exchanger (100) as claimed in claim 11, wherein the intermediate webs (12b, 22b) of the collecting plate (12, 22) are adapted to block at least one channel in the first extruded tube (15a) to configure a separation between the first set of channels (15a1) and the second set of channels (15a2).
 13. The heat exchanger (100) as claimed in claim 12, wherein the intermediate webs (12b, 22b) in the collecting plate (12, 22) are adapted to block at least one channel in the second extruded tube (15b) to configure a separation between the third set of channels (15b3) and the fourth set of channels (15b4).
 14. The heat exchanger (100) as claimed in claim 11, wherein at least one of the first openings (14a) and the first apertures (12a) adapted to distribute the heat exchange fluid to the first set of channels (15a1) of the first extruded tube (15a).
 15. The heat exchanger (100) as claimed in claim 11, wherein the second openings (24) and the second apertures (22) are adapted to configure fluid communication between the first set of channels (15a1) and the second set of channels (15a2) to define first u-flow passage within the first extruded tube (15a).

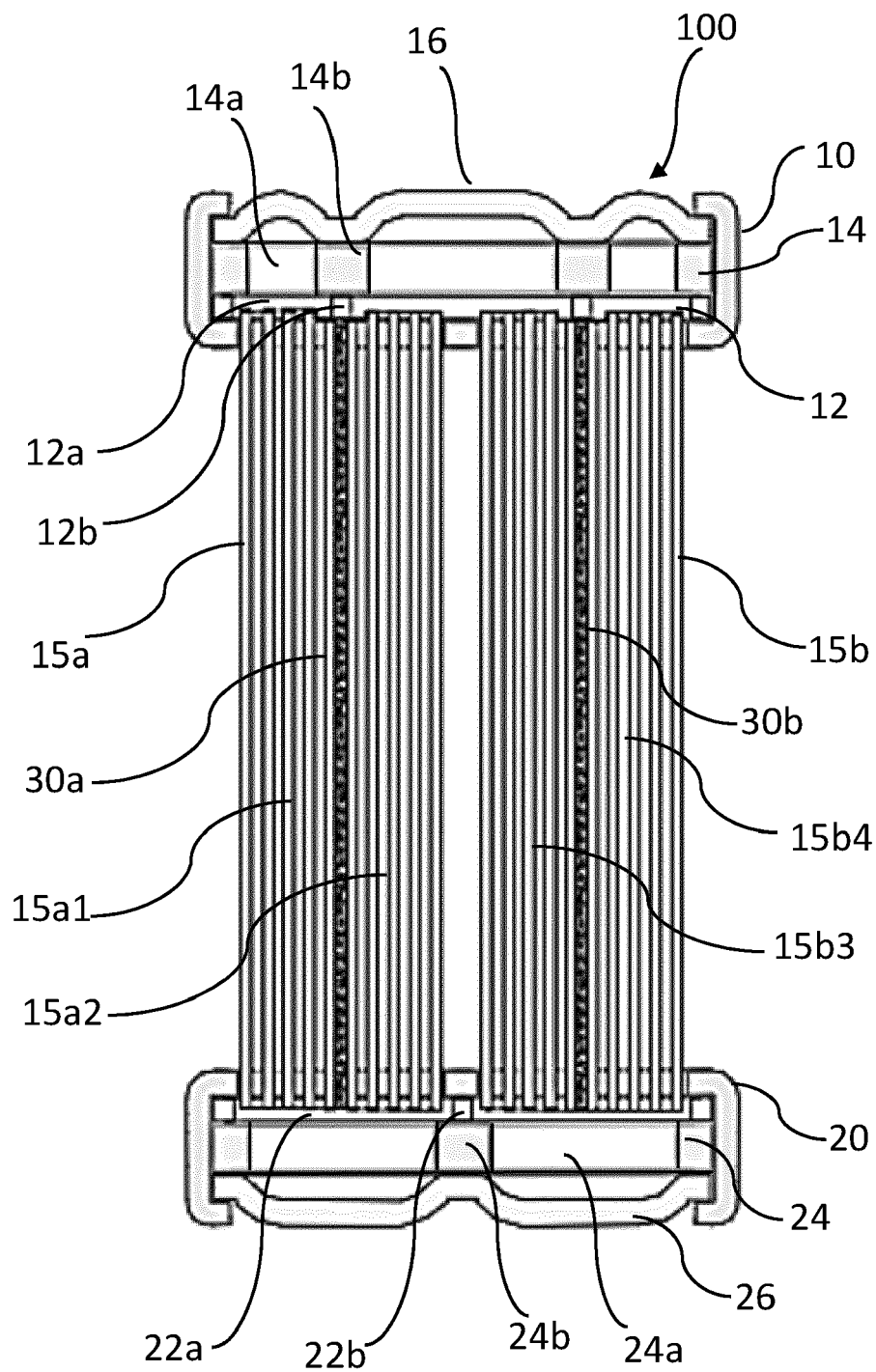


FIG. 1

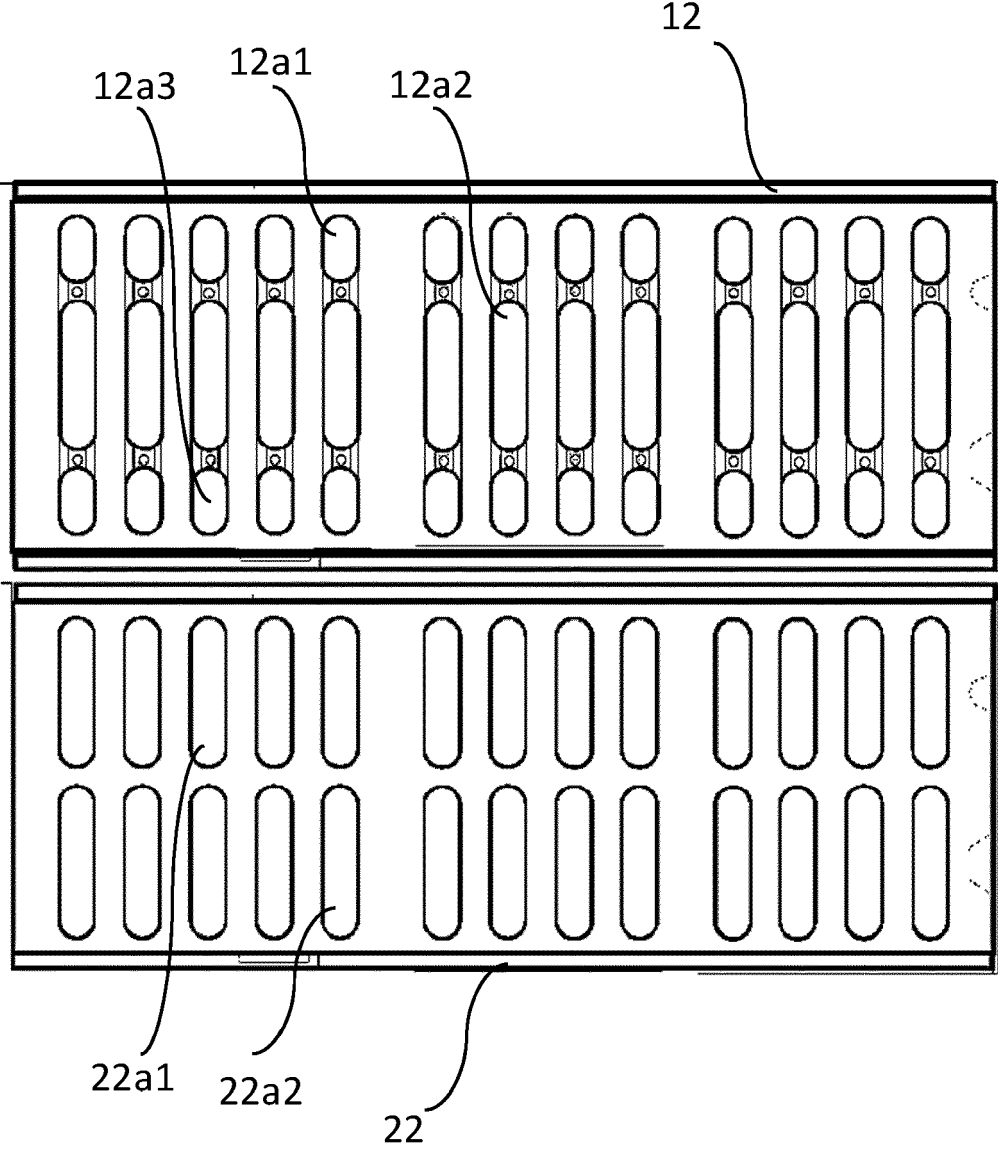


FIG. 2

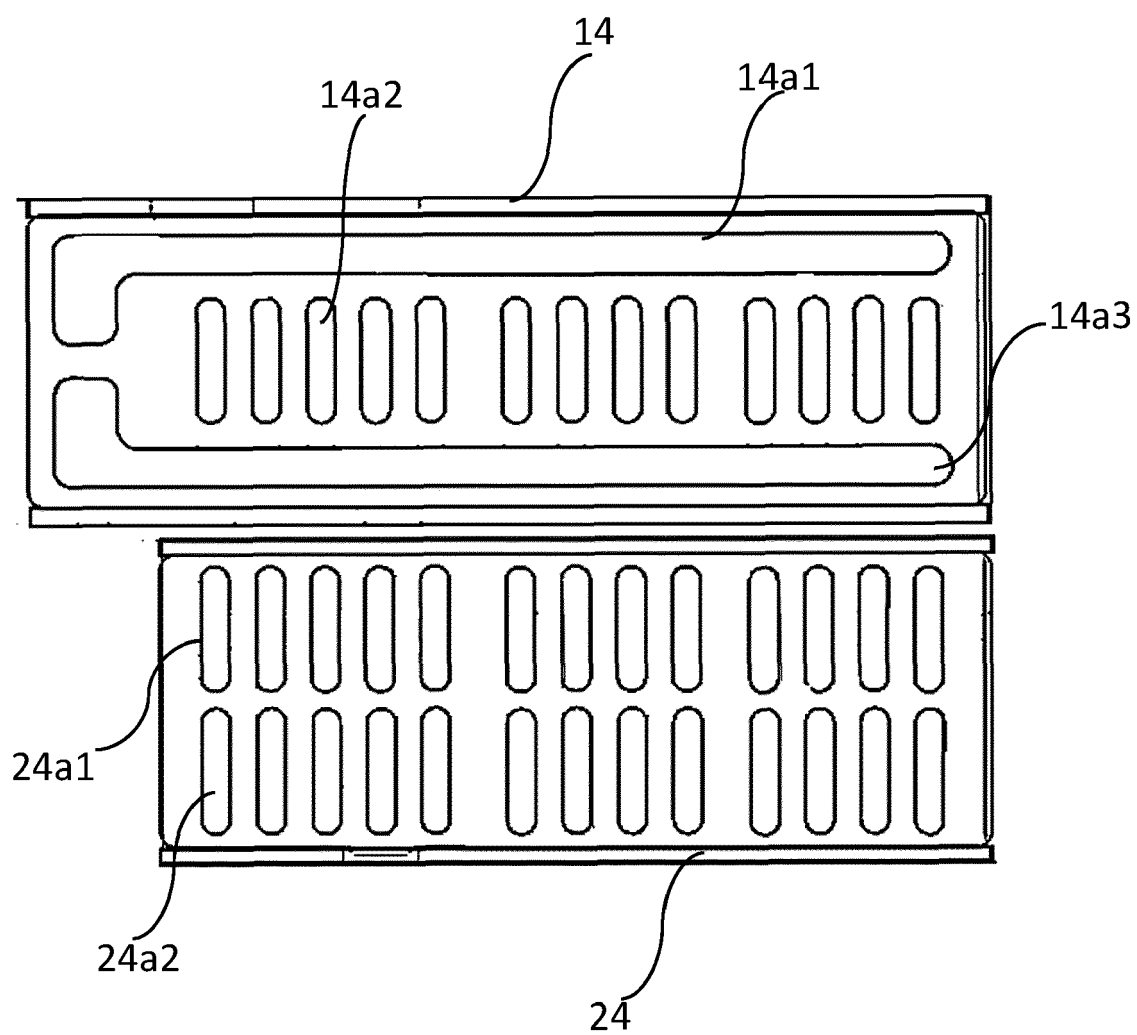


FIG. 3

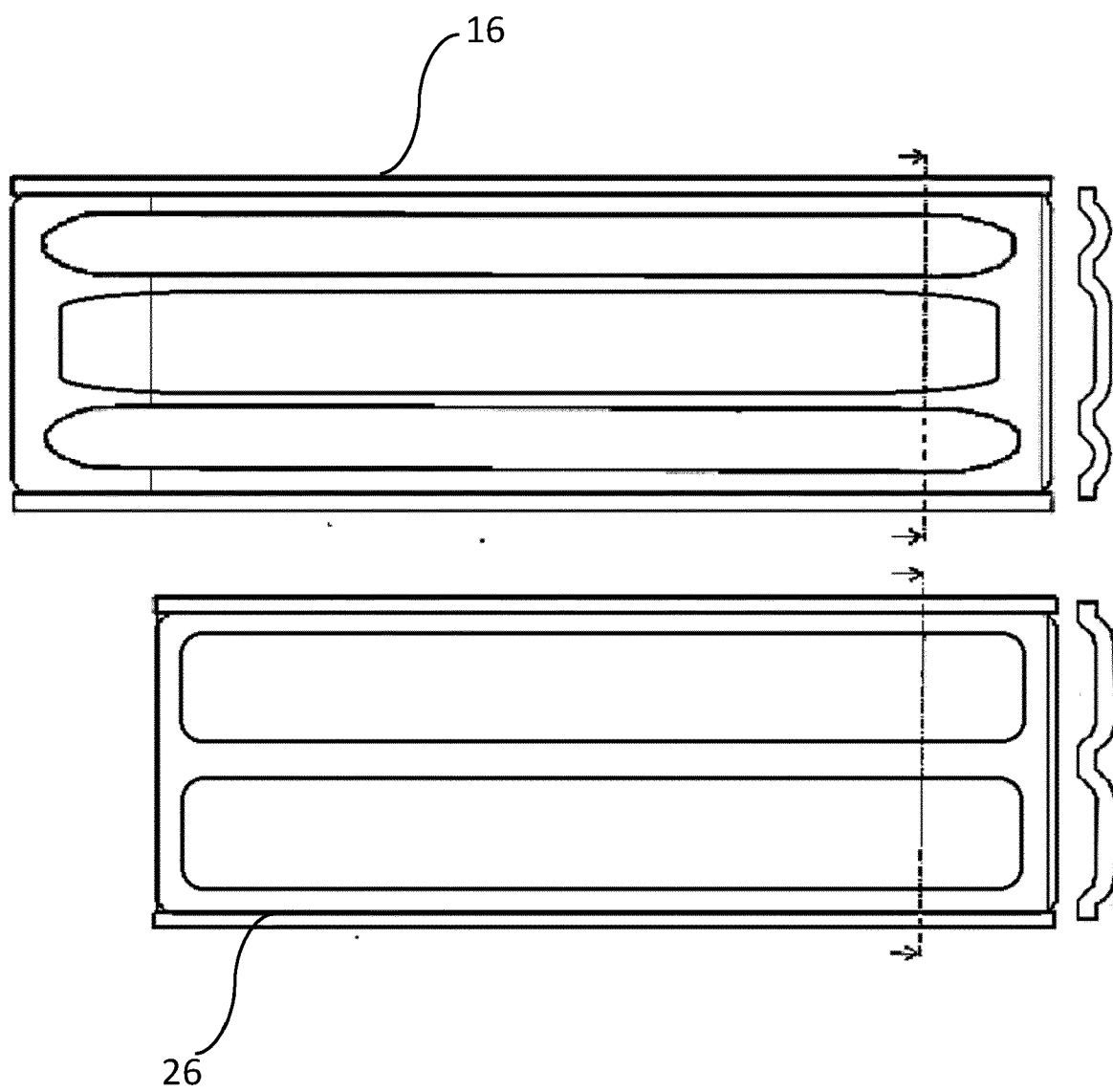


FIG. 4



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Application Number

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EPO FORM 1503 03.82 (P04C01)

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 22 February 2024	Examiner Bloch, Gregor
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

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