



(12)

EUROPEAN PATENT APPLICATION

- (43)

Date of publication:
06.03.2024 Bulletin 2024/10
- (51)

International Patent Classification (IPC):
F28F 9/22 (2006.01)
- (21)

Application number: 22193502.6
- (52)

Cooperative Patent Classification (CPC):
F28D 1/05391; F28F 9/0226; F28F 9/0263;
F28F 2225/08; F28F 2275/122
- (22)

Date of filing: 01.09.2022

- (84)

Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN
- (72)

Inventors:
 - WIDZYK, Lukasz
32 050 Skawina (PL)
 - BUREK, Dariusz
32 050 Skawina (PL)
 - PLUSA, Tomasz
32 050 Skawina (PL)
- (74)

Representative: Valeo Systèmes Thermiques
Service Propriété Intellectuelle
8, rue Louis Lormand
La Verrière
78320 Le Mesnil Saint Denis (FR)
- (71)

Applicant: VALEO SYSTEMES THERMIQUES
78320 Le Mesnil Saint-Denis (FR)

(54)

HEAT EXCHANGER

(57) A heat exchanger (100) comprises a first manifold (102), a second manifold (104) and a heat exchanger core (106). A plurality of heat exchange tubes (108) providing a fluidal communication between the first manifold (102) and the second manifold (104). Each manifold (102, 104) comprises a tank member (110A, 110B) and a header (112A, 112B). The header (112A, 112B) comprises a plurality of apertures (118A, 118B) to receive respective ends of the heat exchange tubes (108) to provide a fluid communication between the manifold (102, 104) and the heat exchange tubes (108). At least one header (112A, 112B) comprises a first region (114A, 114B) having a first thickness and a second region (116A, 116B) having a second thickness. The first region (114A, 114B) is a peripheral portion of the header (112A, 112B) and the second region (116A, 116B) is a portion around one or more apertures (118A, 118B).

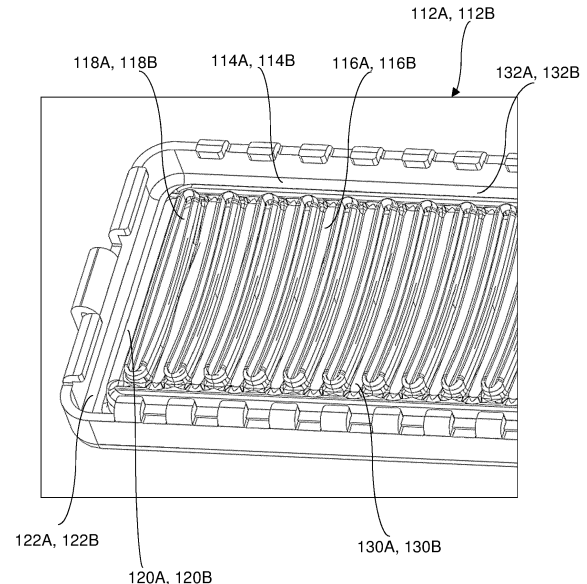


FIG. 5

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] Heat exchangers, such as radiators, charge air coolers, oil coolers and the like, are used in a variety of applications to transfer heat from one medium to another. Typically, the heat exchanger includes a pair of manifolds, and a plurality of heat exchange tubes stacked between the manifolds to provide a fluid communication between the manifolds. Each manifold includes a header with a plurality of openings to receive the plurality of heat exchange tubes. At least one fin is provided between two adjacent heat exchange tubes. The first manifold includes an inlet port for receiving the first heat exchange fluid and a second manifold includes an outlet port. The first fluid flows from the first manifold to the second manifold through the plurality of heat exchange tubes. Further, a second fluid flows around the heat exchange tubes across the fins. The first fluid and the second fluid are in heat exchange configuration.

[0003] The heat exchanger transfers thermal energy between the fluids as a result of the heating or cooling of the tubes, at different temperatures. The thermal difference may cause non-uniform dimensional changes to the interconnected parts of the heat exchanger. For example, the tubes may increase in length while the ends of the tubes remain in a fixed position relative to the first manifold and the second manifold and the header length may change, which induces thermal and mechanical stresses. Since the tubes are usually rigidly attached to a relatively inflexible header by means of soldering, brazing, welding or the like, the resulting stresses lead to joint fatigue failure or tube fatigue in the area next to the tube to header joint. Ultimately, the heat exchangers suffers limited life because of high stresses at their tube-to-header joints.

[0004] Accordingly, there is a need for an improved heat exchanger that reduces stress at the tube to header joints and improves reliability and service life to the heat exchanger.

[0005] 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.

[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.

SUMMARY OF THE INVENTION

[0007] The present invention discloses a heat exchanger comprising a first manifold, a second manifold and a heat exchanger core. The second manifold is arranged spaced apart from the first manifold. The heat exchanger core comprises a plurality of heat exchange tubes providing a fluidal communication between the first manifold and the second manifold. Each of the heat exchange tubes having a first end and a second end. Each manifold comprises a tank member and a header. The header comprises a plurality of apertures to receive respective ends of the heat exchange tubes to provide a fluid communication between the manifold and the heat exchange tubes. At least one header comprises a first region having a first thickness and a second region having a second thickness. The first region is a peripheral portion of the header and the second region is a portion around one or more apertures of the header.

[0008] The header having a base having the plurality of apertures and a channel extending circumferentially around the base. The channel defines the peripheral portion of the header. The second region comprises a portion adjacent to each of the apertures. The first thickness is different from the second thickness. In one embodiment, the second thickness is smaller than the first thickness. The ratio of thickness of the first region and the second region ranges from 1 to 4.

[0009] In one embodiment, the plurality of apertures comprises a first set of apertures and a second set of apertures. In one embodiment, the second region comprises a portion around the first set of apertures. In another embodiment, the second region comprises a portion around the second set of apertures. In yet another embodiment, the second region comprises a portion around the first set of apertures and the second set of apertures.

BRIEF DESCRIPTION OF DRAWINGS

[0010] 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 an exploded view of the heat exchanger of FIG. 1.

FIG. 3 exemplarily illustrates a perspective view of the manifold of FIG. 1.

FIG. 4 exemplarily illustrates an exploded view of the manifold of FIG. 1.

FIG. 5 exemplarily illustrates a perspective view of the header plate of FIG. 1.

FIG. 6 exemplarily illustrates a cross-sectional view of the header plate of FIG. 1.

DETAILED DESCRIPTION

[0011] The heat exchanger comprises a first manifold, a second manifold and a heat exchanger core. The second manifold is arranged spaced apart from the first manifold. The heat exchanger core comprises a plurality of heat exchange tubes providing a fluidal communication between the first manifold and the second manifold. Each of the heat exchange tubes having a first end and a second end. Each manifold comprises a tank member and a header. The header comprises a plurality of apertures to receive respective ends of the heat exchange tubes to provide a fluid communication between the manifold and the heat exchange tubes. At least one header comprises a first region having a first thickness and a second region having a second thickness. The first region is a peripheral portion of the header and the second region is a portion around one or more apertures. The reduction of thickness at region proximal to tube to header joints increases the flexibility, which reduces the stress at the tube to header joints caused by the thermal expansion and contraction of heat exchange tubes discussed in the background section of this document. Consequently, the increase in flexibility at the portion adjacent to the tube to header plate joints adds reliability and increases the life span of the heat exchanger.

[0012] FIG. 1 exemplarily illustrates a perspective view of a heat exchanger 100, according to an embodiment of the present invention. FIG. 2 exemplarily illustrates an exploded view of a heat exchanger 100 of FIG. 1. Referring to FIG. 1 and FIG. 2, the heat exchanger 100 comprises a first manifold 102, a second manifold 104 and a heat exchanger core 106. The heat exchanger 100, for example, may be a radiator. The heat exchanger core 106 comprises a plurality of heat exchange tubes 108 providing a fluidal communication between the first manifold 102 and the second manifold 104. The first manifold 102 comprises a first header 112A and a first tank member 110A, and the second manifold 104 comprises a second header 112B and a second tank member 110B. The header 112A, 112B comprise a plurality of apertures 118A, 118B and each aperture 118A, 118B, shown in FIG. 5, aligned to one corresponding tube 108. The headers 112A, 112B are supported in spaced apart and parallel relationship to each other by the tubes 108.

[0013] FIG. 3 exemplarily illustrates a perspective view

of the manifold 102, 104 of FIG. 1. FIG. 4 exemplarily illustrates an exploded view of the manifold 102, 104 of FIG. 1. Referring to FIG. 3 and FIG. 4, the first tank member 110A connected to the first header 112A configures the first manifold 102. The first manifold 102 may be the inlet manifold. Similarly, the second tank member 110B connected to the second header 112B configures the second manifold 104. The second manifold 104 may be the outlet manifold. The first tank member 110A is connected to the first header 112A so that the first ends of the tubes 108 are in fluid communication with the interior of the first tank member 110A. In like manner, the second tank member 110B is connected to the second header 112B so that the second ends of the tubes 108 are in fluid communication with the interior of the second tank member 110B. A frame assembly is employed to support the periphery of the heat exchanger core 106. Particularly, the side frame assembly includes a first side frame and a second side frame, which extends along the length of the first and second sides of the heat exchanger 100. The first manifold 102 further comprises a first port 140, show in FIG. 2, for example, an inlet port, and the second manifold 104 comprises a second port 120, show in FIG. 2, for example, an outlet port.

[0014] A first fluid may flow from the first port 140 of the first manifold 102, passes through the plurality of heat exchange tubes 108 and exits the second manifold 104 via the first outlet port 120. The first fluid flows from the first manifold 102 to the second manifold 104 in the first fluid flow direction. The second fluid flows between the heat exchange tubes 108 in the second fluid flow direction. The second fluid flow direction may be perpendicular to the first fluid flow direction.

[0015] Referring to FIG. 1, the heat exchanger 100 further comprises heat exchanger fins 122, which are located between the heat exchange tubes 108 to promote the transfer of heat between the first heat exchange fluid within the tubes 108 and the second heat exchange fluid passing over the tubes 108. According to an exemplary embodiment, the heat exchanger fins 122 are constructed of aluminium, brazed or otherwise joined to the tubes 108. However, according to other exemplary embodiments, the heat exchanger fins 122 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 heat exchange fluid. The heat exchanger fins 122 may be louvered fins, corrugated fins, or any other suitable type of fin.

[0016] Further, in this embodiment, the heat exchange tubes 108 are flat tubes. In another embodiment, the heat exchange tubes 108 may be multi-channel tubes containing several flow channels or paths. 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.

[0017] Referring to FIG. 4, the tank member 110A, 110B includes a base portion 124A, 124B having an inner surface. A wall 126A, 126B circumferentially surrounds

the base portion 124A, 124B and depends generally perpendicularly to the plane of the base portion 124A, 124B defining a chamber. A flange portion or tank foot 128A, 128B is circumferentially disposed on the terminating end of the wall 126A, 126B. Referring to FIG. 5, the header 112A, 112B generally includes a planar base 130A, 130B having the plurality of apertures 118A, 118B thereon for receiving the ends of the heat exchange tubes 108 of the heat exchanger 100 there through. The base 130A, 130B of the header 112A, 112B circumferentially surrounded by a channel 132A, 132B sized to receive the foot 128A, 128B of the tank member 110A, 110B.

[0018] Referring to FIG. 5 and FIG. 6, the header 112A, 112B comprises a first region 114A, 114B having a first thickness and a second region 116A, 116B having a second thickness. The first thickness is different from the second thickness. In one embodiment, the first region 114A, 114B may be a peripheral portion of the header 112A, 112B, and the second region 116A, 116B may be the portion around one or more apertures 118A, 118B of the header 112A, 112B. The first thickness is smaller than the second thickness. Specifically, the thickness of the portion around the apertures 118A, 118B is smaller than the thickness of the peripheral portion of the header 112A, 112B. Thereby, the base portion 130A, 130B around the apertures 118A, 118B of the header 112A, 112B provides more flexibility.

[0019] The plurality of apertures 118A, 118B of the header 112A, 112B comprises a first set of apertures and a second set of apertures. In another embodiment, the first region 114A, 114B may be a peripheral portion of the header 112A, 112B, and the second region 116A, 116B may be the portion around the first set of apertures. In yet another embodiment, the second region 116A, 116B may be the portion around the second set of apertures. In one embodiment, the ratio of thickness of the first region 114A, 114B and the second region 116A, 116B ranges from 1 to 4.

[0020] In one embodiment, the heat exchanger 100 comprises the first manifold 102, the second manifold 104 and the heat exchanger core 106. The second manifold 104 is arranged spaced apart from the first manifold 102. The heat exchanger core 106 comprises a plurality of heat exchange tubes 108 providing a fluidal communication between the first manifold 102 and the second manifold 104. Each of the heat exchange tubes 108 having a first end and a second end. Each manifold 102, 104 comprises the tank member 110A, 110B and the header 112A, 112B. The header 112A, 112B comprises a plurality of apertures 118A, 118B to receive respective ends of the heat exchange tubes 108 to provide a fluid communication between the manifold 102, 104 and the heat exchange tubes 108. In one embodiment, at least one header 112A, for example, the first header 112A comprises a first region 114A having a first thickness and a second region 116A having a second thickness. The first region 114A is a peripheral portion of the header 112A and the second region 116A is a portion around one or

more apertures 118A. The channel 132A defines the peripheral portion of the header 112A.

[0021] In another embodiment, at least one header 112B, for example, the second header 112B comprises the first region 114B having the first thickness and the second region 116B having the second thickness. The first region 114B is a peripheral portion of the header 112B and the second region 116B is a portion around one or more apertures 118B. The channel 132B defines the peripheral portion of the header 112B. In yet another embodiment, at least two header 112a, 112B, for example, the first header 112A and the second header 112B comprises the first region 114A, 114B having the first thickness and the second region 116B, 116B having the second thickness.

[0022] The reduction of thickness at region proximal to tube to header joints increases the flexibility, which reduces the stress at the tube to header joints caused by the thermal expansion and contraction of heat exchange tubes 108 discussed in the background section of this document. Consequently, the increase in flexibility at the joints between the tubes 108 and the header 112A, 112B adds reliability and increases the life span of the heat exchanger 100.

[0023] During operation of the heat exchanger 100, the length of heat exchange tubes 108 may vary due to the temperature difference of the heat exchange fluids and the heat transfer between the heat exchange fluids. The length of the tubes 108 may change while the ends of the tubes 108 are fixed to the first header 112A and the second header 112B, respectively, which causes the header 112A, 112B to bend, and then the tubes 108. However, the change in thickness at the first region 114A, 114B of the header 112A, 112B increases the flexibility at the tube to header joints, or the base 130A, 130B of the header, 112B and allows the header 112A, 112B to expand and bend freely.

[0024] In another embodiment, the header 112A, 112B may be designed so that at least a portion of the base 130A, 130B of the header 112A, 112B has the second thickness. For example, the portion around at least a set of apertures 118A, 118B may be configured to have the second thickness. This allows the header 112A, 112B to be more flexible at the particular portion of the base 130A, 130B of the header 112A, 112B, while the remaining portion of the header 112A, 112B may have lesser flexibility. Thus, the present invention provides flexibility either at a selective region of the base 130A, 130B of the header 112A, 112B, or the entire region of the base 130A, 130B of the header 112A, 112B. Consequently, the increase in flexibility at the joints between the tubes 108 and the header 112A, 112B adds reliability and increases the life span of the heat exchange tubes 108.

[0025] 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), comprising:

a first manifold (102);
 a second manifold (104) arranged spaced apart
 from the first manifold (102), and
 a heat exchanger core (106) comprising a plu-
 rality of heat exchange tubes (108) providing a
 fluidal communication between the first manifold
 (102) and the second manifold (104), each of
 the heat exchange tubes (108) having a first end
 and a second end, wherein each manifold (102,
 104) comprises a tank member (110A, 110B)
 and a header (112A, 112B), the header (112A,
 112B) comprises a plurality of apertures (118A,
 118B) to receive respective ends of the heat ex-
 change tubes (108) to provide a fluid communi-
 cation between the manifold (102, 104) and the
 heat exchange tubes (108), **characterized in**
that,
 at least one header (112A, 112B) comprises a
 first region (114A, 114B) having a first thickness
 and a second region (116A, 116B) having a sec-
 ond thickness, the first region (114A, 114B) is a
 peripheral portion of the header (112A, 112B)
 and the second region (116A, 116B) is a portion
 around one or more apertures (118).

2. The heat exchanger (100) of claim 1, wherein the
 header (112A, 112B) having a base (120A, 120B)
 having the plurality of apertures (118A, 118B) and a
 channel (122A, 122B) extending circumferentially
 around the base (120A, 120B), the channel (122A,
 122B) defines the peripheral portion of the header
 (112A, 112B).

3. The heat exchanger (100) of claim 1, wherein the
 first thickness is different from the second thickness.

4. The heat exchanger (100) of claim 1, wherein the
 second thickness is smaller than the first thickness.

5. The heat exchanger (100) of claim 1, wherein the
 second region (116A, 116B) comprises a portion ad-
 jacent to each of the apertures (118A, 118B).

6. The heat exchanger (100) of claim 1, wherein the
 plurality of apertures (118A, 118B) comprises a first
 set of apertures and a second set of apertures.

7. The heat exchanger (100) of claim 1 and 6, wherein
 the second region (116A, 116B) comprises a portion
 around the first set of apertures.

8. The heat exchanger (100) of claim 1 and 6, wherein
 the second region (116A, 116B) comprises a portion
 around the second set of apertures.

9. The heat exchanger (100) of claim 1 and 6, wherein
 the second region (116A, 116B) comprises a portion
 around the first set of apertures and the second set
 of apertures.

10. The heat exchanger (100) of claim 1, wherein the
 ratio of thickness of the first region (114A, 114B) and
 the second region (116A, 116B) ranges from 1 to 4.

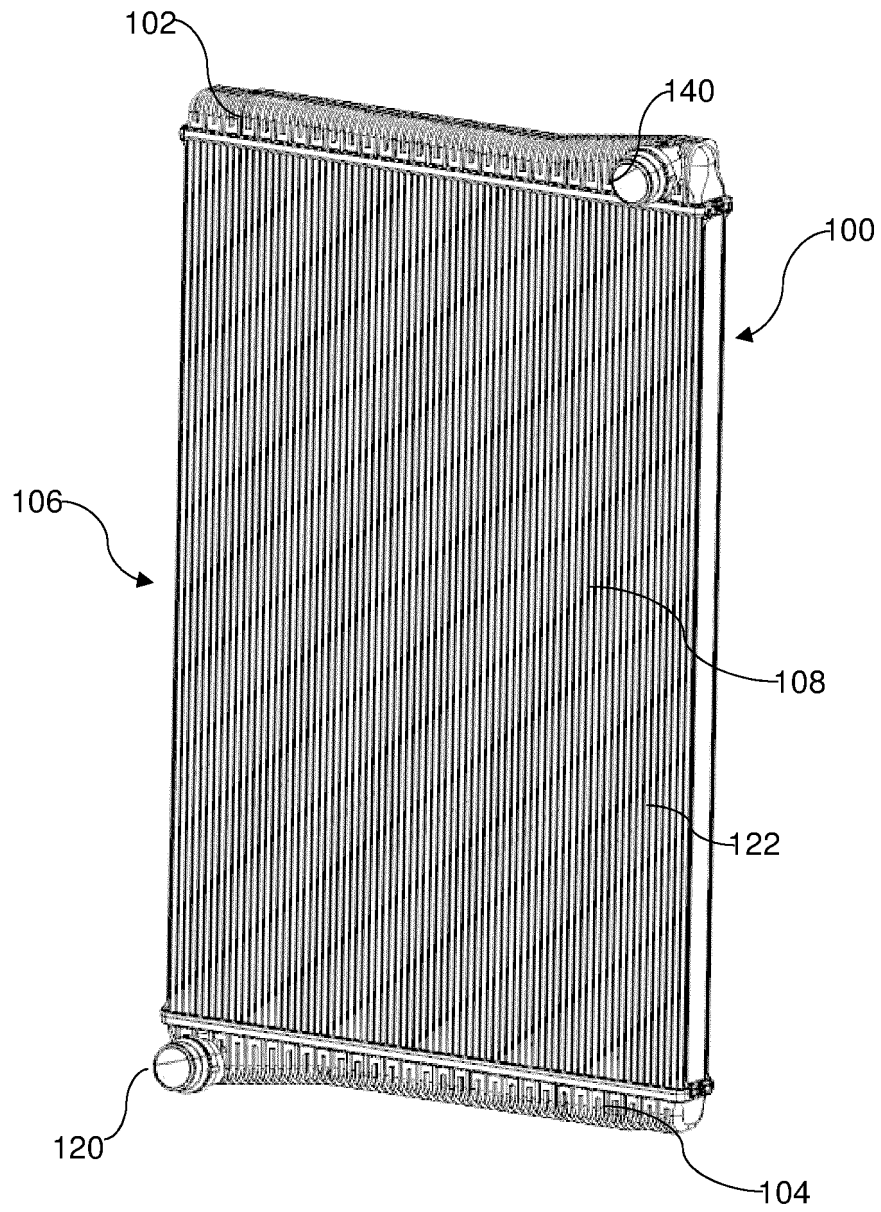


FIG. 1

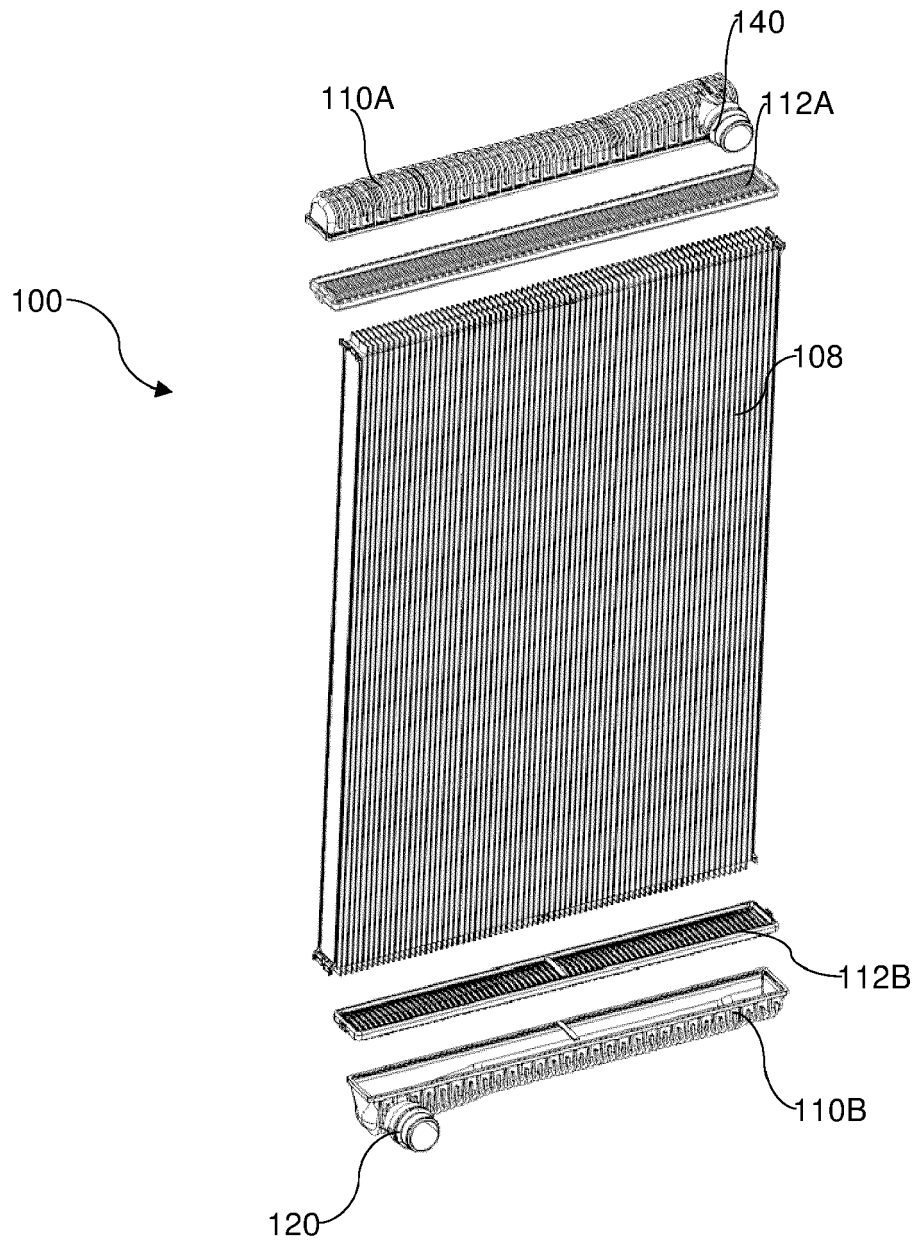
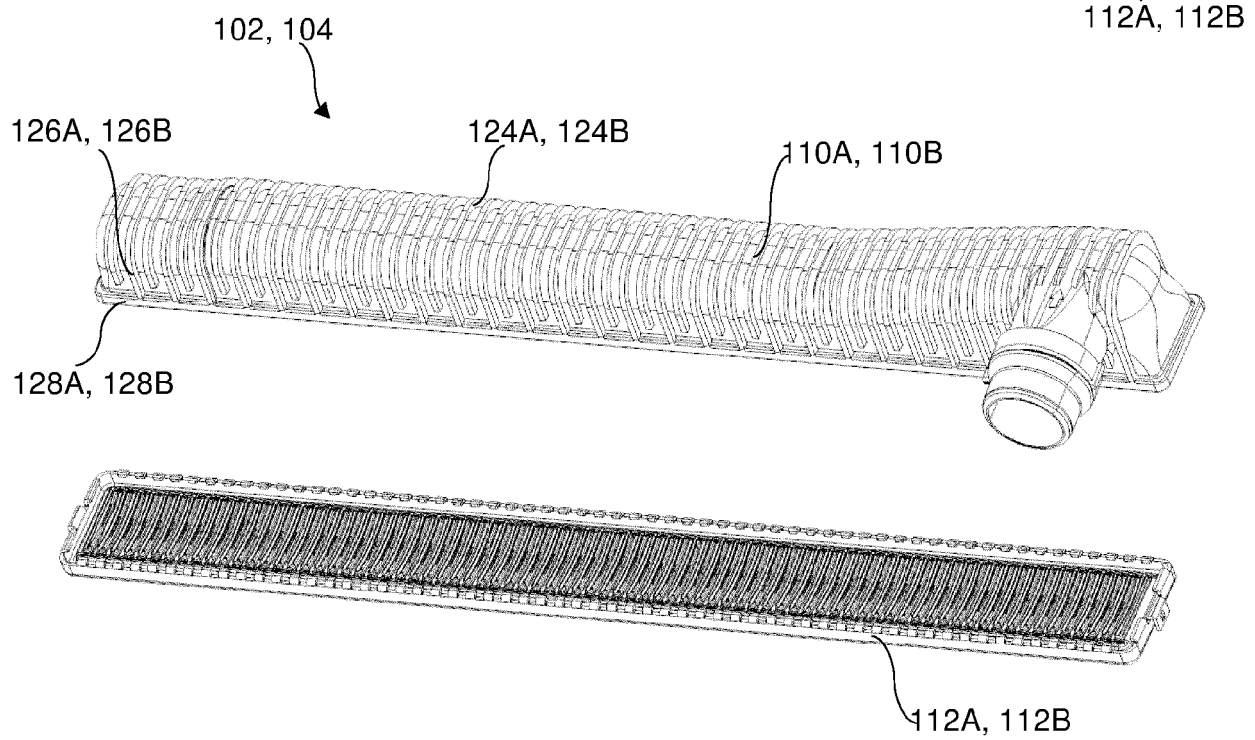
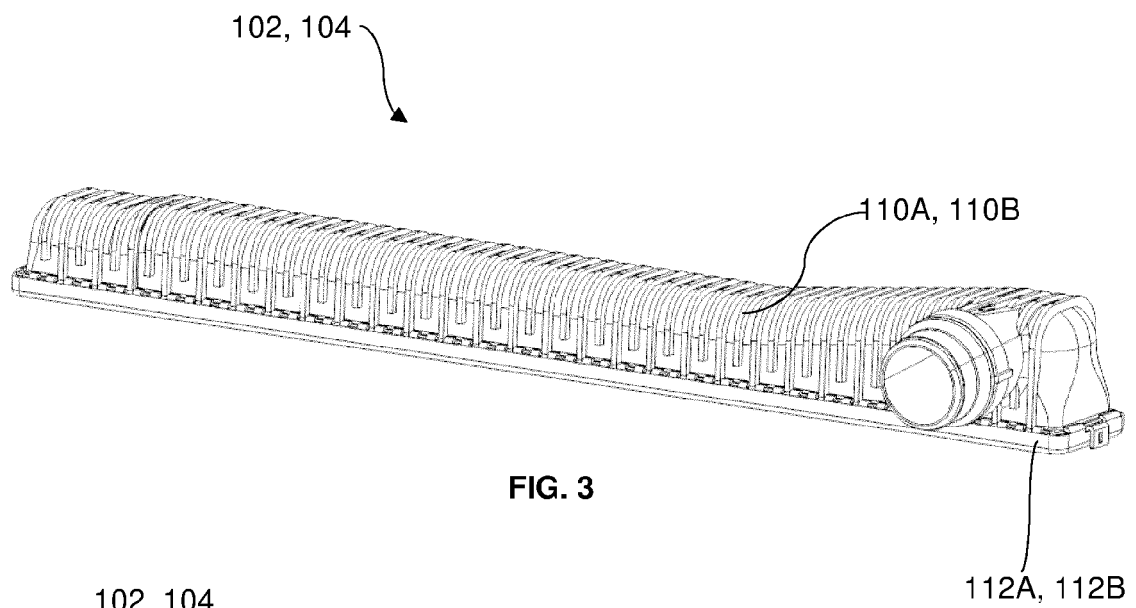


FIG. 2



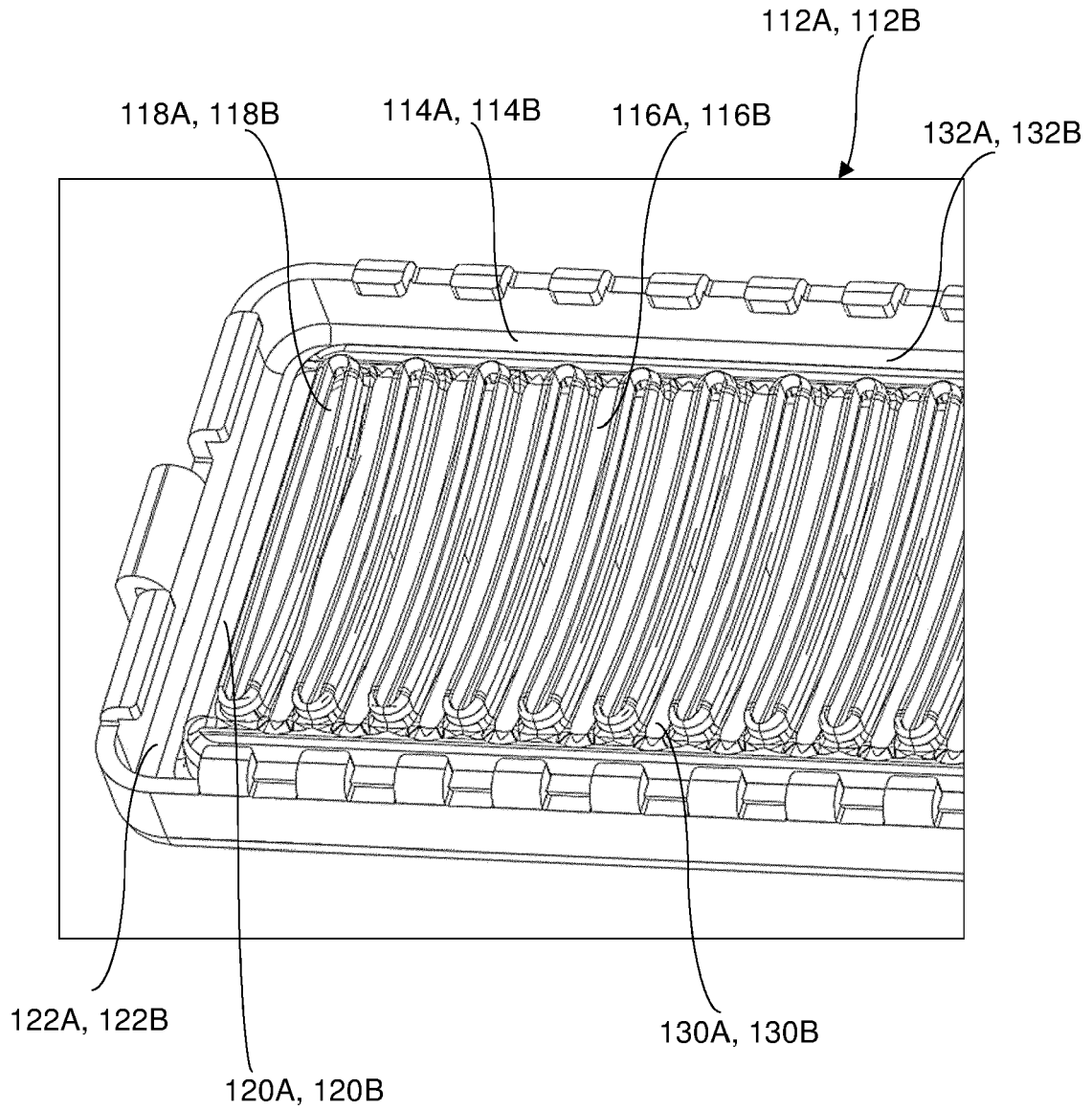


FIG. 5

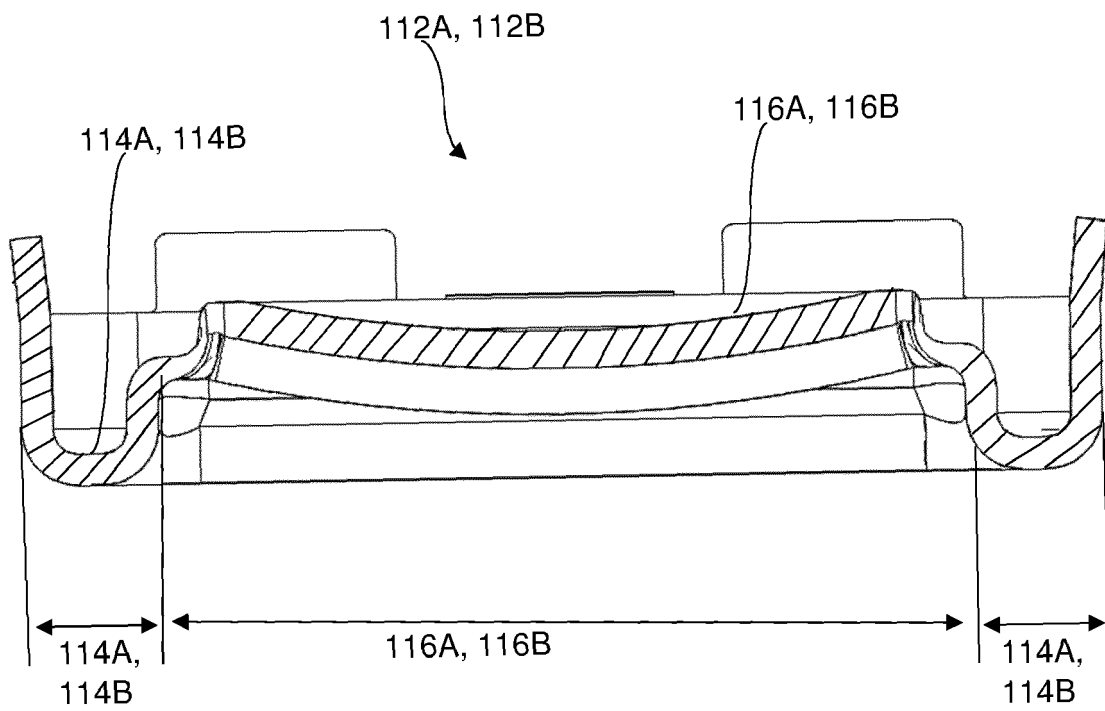


FIG. 6



EUROPEAN SEARCH REPORT

Application Number

EP 22 19 3502

5

10

15

20

25

30

35

40

45

50

55

1

EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2017/010058 A1 (ABELL BRADLEY D [US] ET AL) 12 January 2017 (2017-01-12) * paragraph [0041]; figures 4, 6-10 * -----	1-10	INV. F28F9/22
X	EP 1 972 879 B1 (MAHLE BEHR GMBH & CO KG [DE]) 1 November 2017 (2017-11-01) * paragraph [0015]; figures 5, 6 * -----	1-10	
X	US 2004/226693 A1 (IWASAKI MITSURU [JP] ET AL) 18 November 2004 (2004-11-18) * paragraph [0037] - paragraph [0039] * -----	1-10	
X	US 2012/018135 A1 (CIAFFARAF A MARIO [GB] ET AL) 26 January 2012 (2012-01-26) * figures 3, 6 * -----	1-10	
X	US 2016/238326 A1 (SHIN SUNG HONG [KR] ET AL) 18 August 2016 (2016-08-18) * paragraph [0071]; figure 6 * -----	1-10	
			TECHNICAL FIELDS SEARCHED (IPC)
			F28F F28D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 31 January 2023	Examiner Vassoille, Bruno
CATEGORY OF CITED DOCUMENTS 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 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			

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

EP 22 19 3502

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

31-01-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2017010058 A1	12-01-2017	EP 3115724 A1 US 2017010058 A1	11-01-2017 12-01-2017
EP 1972879 B1	01-11-2017	DE 102007013483 A1 EP 1972879 A2	25-09-2008 24-09-2008
US 2004226693 A1	18-11-2004	CN 1542398 A EP 1462753 A2 JP 2004286358 A US 2004226693 A1	03-11-2004 29-09-2004 14-10-2004 18-11-2004
US 2012018135 A1	26-01-2012	NONE	
US 2016238326 A1	18-08-2016	DE 102016001686 A1 US 2016238326 A1	18-08-2016 18-08-2016