(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 872 433 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
01.09.2021 Bulletin 2021/35

(51) Int Cl.:
F28D 1/053 *(2006.01)* *F28F 1/02* *(2006.01)*
F28F 1/12 *(2006.01)*

(21) Application number: **20461514.0**

(22) Date of filing: **28.02.2020**

(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

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(54) A HEAT EXCHANGER AND A HEADER TANK ASSEMBLY THEREFOR

(57) The heat exchanger includes at least one header-tank assembly that includes a header and a tank. The header includes a header groove disposed along at least a portion of a periphery thereof defining inside walls and outside walls of the header. The header further includes a plurality of tabs formed on at least one pair of outside walls. The header still further includes a plurality of slots formed thereon to receive heat exchange tubes. The tank includes tank foot portion received in a corresponding header groove, wherein the tabs are crimped over the corresponding tank foot portion. The header includes at least one protrusion protruding within the header groove. The at least one protrusion supports and presses the tank foot portion against outside walls of the header during crimping between the header and the tank.

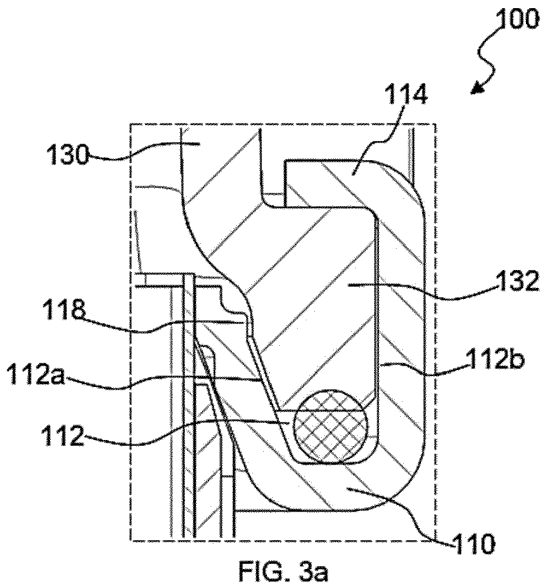

FIG. 3a

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Description

[0001] The present invention relates to a heat exchanger, more particularly, the present invention relates to a header-tank assembly for the heat exchanger.

[0002] A conventional heat exchanger **1,** for example a radiator for use in a vehicle as shown in FIG. 1, includes at least a header-tank assembly **2.** Each header-tank assembly **2** includes a tank **4,** a header **6** and a gasket **8** disposed between the tank **4** and the header **6.** The tank **4** is generally in the form of an enclosure defined by sidewalls, wherein the sidewalls are connected at one end to form a closed end and other end of the sidewalls forms an open end opposite to the closed end. The tank **4** includes tank foot portion **4a** formed along a periphery of the open end of the tank **4,** particularly along longitudinal sides and lateral sides of the tank **4.** The header **6** is complimentary to the tank **4** and closes the open end of the tank **4.** The header **6** includes a plurality of tabs **6a** and **6b** disposed along longitudinal and lateral sides thereof respectively. Generally, the tabs **6a** and **6b** disposed on the respective longitudinal sides and the lateral sides of the header **6** configure connection between the tank **4** and the header **6** and arrest any relative movement between the tank **4** and the header **6.** Specifically, the tabs **6a** disposed along longitudinal sides of the header **6** are crimped to the tank foot portion **4a** disposed along longitudinal sides of the tank **4** to arrest relative movement between the tank **4** and the header **6** in lateral and vertical directions. Similarly, the tabs **6b** disposed along lateral sides of the header **6** are crimped to the tank foot portion **4a** along lateral sides of the tank **4** to arrest relative movement between the tank **4** and the header **6** in longitudinal and vertical directions. The tabs **6a** and **6b** of the header **6** crimped over the tank foot portion **4a** of the tank **4** form a crimping connection between the tank **4** and the corresponding header **6** for configuring the header-tank assembly **2.** The header **6** further includes a plurality of slots **6c** formed thereon to receive a plurality of heat exchange tubular elements, particularly, heat exchange tubes **9.**

[0003] The tank **4** receives a first heat exchange fluid, which may be a pressurized heat exchanging fluid and distributes the heat exchange fluid to the heat exchange tubes **9** in fluid communication therewith. Another opposite tank **4** receives and collects the heat exchange fluid from the heat exchange tubes **9** after the heat exchange fluid has rejected heat to air surrounding the heat exchange tubes **9.** The pair of tanks **4** in conjunction with the corresponding headers **6** facilitate distribution of the first heat exchange fluid to and collection of the first heat exchange fluid from the heat exchange tubes **9.** Particularly, the first heat exchange fluid ingresses the tank **4** via an inlet to the tank **4,** passes through the heat exchange tubes **9,** and in the process, undergoes heat exchange with a second heat exchange fluid, such as for example, air flowing around the heat exchange tubes **9.** In order to achieve better heat exchange between first heat exchange fluid flowing through the heat exchange tubes **9** and the second heat exchange fluid flowing around the heat exchange tubes **9,** a plurality of fins **7** or turbulators may be disposed between the heat exchange tubes **9.** The first heat exchange fluid after rejecting heat to the second heat exchange fluid egresses through an outlet to the tank **4.**

[0004] The crimping connection between the tank **4** and the corresponding header **6** is required to be a secure connection, and accordingly the crimping between the tank **4** and the header **6** is required to be as good as possible. Generally, the header **6** includes header groove **6d** configured along periphery thereof. The header groove **6d** is complimentary to the tank foot portion **4a** to be able to receive the respective tank foot portion **4a** therein. In addition, the configuration of the header groove **6d** ensures proper connection between the header **6** and a heat exchanger housing **5.** However, the header groove **6d** sometimes does not match with the tank foot portion **4a** and fails to provide stable support to the tank foot portion **4a** during the crimping operation. The problem is aggravated in case the header **6** is of thicker section along certain section. Due to the tank foot portion **4a** being unstably supported in the header groove **6d,** there are chances of the tank foot portion **4a** being displaced as crimping tool presses the tabs **6a** and **6b** of the header **6** over the tank foot portion **4a.** The displacement of the tank foot portion **4a** may cause misalignment between the tank **4** and the header **6.** In addition, due to tank foot portion **4a** unstably supported in the header groove **6d,** the tank foot portion **4a** may get deformed or damaged during crimping between the header **6** and the tank **4.** More specifically, when crimping force is applied on the tabs **6a** and **6b,** due to the displacement of the tank foot portion **4a,** the tabs **6a** and **6b** may strike the tank foot portion **4a** instead of fitting over edge of the tank foot portion **4a,** thereby damaging the tank foot portion **4a.** The damage caused to the tank foot portion **4a** may cause other problems such as leakage, mechanical failure, pressure drop, that in turn may cause inefficient operation and performance of the conventional heat exchanger **1.**

[0005] Accordingly, there is a need for a heat exchanger configured with a header-tank assembly wherein a header is configured with features to provide stable support to the tank foot portion received in a header groove, thereby preventing chances of misalignment and damage to the tank, particularly, tank foot portion during crimping between the header and the corresponding tank. Further, there is a need for a heat exchanger configured with a header-tank assembly, wherein a header is configured with features to prevent leakage, mechanical failure, pressure drop in the header-tank assembly, thereby resulting in efficient operation and performance of the heat exchanger.

[0006] An object of the present invention is to provide a heat exchanger configured with a header tank assembly that obviates the drawbacks associated with conven-

tional header tank assembly.

[0007] Still another object of the present invention is to provide a heat exchanger configured with a header-tank assembly that is simple in construction and convenient to manufacture.

[0008] Yet another object of the present invention is to provide a heat exchanger configured with a header-tank assembly, wherein a header of the header-tank assembly is configured with features that provide additional support to the tank foot portion received in the respective header groove during crimping between the tank and the corresponding header.

[0009] Still another object of the present invention is to provide a heat exchanger configured with a header-tank assembly, wherein a header of the header-tank assembly is configured with features that prevents deformation of the tank foot portion during crimping between the tank and the corresponding header.

[0010] Another object of the present invention is to provide a heat exchanger configured with a header-tank assembly, wherein a header of the header-tank assembly is configured with features that act as reinforcement for side portion of the header along the slots.

[0011] Another object of the present invention is to provide a heat exchanger configured with a header-tank assembly, wherein a header of the header-tank assembly is configured with features that permits efficient brazing connection between the header and the heat exchanger housing and smooth insertion of the heat exchange tubes in the slots.

[0012] 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.

[0013] A heat exchanger is disclosed in accordance with an embodiment of the present invention. The heat exchanger includes at least one header-tank assembly. The header-tank assembly includes a header and a tank. The header includes a header groove disposed along at least a portion of a periphery thereof and defining inside walls and outside walls of the header. The header further includes a plurality of tabs formed on at least one pair of outside walls disposed along at least one of opposite lateral sides and opposite longitudinal sides of the header. The header still further includes a plurality of slots formed thereon to receive heat exchange tubes. The tank includes tank foot portion that is received in the corresponding header groove, wherein the tabs formed on the header are crimped over the corresponding tank foot portion. The header includes at least one protrusion protruding within the header groove. The at least one protrusion supports and presses the tank foot portion against the outside walls of the header during crimping between the header and the tank.

[0014] Generally, the protrusion is protruding towards the respective outside walls.

[0015] Specifically, the protrusion protrudes from at least one pair of opposing inside walls, disposed respectively along the pair of opposite lateral sides and/or the pair of opposite longitudinal sides of the header.

[0016] Generally, the protrusion is a single protrusion that continuously extends along each of the inside walls of the header, the protrusions formed on intersecting inside walls respectively are disconnected from each other at the intersection between the inside walls.

[0017] Alternatively, multiple protrusions formed on the header are intermittently disposed along the inside walls of the header.

[0018] In accordance with an embodiment of the present invention, in case of multiple protrusions formed along the inside walls of the header, the protrusions are uniformly spaced with respect to each other.

[0019] In accordance with another embodiment of the present invention, in case of multiple protrusions formed along inside walls of the header, the protrusions are non-uniformly distributed with respect to each other.

[0020] Particularly, the at least one protrusion is formed on the inside walls of the header by a single step stamping operation.

[0021] Generally, the header along with the at least one protrusion formed on the inside walls thereof is of metal, whereas the tank along with the tank foot portion is of plastic.

[0022] 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 illustrates a heat exchanger configured with a header-tank assembly in accordance with the prior art, also illustrated is an enlarged view of the header-tank assembly;

FIG. 2a illustrates a schematic representation of a heat exchanger in accordance with an embodiment of the present invention;

FIG. 2b illustrates an isometric view of a header of a header-tank assembly of the heat exchanger of **FIG. 2a,** also illustrated is an enlarged view of a corner section of the header;

FIG. 2c illustrates an isometric view of a portion of a header in accordance with another embodiment of the present invention;

FIG. 2d illustrates an isometric view of a portion of

a header in accordance with yet another embodiment of the present invention; and

FIG. 3a illustrates a sectional view of the header tank assembly of a header in accordance with any one of the embodiments depicted in **FIG. 2a- FIG. 2d** along a first section plane passing through the at least one protrusion; and

FIG. 3b illustrates a sectional view of the header tank assembly of **FIG. 2a- FIG. 2d** along a second section plane passing through a portion between the adjacent protrusions.

[0023] 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.

[0024] The present disclosure envisages a Water Charge Air-Cooler, configured with a header-tank assembly, wherein a header of the header-tank assembly is configured with features such as for example, at least one protrusion configured on at least one pair of opposite inside walls of the header. The at least one protrusion provides additional support to the tank foot portion received in the respective header grooves during crimping between the tank and the corresponding header. In the forthcoming description the invention is explained with example of Charge Air-Cooler, however, the present invention is applicable to any heat exchanger, wherein secure crimping connection is required between a tank and a header thereof.

[0025] A heat exchanger **200,** particularly, a Water Charge Air-Cooler is disclosed in accordance with an embodiment of the present invention. The heat exchanger **200** includes at least one header-tank assembly **100.** Generally, the heat exchanger **200** includes a pair of header-tank assemblies **100.** The heat exchanger **200** further includes a plurality of heat exchange tubular elements, particularly, heat exchange tubes, simply referred to as tubes connected to and fluid communication with the at least one header-tank assembly **100** and forming a core. Generally, the tubes refer to tubular elements with circular cross-section, however, in the present specification tubes refer to tubular elements of any cross-section. In case the flow through the heat exchanger **200** is a U-flow, there is a single header-tank assembly disposed at one side of a core or two header-tank assemblies with diversion for the fluid within one of them. In case the flow through the heat exchanger **200** is an I-flow, there are two header-tank assemblies, each on one side of the core.

[0026] In case of the heat exchanger **200** configured to provide I-flow for the heat exchange fluid, there are two header-tank assemblies as illustrated in **FIG. 2a.** One header-tank assembly **100** disposed on one side of the heat exchanger core distributes a first heat exchange fluid to the heat exchange tubes. Another header-tank assembly **100** disposed at opposite side of the heat exchanger core collects the first heat exchange fluid after the first heat exchange fluid has passed through the tubes and exchanged heat with a second heat exchange fluid flowing around and in-between the heat exchange tubes. However, as both the header-tank assemblies are similar in configuration and operation and for the sake of brevity of the present document, the accompanying figures and corresponding description explains the configuration and operation of only one header-tank assembly **100.**

[0027] **FIG. 2a** illustrates a schematic representation of the heat exchanger **200.** Referring to **FIG. 2b** - **FIG. 2d** of the accompanying drawings, each header **110** of the header-tank assembly **100** includes a header groove **112** or a plurality thereof, a plurality of tabs **114** and a plurality of slots **116.** In case of plurality of header grooves, the header grooves are disconnected from each other. Further referring to **FIG. 3a - FIG. 3b** of the accompanying drawings, a tank **130** includes a tank foot portion **132** received in the header groove **112** and the tabs **114** crimped over the tank foot portion **132.**

[0028] Again referring to the **FIG. 2b - FIG. 2d** of the accompanying drawings, the header groove **112** is disposed along at least a portion of the periphery of the header **110** and is defining inside walls **112a** and outside walls **112b** of the header **110.** Specifically, the inside walls **112a** and the outside walls **112b** are separated by the header groove **112.** More specifically, the outside walls **112b** define the boundary of the header **110.** Further, the outside walls **112b** circumscribes the inside walls **112a** and is spaced away from the inside walls **112a.** The inside wall **112a** is of a shape that provides shape guidance to the tank foot portion **132,** thereby urging the tank foot portion **132** towards the outside wall and reducing play between the tank foot portion **132** and the header groove **112.** The header groove **112** is complimentary to the tank foot portion **132** to receive the tank foot portion **132** therein. In addition, the configuration of the header groove **112** ensures proper connection between the header **110** and heat exchanger housing.

[0029] The tabs **114** formed on at least one pair of the opposing outside walls **112b,** disposed respectively along the opposite lateral sides and/or opposite longitudinal sides of the header are crimped over the tank foot portion **132** received in the header groove **112** to form crimping connection between the header **110** and the tank **130.** Generally, a crimping tool interacts with the tabs **114** to cause bending of the tabs **114** over the respective tank foot portion **132** received in the header groove **112.** To form a secure crimping connection between the header **110** and the tank **130,** the tank foot portion **132** is required to be stably supported in the header groove **112** as the crimping tool interacts with the tabs **114 to** cause bending of the tabs **114** over the respective tank foot portion **132** received in the header groove **112.** However, the header groove **112** sometimes does not match with the respective tank foot portion **132** and fails

to provide stable support to the corresponding tank foot portion **132** during the crimping operation between the header **110** and the tank **130.** Due to the tank foot portion **132** being unstably supported or unsupported in the respective header groove **112,** the tank foot portion **132** may move within the header groove **112** during crimping between the header **110** and the tank **130** and may be deformed or damaged. More specifically, when crimping force is applied on the tabs **114,** due to the displacement of the tank foot portion **132,** the tabs **114** may strike the tank foot portion **132** instead of fitting over edge of the tank foot portion **132,** thereby damaging the tank foot portion **132.** Also, due to damage caused to the tank foot portion **132** or to misalignment, there are chances of fluid leakage.

[0030] To address the abovementioned issues, at least one protrusion **118** is formed on an inside wall **112a** of the header **110.** Specifically, the protrusion **118** protrudes within the header groove **112** to support the tank foot portion **132** received in the respective header groove **112** during crimping between the header **110** and the tank **130.** The protrusion **118** protrudes from at least one pair of opposing inside walls **112a,** disposed respectively along the opposite lateral sides and/or opposite longitudinal sides of the header **110.** More specifically, the at least one protrusion **118** extends towards the respective outside walls **112b** of the header **110** to hold the tank foot portion **132** between the inside walls **112a** and the outside walls **112b** of the header **110** and to limit any play of the tank foot portion **132** within the header groove **112** during crimping between the header **110** and the tank **130.** The at least one protrusion **118** urges the tank foot portion **132** against the outside walls **112b and** securely and stably supports tank foot portion **132** in the respective header groove **112** during crimping between the header **110** and the tank **130.** In accordance with one embodiment, the at least one protrusion **118** formed along each of the inside walls **112a** along opposite lateral sides of the header **110** supports the corresponding tank foot portion **132** configured at the lateral sides of the tank **130.** In accordance with another embodiment, the at least one protrusion **118** formed along each of the inside walls **112a** along opposite longitudinal sides of the header **110** supports the corresponding tank foot portion **132** at the longitudinal sides of the tank **130.** In accordance with an embodiment, protrusion **118** continuously extends along the inside walls **112a** of the header **110,** particularly, the protrusion **118** continuously extends along each of the inside walls **112a** and such protrusions **118** formed on intersecting inside walls are disconnected from each other at the intersection of the inside walls **112a.** Alternatively, multiple protrusions are intermittently formed along each of the inside walls **112a** of the header **110,** particularly, the protrusions **118** formed on each of the inside walls **112a** are disconnected from each other. In accordance with an embodiment, the multiple protrusions **118** formed along the inside walls **112a** of the header **110** are uniformly spaced with respect to each other. In accordance with another embodiment, the multiple protrusions **118** are non-uniformly distributed on the inside walls **112a** of the header **110.** Generally, the at least one protrusion **118** is formed on the inside walls **112a** of the header **110** by a single step stamping operation. The at least one protrusion **118** provides additional support to the tank foot portion **132** received within the header groove **112** to arrest any relative movement between the tank foot portion **132** and the header groove **112** during crimping between the header **110** and the tank **130.** The header **110** and the at least one protrusion **118** formed on the inside walls **112a** thereof is of metal, whereas the tank **130** along with the tank foot portion **132** may be of plastic or metal. **FIG. 3a** illustrates a sectional view of the header-tank assembly **100** along a first section plane passing through the at least one protrusion **118.** As illustrated in **FIG. 3a,** the at least one protrusion **118** is of triangular cross section pointed towards the tank foot portion **132.** However, the at least one protrusion **118** is not limited to triangular cross section and can be of any other cross section bulging towards the outside walls **112b** as far as the at least one protrusion **118** extends within the header groove **112** to urge the tank foot portion **132** towards the outside walls **112b.** Such cross section of the at least one protrusion **118** stably and securely holds the tank foot portion **132** in the respective header groove **112** as the tabs of the header **110** are crimped over the respective tank foot portion **132.** Such configuration of the at least one protrusion **118** provides additional support to the tank foot portion **132** to arrest movement of the tank foot portion **132** within the header groove **112** during crimping between the header **110** and the tank **130,** thereby preventing damage caused by any movement of the tank foot portion **132** in the header groove **112** during crimping. **FIG. 3b** illustrates a sectional view of the header-tank assembly **100** along a second section plane passing through a portion of the header between the adjacent protrusions **118** formed on inside walls of the header **110.**

[0031] The slots **116** formed on the header **110** receive heat exchange tubes **120.** The slots **116** are generally oblong shaped and complimentary to the shape of the heat exchange tubes **120,** to receive the heat exchange tubes **120** therein. However, the present invention is not limited to any particular shape of the slots **116** as far as the slots **116** are complimentary to the heat exchange tubes **120** and are capable of receiving the heat exchange tubes **120** to configure fluid communication between the heat exchange tubes **120** and the header tank assembly **100** on which the header **110** is a part of.

[0032] In case the heat exchanger **200** is configured to provide U-flow for heat exchange fluid there through, there may be a single header-tank assembly disposed on one side of the heat exchanger core. More specifically, an interior of a tank **130** of the header-tank assembly **100** is divided into two sections, a first section and a second section, wherein the first section distributes a first heat exchange fluid to the tubes. The first heat exchange fluid flows through a first pass and follows a second return

pass to return to the header tank assembly, particularly to the second section, in the process rejecting heat to the second heat exchange fluid flowing across the tubes. The second section of the tank **130** collects the first heat exchange fluid from the second return pass. The header-tank assembly **100** includes a header **110** and the tank **130.** The header-tank assembly **100** further includes a gasket disposed between the header **110** and the tank **130** thereof to prevent leakage between the tank **130** and the corresponding header **110.** Alternatively, two header-tank assemblies with diversion for the fluid within one of them are provided to enable U-flow of the heat exchange fluid.

[0033] Several modifications and improvement might be applied by the person skilled in the art to a heat exchanger and a header tank assembly therefor, as disclosed above and such modifications and improvements will still be considered within the scope and ambit of the present invention, as long as the heat exchanger includes a header and a tank. The header includes a header groove disposed along at least a portion of a periphery thereof, preferably along the whole periphery, and defining inside walls and outside walls of the header. The header further includes a plurality of tabs formed on at least one pair of the outside walls disposed along at least one of opposite lateral sides and opposite longitudinal sides of the header. The header still further includes a plurality of slots formed thereon to receive heat exchange tubes. The tank includes tank foot portion that are received in the corresponding header groove, wherein the tabs formed on the header are crimped over the corresponding tank foot portion. The header includes at least one protrusion protruding within the header groove, the at least one protrusion supports and the presses the tank foot portion against outside walls of the header during crimping between the header and the tank.

Claims

1. A heat exchanger (200) comprising at least one header-tank assembly (100), the header-tank assembly (100) comprising:

- a header (110) comprising:
  - a header groove (112) disposed along at least a portion of a periphery thereof and defining inside walls (112a) and outside walls (112b) of the header (110);
  - a plurality of tabs (114) formed on at least one pair of outside walls (112b) disposed along at least one of opposite lateral sides and opposite longitudinal sides of the header (110); and
  - a plurality of slots (116) formed thereon adapted to receive heat exchange tubes (120);
- a tank (130) comprising tank foot portion (132) received in the corresponding header groove (112), wherein the tabs (114) formed on the header (110) are crimped over the corresponding tank foot portion (132);

characterized in that the header (110) comprises at least one protrusion (118) protruding within the header groove (112), the at least one protrusion supports and presses the tank foot portion (132) against the outside walls (112b) of the header (110) during crimping between the header (110) and the tank (130).

2. The heat exchanger (200) as claimed previous claim, wherein the protrusion (118) is protruding towards the respective outside walls (112b).

3. The heat exchanger (200) as claimed in the previous claim, wherein the protrusion (118) protrudes from at least one pair of opposing inside walls (112a), disposed respectively along the pair of opposite lateral sides and/or the pair of opposite longitudinal sides of the header (110).

4. The heat exchanger (200) as claimed in any of the preceding claims, wherein protrusion (118) is a single protrusion that continuously extends along each of the inside walls (112a) of the header (110), the protrusions (118) formed on intersecting inside walls (112a) respectively are disconnected from each other at the intersection between the inside walls (112a).

5. The heat exchanger (200) as claimed in any of the preceding claims, wherein multiple protrusions are intermittently disposed along the inside walls (112a) of the header (110).

6. The heat exchanger (200) as claimed in any of the preceding claims, wherein in case of multiple protrusions (118) formed along the inside walls (112a) of the header (110), the protrusions (118) are uniformly spaced with respect to each other.

7. The heat exchanger (200) as claimed in any of the preceding claims, wherein in case of multiple protrusions (118) formed along the inside walls (112a) of the header (110), the protrusions (118) are non-uniformly distributed with respect to each other.

8. The heat exchanger (200) as claimed in any of the preceding claims, wherein the at least one protrusion (118) is formed on the inside walls (112a) of the header (110) by a single step stamping operation.

9. The heat exchanger (200) as claimed in any of the preceding claims, wherein the header (110) along with the at least one protrusion (118) formed on the inside walls (112a) thereof is of metal, whereas the

tank (130) along with the tank foot portion (132) is of plastic.

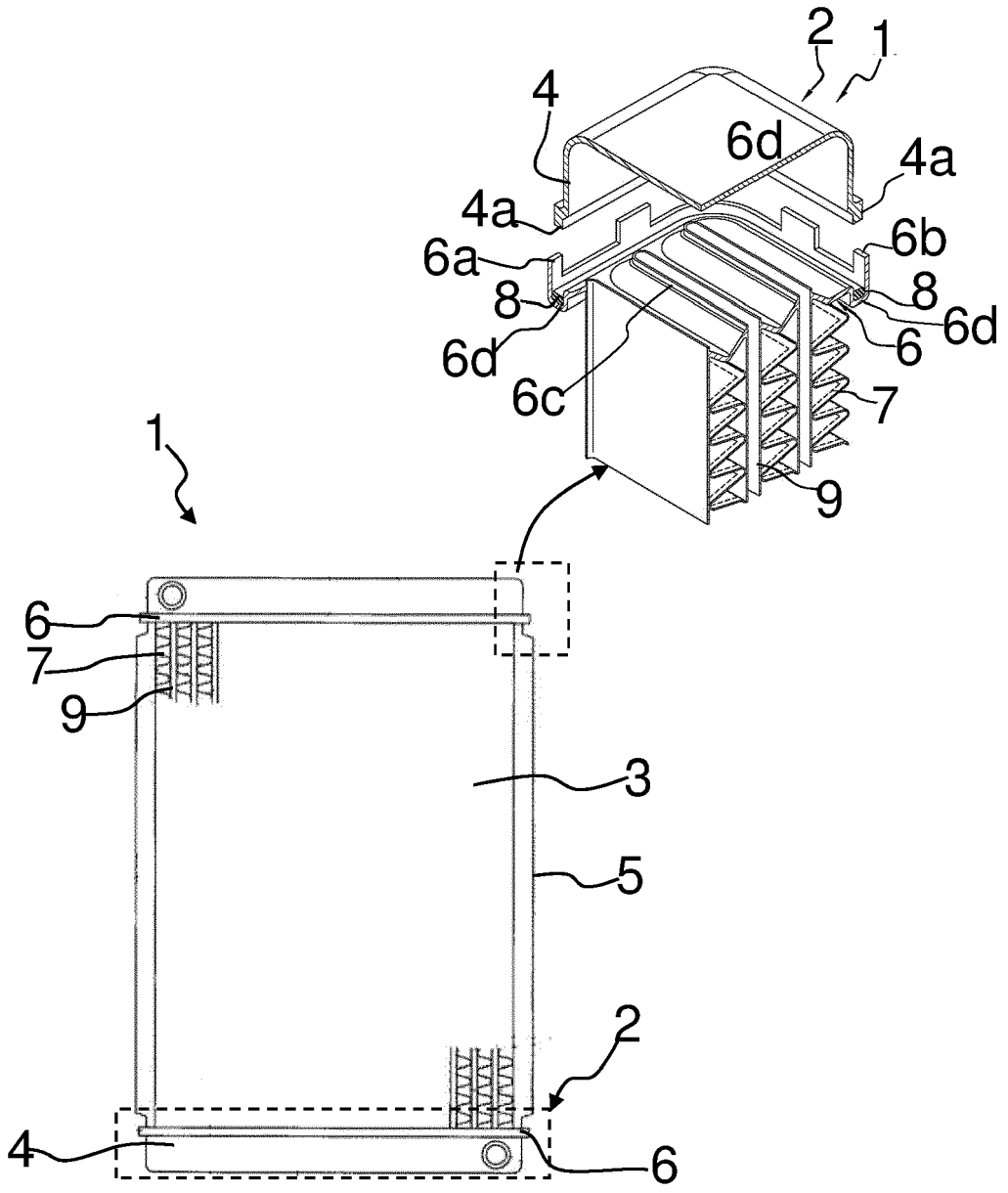


FIG. 1
(PRIOR ART)

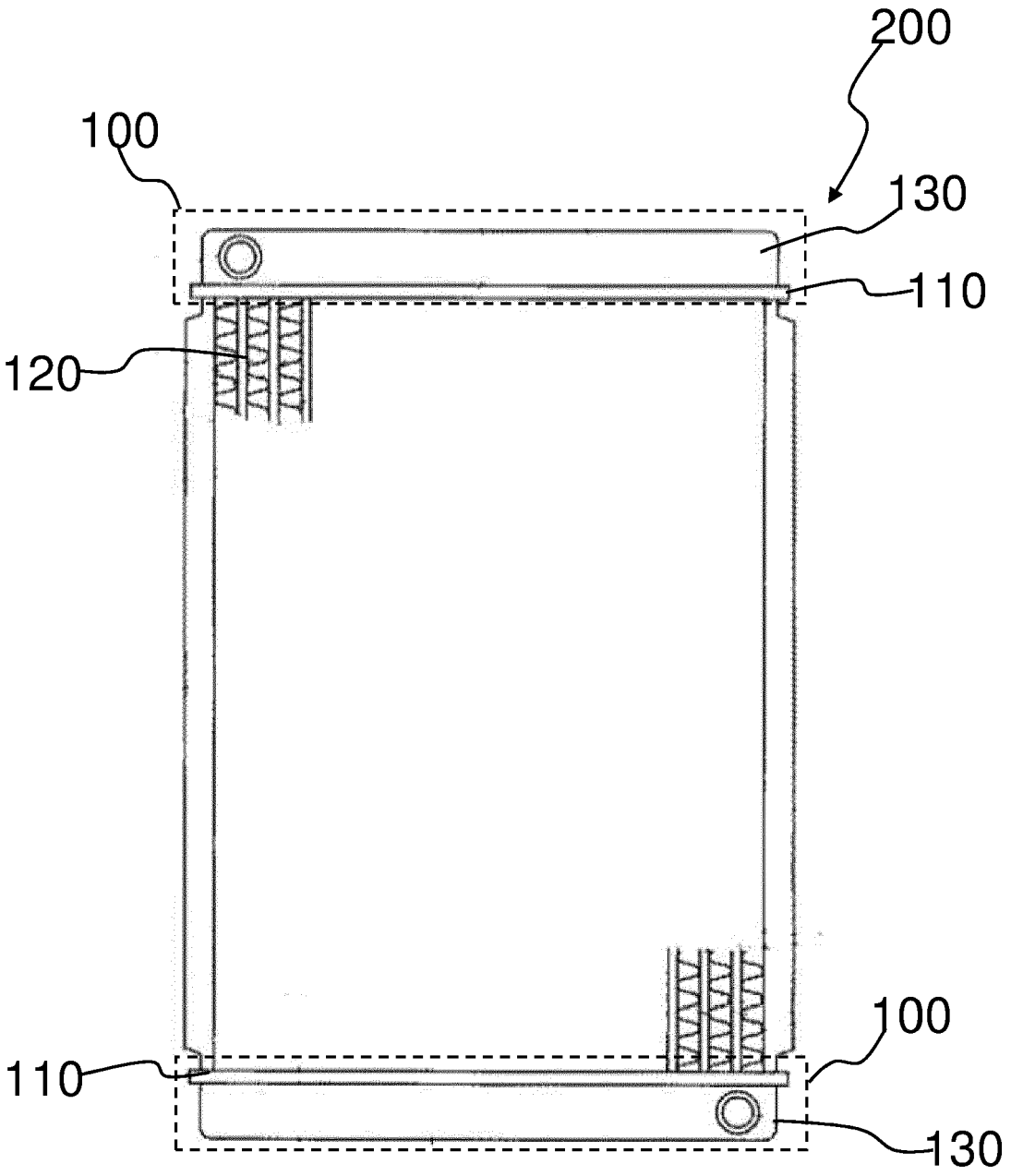
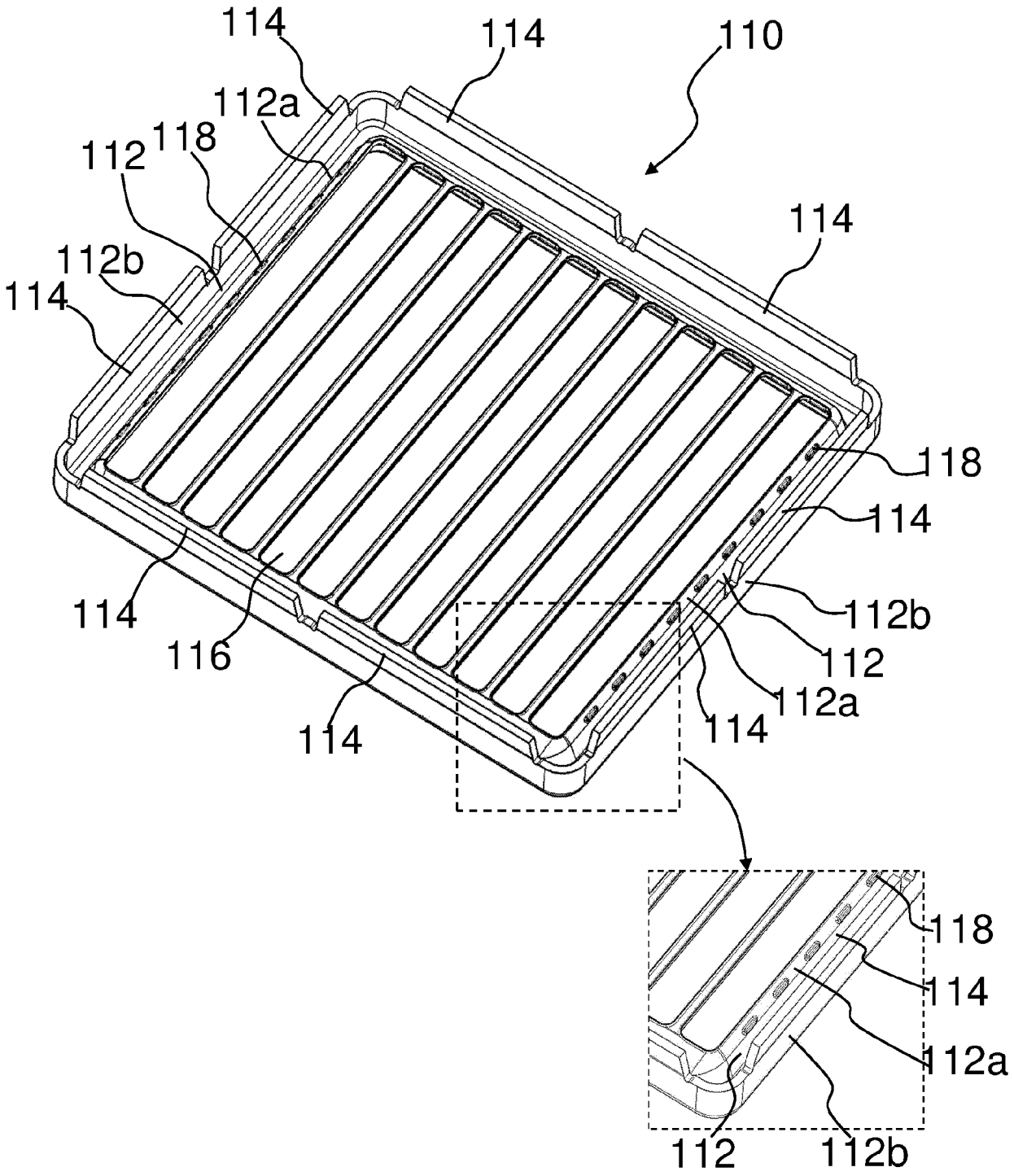


FIG. 2a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112b

FIG. 2b

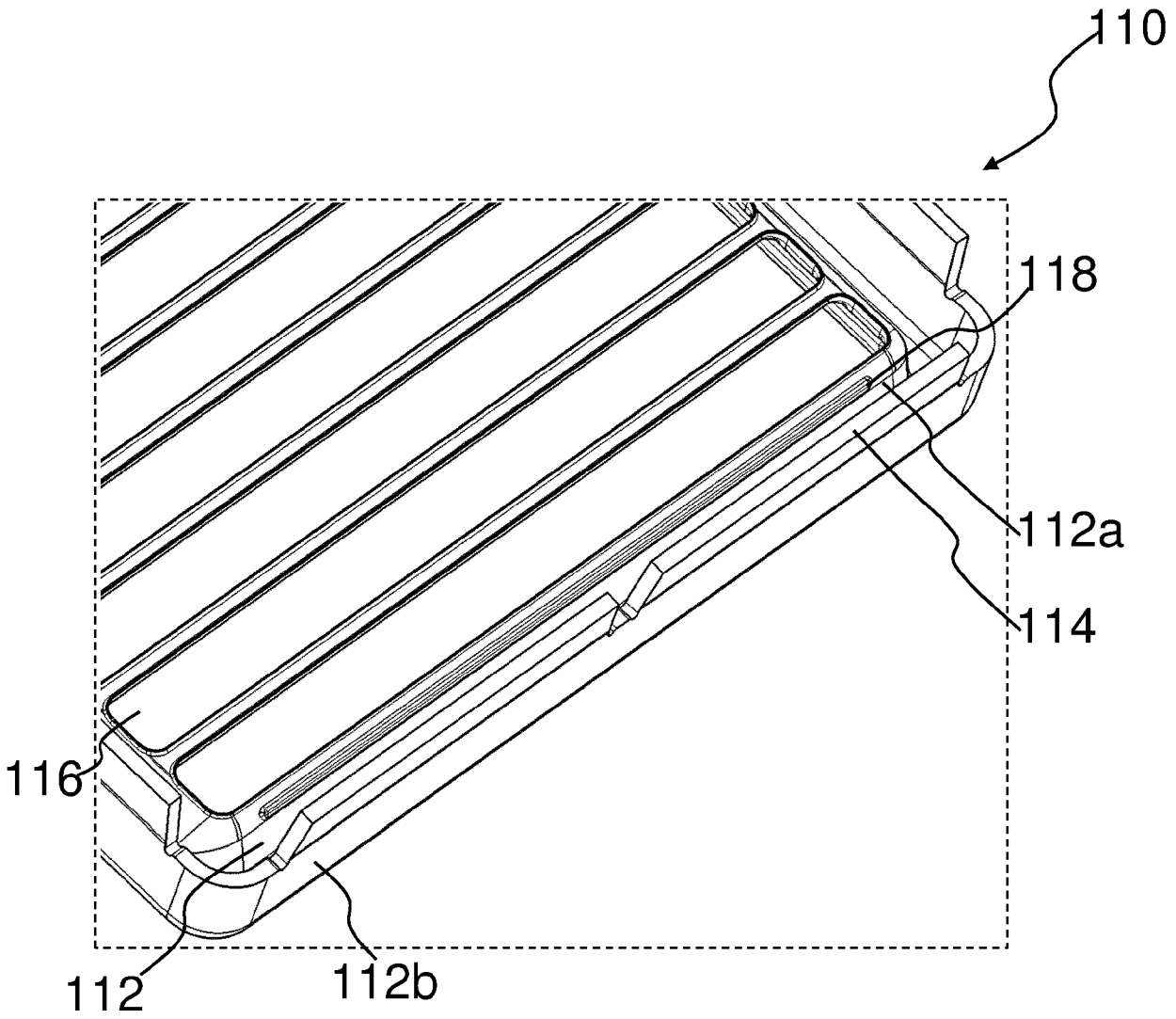

FIG. 2c

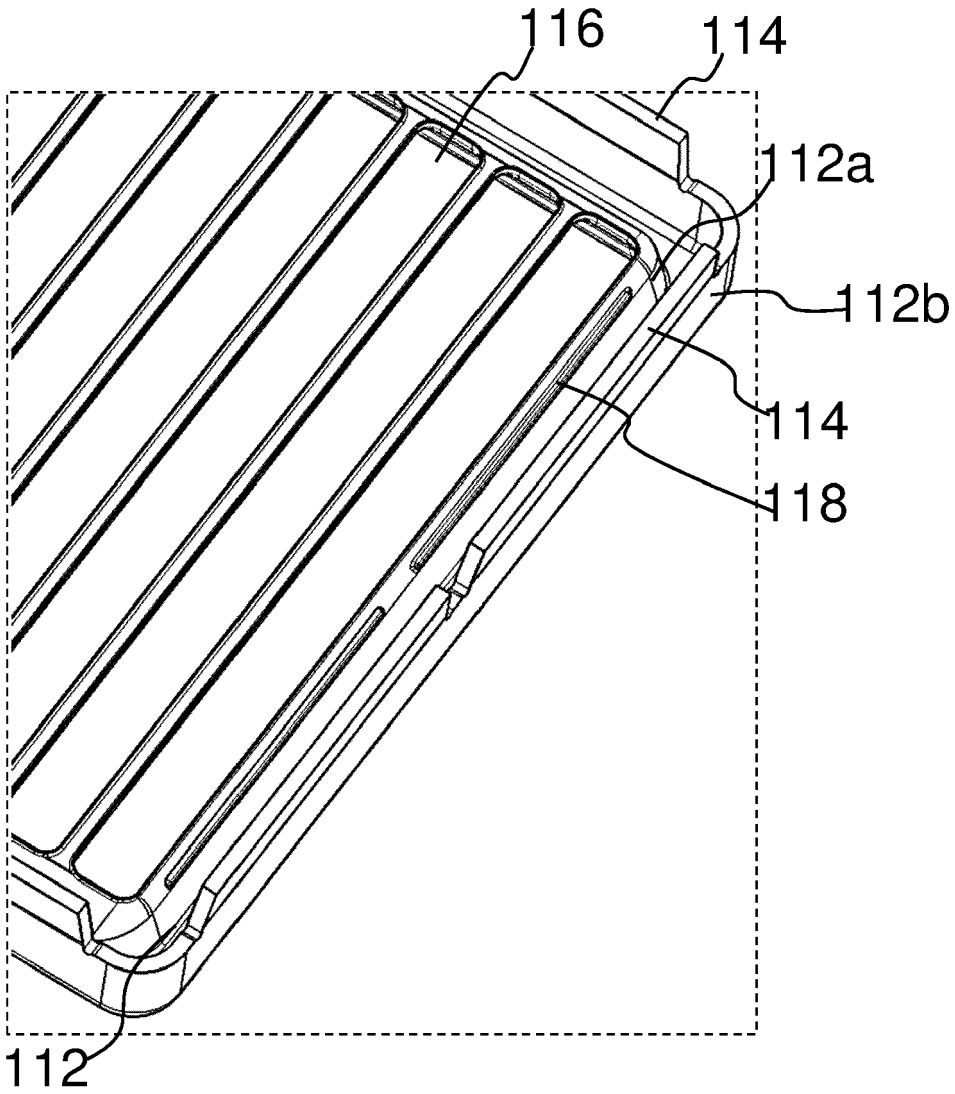

FIG. 2d

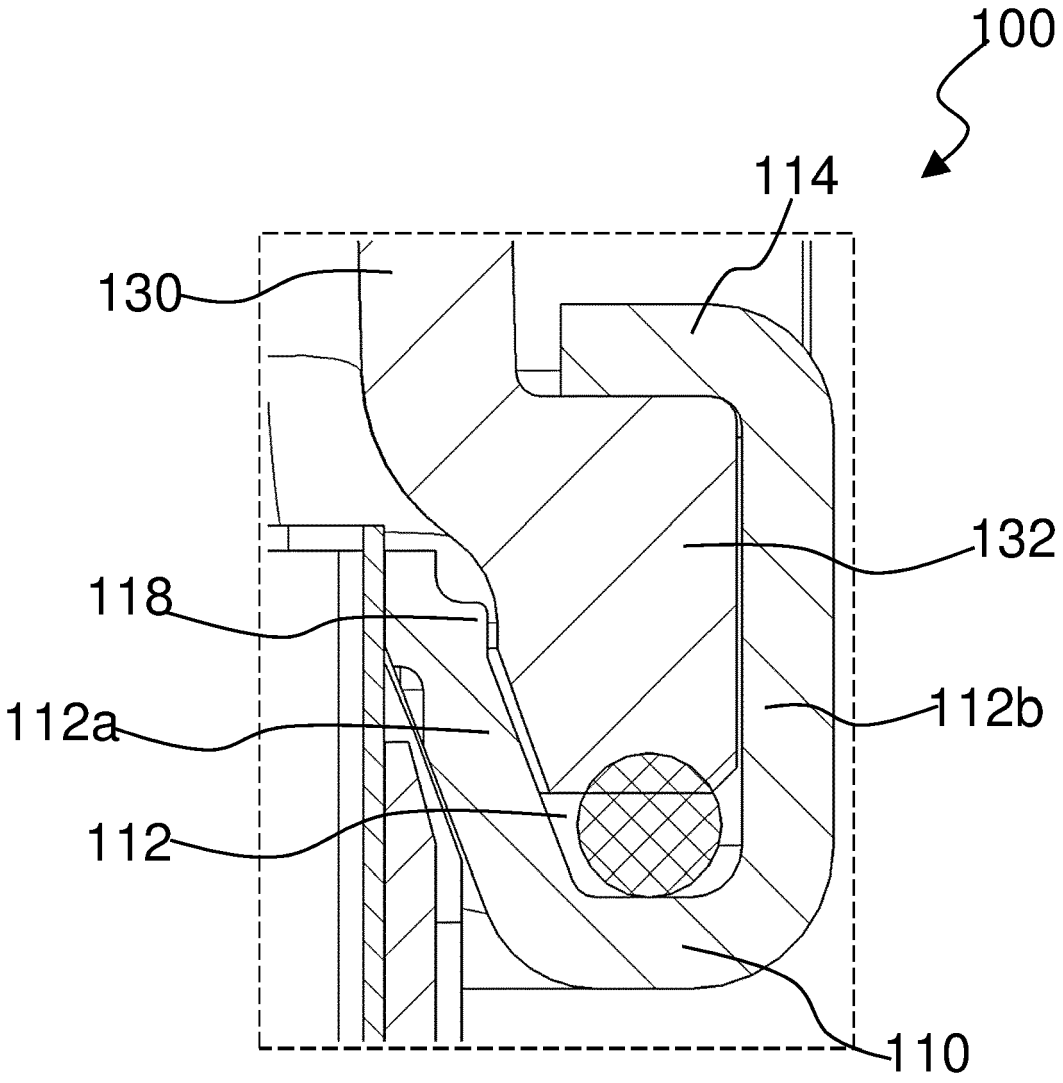

FIG. 3a

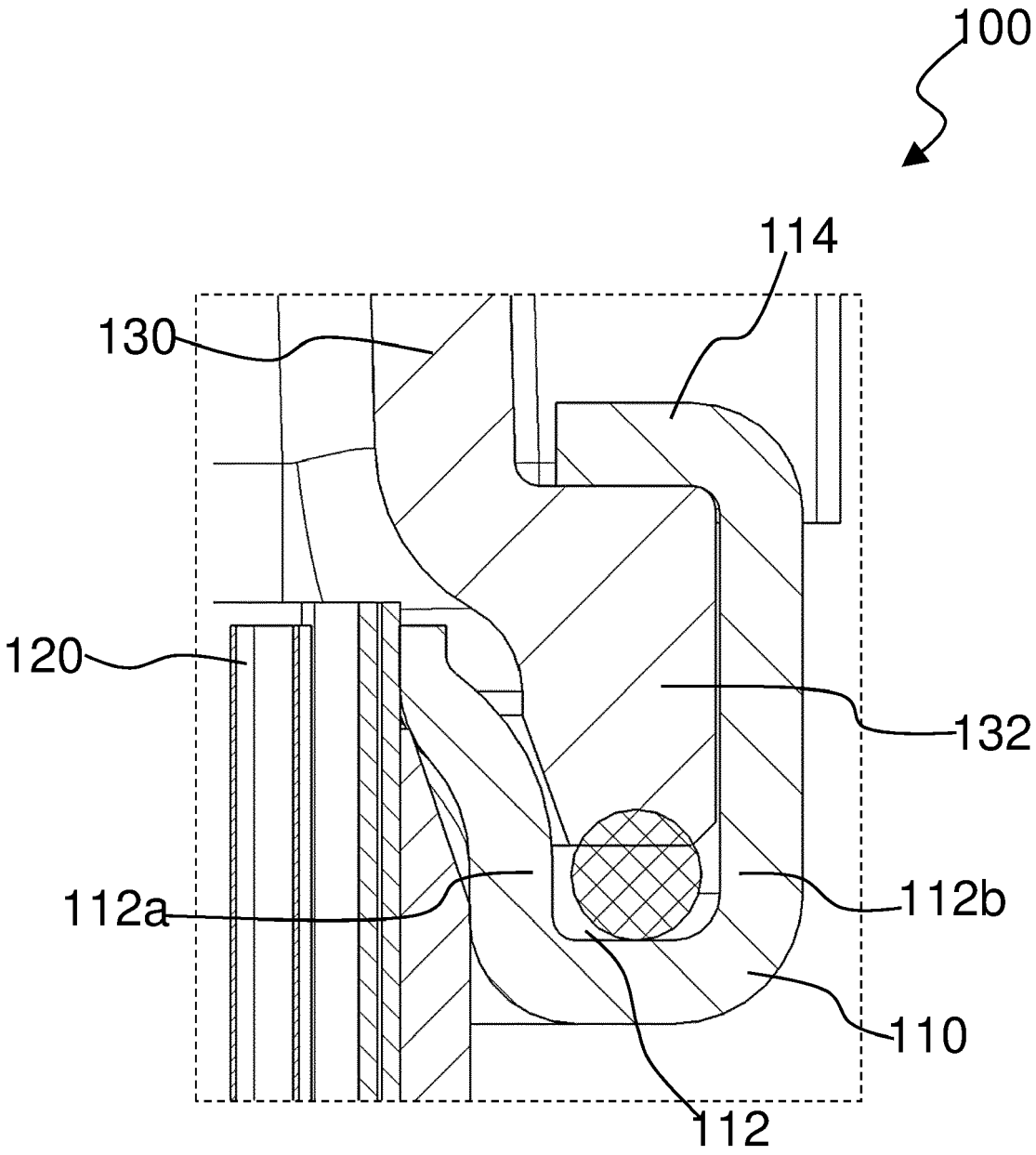

FIG. 3b

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EUROPEAN SEARCH REPORT

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Place of search	Date of completion of the search	Examiner
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