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(54) A HEAT EXCHANGER

(57) A heat exchanger (200) comprising at least one header-tank assembly (100) and a plurality of tubular elements (30). The header-tank assembly (100) comprising a header (10) and a tank (20). The header (10) comprising apertures (12a) arranged along and between longitudinal walls (10b) of the header (10) that extend along length of the header (10). The tank (20) is secured to the header (10) and is configured to receive a heat exchange fluid therein. The tubular elements (30) are securely received in the apertures (12a) and are in fluid communication with respect to the tank (20). At least one of the apertures (12a) comprises undercuts (14a, 14b) formed along at least a portion of periphery thereof.

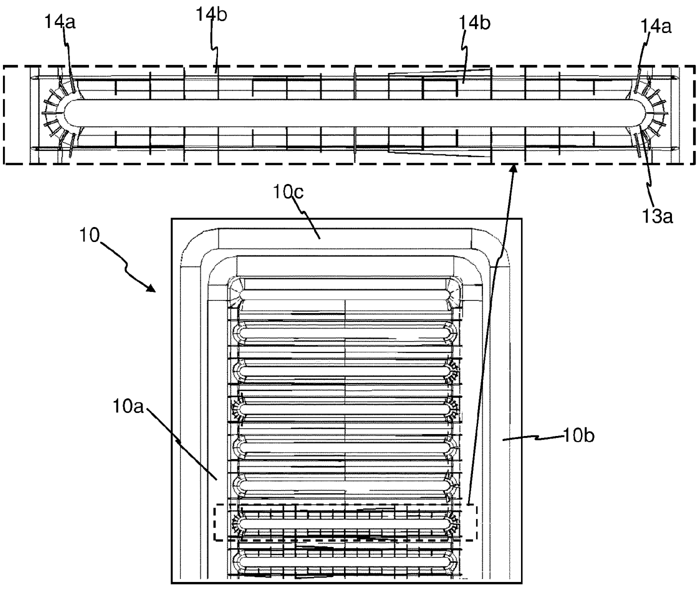

FIG. 5

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Description

FIELD OF INVENTION

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

BACKGROUND

[0002] A conventional heat exchanger, for example a radiator for use in automobiles, comprises at least a header-tank assembly and a plurality of tubular elements in fluid communication with the at least one header-tank assembly. Each header-tank assembly comprises a tank, a header and optionally a gasket disposed between the tank and the header to configure leak-proof connection between the tank and the header. The tank is generally in the form of an enclosure defined by walls, particularly, opposite longitudinal walls and opposite lateral walls, wherein the walls are connected at one end to form a closed end, whereas other end of the walls forms an open end of the tank opposite to the closed end. The tank comprises foot portions formed along a periphery of the open end of the tank, particularly along longitudinal and lateral sides of the tank. The header is complementary to the tank and engages with the open end of the tank. The header comprises tabs disposed along longitudinal and lateral sides thereof. Generally, the tabs are crimped to the foot portion of the tank to arrest any relative movement between the tank and the header and configure header-tank assembly. Further, the header comprises apertures formed thereon to receive corresponding tubular elements that are secured to the header by using a joining process, such as for example, brazing.

[0003] The tank receives a first heat exchange fluid, often, pressurized and heated heat exchanging fluid, particularly coolant that get heated after undergoing heat exchange to extract heat from a drive, for example, an engine in an internal combustion engine driven vehicle. The tanks in conjunction with the corresponding headers facilitate distribution of the first heat exchange fluid to and collection of the first heat exchange fluid from tubular elements that are generally, heat exchange tubes. Generally, the heat exchange tubes are secured to the header by brazing. Particularly, the first heat exchange fluid ingresses with respect to the tank via an inlet, is distributed to and passes through the heat exchange tubes, and in the process, undergoes heat exchange with a second heat exchange fluid, particularly, air flowing around the heat exchange tubes. In order to achieve better heat exchange between the first heat exchange fluid, for example, coolant flowing through the heat exchange tubes and the second heat exchange fluid, for example, air flowing around the heat exchange tubes, a plurality of fins are disposed adjacent the heat exchange tubes to retard air flow across the heat exchange tubes.

[0004] The heat exchanger is generally subjected to thermal shock test and to thermal stresses during operation thereof. The thermal stresses may cause the length of the tubes to change, thereby resulting in deformation of the headers and the tubes secured to the headers. The thermal stresses and deformation of the tubes and headers resulting from the thermal stresses may cause mechanical failure of the tubes, the fins, the headers and the joint between the tubes and the headers leading to reliability issues, frequent breakdowns and replacements, high maintenance, inefficient operation and reduced service life. Also uncontrolled deformation, particularly, difference in elongation of the adjacent tubular elements may further aggravate the problems caused by the thermal stresses.

[0005] Accordingly, there is a need for a heat exchanger that addresses the problems such as deformation and mechanical failure of the headers, the fins and the tubes secured to the headers due to high thermal stresses at critical areas. Particularly, there is a need for a heat exchanger that ensures robust and secure connection between the header and the tubular elements. There is a need for a heat exchanger that is reliable, require less maintenance and exhibits longer service life compared to conventional heat exchanger. Further, there is a need for a heat exchanger that exhibits controlled elongation of the adjacent tubular elements to control and limit difference in elongation between adjacent tubular elements.

[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

[0007] A heat exchanger is disclosed in accordance with an embodiment of the present invention. The heat exchanger comprising at least one header-tank assembly and a plurality of tubular elements. The header-tank assembly comprising a header and a tank. The header comprising apertures arranged along and between longitudinal walls of the header that extend along length of the header. The tank is secured to the header and is configured to receive a heat exchange fluid therein. The tubular elements are securely received in the apertures and are in fluid communication with respect to the tank. At least one of the apertures comprises undercuts formed along at least a portion of periphery thereof.

[0008] Generally, the undercuts radially extends outwardly from the aperture.

[0009] Particularly, the undercuts receive and retain clad between the header and the corresponding tubular elements in order to configure robust brazing there between.

[0010] Generally, the undercuts are formed along at least one of lateral sides and longitudinal sides of the aperture, the longitudinal side of the aperture being orthogonal to the longitudinal wall of the header.

[0011] Preferably, the undercuts are formed on opposite lateral sides of the at least one of the apertures.

[0012] Particularly, at least one of the undercuts is sloping towards the corresponding aperture.

[0013] Further, at least one of the undercuts is converging towards the corresponding aperture

[0014] Specifically, the undercuts formed on a first lateral side of the aperture is more in number than the undercuts formed on a second lateral side of the aperture opposite to the first lateral side.

[0015] Generally, the undercuts are uniformly distributed along entire periphery of the aperture.

[0016] Particularly, all the undercuts for a corresponding aperture are of uniform dimensions.

[0017] More particularly, the different apertures are formed with the undercuts of different configurations.

[0018] Preferably, the undercuts are obtained by the stamping process.

[0019] Generally, the heat exchanger comprises a pair of opposite header-tank assemblies, wherein apertures formed on at least one of the header comprises corresponding undercuts.

[0020] A header for a heat exchanger is disclosed in accordance with an embodiment of the present invention. The header comprising a base portion, a pair of opposite longitudinal walls and a pair of opposite lateral walls. The base portion is formed with apertures that securely receive tubular elements. At least one pair of the longitudinal walls and the lateral walls is connected to a tank to form a header-tank assembly. At least one of the apertures comprises undercuts formed along at least a portion of periphery thereof.

[0021] In accordance with an embodiment of the present Invention, at least one pair of the longitudinal walls and the lateral walls is formed with crimping tabs that are crimped over corresponding foot portions of the tank to configure crimping connection between the header and the tank.

BRIEF DESCRIPTION

[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 front view and an enlarged exploded view of a heat exchanger configured with a header-tank assembly in accordance with an embodiment of the present invention;

FIG. 2 illustrates an isometric view of a header for a header tank assembly for the heat exchanger of FIG. 1, also is depicted an enlarged view of a portion of the header;

FIG. 3 illustrates a schematic representation of a portion of the header of FIG. 2, also is depicted enlarged view of one of the apertures with undercuts formed on one lateral side thereof;

FIG. 4 illustrates a schematic representation of a portion of the header of FIG. 2, also is depicted enlarged view of one of the apertures with undercuts formed on opposite lateral side thereof;

FIG. 5 illustrates a schematic representation of a portion of the header of FIG. 2, also is depicted enlarged view of one of the apertures with undercuts formed all along the periphery thereof;

FIG. 6 illustrates a schematic representation of a portion of the header of FIG. 2, also is depicted enlarged view of one of the apertures with undercuts formed all along the periphery thereof in accordance with another embodiment;

FIG. 7 illustrates a schematic representation of the header of FIG. 2, also is depicted enlarged view of one of the apertures with different configuration of undercuts formed on opposite lateral sides thereof; and

FIG. 8 illustrates a sectional view of the header of FIG. 2, wherein one of aperture formed on the header receiving a corresponding tubular element is configured with undercut at the interface of the tube and the corresponding aperture.

DETAILED DESCRIPTION OF THE INVENTION

[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] Although, the present invention is explained in the forthcoming description and the accompanying drawings with an example of a heat exchanger for a motor vehicle, particularly, the heat exchanger comprising at least one header-tank assembly and a plurality of tubular elements. The header-tank assembly comprising a header and a tank. The header comprising apertures arranged along and between longitudinal walls of the header that extends along length of the header. The tank is secured to the header and is configured to receive a heat exchange fluid therein. The tubular elements are securely received in the apertures and are in fluid communication with respect to the tank. More specifically, the extreme ends of the tubular elements received in the corresponding apertures are joined to the header by a joining process, such as for example, brazing. However, the present invention is applicable for any heat exchanger used in vehicular or non-vehicular environment, wherein it is required to configure robust and leak proof connection / joint between elements thereof, particularly, the joint between the tubular elements and the header to prevent leakage and drawbacks associated with the leakage of heat exchanger fluid through lose / insecure joints.

[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.

[0026] FIG. 1 illustrates a heat exchanger 200 in accordance with an embodiment of the present invention. The heat exchanger 200 comprising at least one header-tank assembly 100 and a plurality of tubular elements 30. The header-tank assembly 100 comprising a header 10 and a tank 20.

[0027] FIG. 2 illustrates an isometric view of the header 10 of the header tank assembly 100 of the heat exchanger 200. The header 10 comprising apertures 12a arranged along and between longitudinal walls 10b of the header 10 that extend along length of the header 10.

[0028] The tank 20 is secured to the header 10 and is configured to receive a heat exchange fluid therein. More specifically, the tank 20 secured to the header 10 and in conjunction with the header 10 defines an enclosure for receiving first heat exchange fluid therein. Generally, the tank 20 is secured to the header by crimping. Particularly, at least one of the header 10 and the tank 20 is formed with tabs 12, 22 for configuring crimping connection between the header 10 and the tank 20. Once the header 10 and the tank 20 are assembled by the crimping connection, the header 10 and the tank 20 are joined by a joining process such as for example, brazing to configure the header-tank assembly 100. However, the present invention is not limited to any particular joining process for configuring joint between the header 10 and the tank 20 as far as the joining process is able to configure robust and leak proof joint between the header 10 and the tank 20 for forming the header-tank assembly 100.

[0029] The tubular elements 30 are securely received in the corresponding apertures 12a and are in fluid communication with respect to an interior of the tank 20 of the header-tank assembly 100 to configure flow of first exchange fluid, particularly, coolant through the tubular elements 30. The tubular elements 30 received in the apertures 12a formed on the header 10 are secured to the header 10 by a joining process such as for example, brazing. More specifically, the pre-assembly of headers 10 and the corresponding tanks 20 and tubular elements 30 received in the apertures 12a formed on the headers 10 are subjected to brazing in the brazing furnace to configure joint between the headers 10 and the respective tanks 20 and between the headers 10 and the tubular elements 30. The tubular elements 30 connecting the spaced apart headers 10 configure fluid communication between the headers 10. The first heat exchange fluid flowing through the tubular elements 30 undergo heat exchange with respect to a second heat exchange fluid, particularly, air flowing outside the tubular elements. The adjacent tubular elements 30 are separated by tabulators or fins. The tabulator or fins to retard the flow of second heat exchange fluid across the core of the heat exchanger 200, thereby improving heat exchange between first and second heat exchange fluids. In accordance with one embodiment, the first heat exchange fluid after undergoing heat exchange with the second heat exchange fluid is collected in a second header tank assembly disposed opposite to the first header tank assembly.

[0030] Alternatively, proximal ends of first and second set of tubular elements are in fluid communication with a first portion and a second portion of the header-tank assembly separated by a baffle and disposed on same side of the heat exchanger, while distal ends of the first and second set of the tubular elements 30 are connected to configure u-flow of the first heat exchange fluid. More particularly, the first portion of the header-tank assembly distributes the first heat exchange fluid to the tubular elements and the second portion of the header-tank assembly collects the first heat exchange fluid after the first heat exchange fluid has undergone heat exchange with the second heat exchange fluid.

[0031] The connection between the header 10 and the tubular elements 30 is required to be a robust connection in order to withstand thermal stresses and prevent deformation of the header 10 and the tubular elements 30 and subsequent damage to the header 10 and the tubular elements 30. In order to configure robust connection between the tubular elements 30 received in the corresponding apertures 12a formed on the header 10, undercuts 14a, 14b are provided along at least a portion of the periphery of at least one of the apertures 12a. The undercuts 14a, 14b ensure optimized distribution of the clad at the interface between the apertures 12a formed on the header 10 and the corresponding tubular elements 30. The undercuts 14a, 14b ensure proper distribution of the clad at the interface between the apertures 12a formed on the header 10 and the corresponding tubular elements 30 because gravity and capillary action assist proper distribution of the clad. With the incorporation of undercuts 14a, 14b on the apertures 12a, the brazing connection is robust to withstand thermal stresses and the strain on the tubular elements 30 and the header 10 is reduced. Particularly, referring to FIG. 8, the clad material fills the undercuts provided at the interface between the tubular element 30 and the aperture 12a formed on the header 10 to form robust connection between the tubular element 30 and the header 10. The proper distribution of the clad at the interface between the apertures 12a formed on the header 10 and the corresponding tubular elements 30 ensure good level of brazing radius. The undercuts 14a, 14b provide space for retaining the clad at the interface of the tubular elements 30 and the header 10, thereby configuring a robust brazing joint between the header 10 and the extreme ends of the tubular elements 30. Particularly, the brazing joint between the tubular elements 30 and the header 10 with apertures 12a configured with the undercuts 14a, 14b is more secure compared to joint between tubular elements and header with apertures without undercuts because of optimal distribution of clad at the interface of tubular element and the aperture and clad forming secure brazing connection. Preferably, all the apertures 12a comprises the undercuts 14a, 14b formed along at least a portion of periphery thereof. FIG. 3 to FIG. 7 illustrates different configurations of the header 10, wherein the apertures 12a formed on the header 10 are formed with different configurations of the undercuts 14a, 14b. Generally, the undercuts 14a, 14b radially extends outwardly from the aperture 12a. Particularly, the undercuts 14a, 14b receive and retain clad between the header 10 and the corresponding tubular elements 30 in order to configure robust brazing there between. As the present invention is not limited to any particular joining process for configuring joint between the header 10 and the tubular elements 30, the undercuts 14a, 14b provide sufficient space for retaining fused or filler material at the interface between the header 10 and the tubular elements 30 for configuring robust joint there between, irrespective of the joining process. In case of welding, the undercuts 14a, 14b receive and retain fused material or filler material to configure robust joint between the header 10 and the tubular elements 30.

[0032] Generally, the undercuts 14a and 14b are formed along at least one of lateral sides 13a and longitudinal sides 13b of the aperture 12a respectively, the longitudinal side 13b of the aperture 12a being orthogonal to the longitudinal wall 10b of the header 10. Generally, the undercuts 14a are formed on one of the lateral sides 13a of the aperture as illustrated in FIG. 3. Alternatively, the undercuts 14a are formed on opposite lateral sides 13a of the at least one of the apertures 12a as illustrated in FIG. 4. In accordance with one embodiment, at least one of the undercuts 14a, 14b is sloping towards the corresponding aperture 12a. Further, at least one of the undercuts 14a, 14b is converging towards the corresponding aperture 12a. In accordance with an embodiment, the undercuts 14a formed on the first lateral side 13a of the aperture 12a is more in number than the undercuts 14a formed on the second lateral side 13a of the aperture 12a opposite to the first lateral side. Similarly, the undercuts 14b formed on the first longitudinal side 13b of the aperture 12a is more in number than the undercuts 14b formed on the second longitudinal side 13b of the aperture 12a opposite to the first longitudinal side 13b. Generally, the undercuts 14a, 14b are uniformly distributed along entire periphery of the aperture 12a. In accordance with one embodiment of the present invention, all the undercuts 14a, 14b formed on a corresponding aperture 12a are of uniform dimension. Alternatively, the different apertures 12a are formed with the undercuts 14a, 14b of different configurations. Preferably, the undercuts 14a, 14b are obtained by the stamping process. More specifically, the undercuts 14a, 14b are formed in-situ as the apertures 12a are formed on the header 10 by the stamping process.

[0033] Although the header 10 illustrated in FIG. 3 - FIG. 7 of the accompanying drawings is formed apertures 12a with different configuration and placement of the undercuts 14a, 14b formed along at least a portion of the periphery thereof. However, all the apertures 12a formed on the header 10 can have any one of the configurations depicted in FIG. 3 - FIG. 7 or the apertures 12a can have different combinations of the configurations depicted in FIG. 3 - FIG. 7. For example, the header 10 is formed with apertures 12a, wherein all the apertures 12a are of same configuration, particularly, the undercuts 14a, 14b are configured on both lateral sides 13a of each of the apertures 12a as illustrated in FIG. 4. Alternatively, all the apertures 12a configured on the header 10 are formed with the undercuts 14a, 14b along entire periphery of the apertures 12a as illustrated in FIG. 5. The present invention is not limited to any particular configuration of the apertures 12a, more specifically, any particular number, orientation, placement and spacing between the adjacent undercuts 14a, 14b formed along at least a portion of the periphery of the apertures 12a.

[0034] Also is disclosed a heat-exchanger 200 in accordance with an embodiment of the present invention, wherein at least one header-tank assembly 100 of the heat exchanger 200 comprises the header 10 as explained in the above. More specifically, the heat exchanger 200 comprises the pair of opposite header-tank assemblies 100, wherein apertures 12a formed on at least one of the header 10 comprises corresponding undercuts 14a, 14b. In one embodiment, all the apertures 12a formed on opposite headers 10 are configured with undercuts 14a, 14b. In another embodiment, all the apertures formed on one of the headers 10 corresponding to one of the header-tank assembly 100 is configured with undercuts 14a, 14b.

[0035] A header 10 for a heat exchanger 200 is disclosed in accordance with an embodiment of the present invention. The header 10 comprising a base portion 10a, a pair of opposite longitudinal walls 10b and a pair of opposite lateral walls 10c orthogonal to the longitudinal walls 10b. The base portion 10a is formed with apertures 12a that securely receive tubular elements 30. At least one pair of the longitudinal walls 10b and the lateral walls 10c is connected to a tank 20 to form a header-tank assembly 100. At least one of the apertures 12a comprises undercuts 14a, 14b formed along at least a portion of periphery thereof.

[0036] In accordance with an embodiment of the present Invention, at least one pair of the longitudinal walls 10b and the lateral walls 10c is formed with crimping tabs 12b, 12c that are crimped over corresponding foot portions of the tank 20 to configure crimping connection between the header 10 and the tank 20.

[0037] 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 (200) comprising:

- at least one header-tank assembly (100) comprising:
  - ◦ a header (10) comprising apertures (12a) arranged along and between longitudinal walls (1 0b) of the header (10) that extend along length of the header (10);
  - ◦ a tank (20) adapted to be secured to the header (10) and configured to receive a heat exchange fluid therein,
- a plurality of tubular elements (30) securely received in the apertures (12a) and in fluid communication with respect to the tank (20),
characterized in that at least one of the apertures (12a) comprises undercuts (14a, 14b) formed along at least a portion of periphery thereof.

2. The heat exchanger (200) as claimed in the previous claim, wherein the undercuts (14a, 14b) extend radially outwardly from the aperture (12a) .

3. The heat exchanger (200) as claimed in any of the preceding claims, wherein the undercuts (14a, 14b) are adapted to receive and retain clad between the header (10) and the corresponding tubular elements (30) in order to configure robust brazing connection there between.

4. The heat exchanger (200) as claimed in any of the preceding claims, wherein the undercuts (14a, 14b) are formed along at least one of lateral sides (13a) and longitudinal sides (13b) of the aperture (12a), the longitudinal side (13b) of the aperture (12a) being orthogonal to the longitudinal wall (10b) of the header (10).

5. The heat exchanger (200) as claimed in any of the preceding claims, wherein the undercuts (14a) are formed along opposite lateral sides (13a) of the at least one of the apertures (12a).

6. The heat exchanger (200) as claimed in any of the preceding claims, wherein at least one of the undercuts (14a, 14b) is sloping towards the corresponding aperture (12a).

7. The heat exchanger (200) as claimed in any of the preceding claims, wherein at least one of the undercuts (14a, 14b) is converging towards the corresponding aperture (12a).

8. The heat exchanger (200) as claimed in any of the preceding claims, wherein the undercuts (14a) formed on a first lateral side of the aperture (12a) is more in number than the undercuts (14a) formed on a second lateral side of the aperture (12a) opposite to the first lateral side.

9. The heat exchanger (200) as claimed in any of the preceding claims, wherein the undercuts (14a, 14b) are uniformly distributed along entire periphery of the aperture (12a).

10. The heat exchanger (200) as claimed in any of the preceding claims, wherein all the undercuts (14a) for a corresponding aperture (12a) are of uniform dimensions.

11. The heat exchanger (200) as claimed in any of the preceding claims, wherein different apertures (12a) are formed with the undercuts (14a, 14b) of different configurations.

12. The heat exchanger (200) as claimed in any of the preceding claims, wherein the undercuts (14a, 14b) are obtained by stamping process.

13. The heat exchanger (200) as claimed in any of the preceding claims comprises a pair of opposite header-tank assemblies (100), wherein apertures (12a) formed on at least one of the header (10) comprises corresponding undercuts (14a, 14b).

14. A header (10) for a heat exchanger, the header (10) comprising:

- a base portion (10a) formed with apertures (12a) adapted to securely receive tubular elements (30);
- a pair of opposite longitudinal walls (10b);
- a pair of opposite lateral walls (10c),

wherein at least one pair of the longitudinal walls (10b) and the lateral walls (10c) is connected to a tank (20) to form a header-tank assembly (100),
characterized in that at least one of the apertures (12a) comprises undercuts (14a, 14b) formed along at least a portion of periphery thereof.

15. The header (10) as claimed in the previous claim, wherein at least one pair of the longitudinal walls (10b) and the lateral walls (10c) is formed with crimping tabs (12b, 12c) adapted to be crimped over corresponding foot portions of the tank (20) to configure crimping connection between the header (10) and the tank (20).

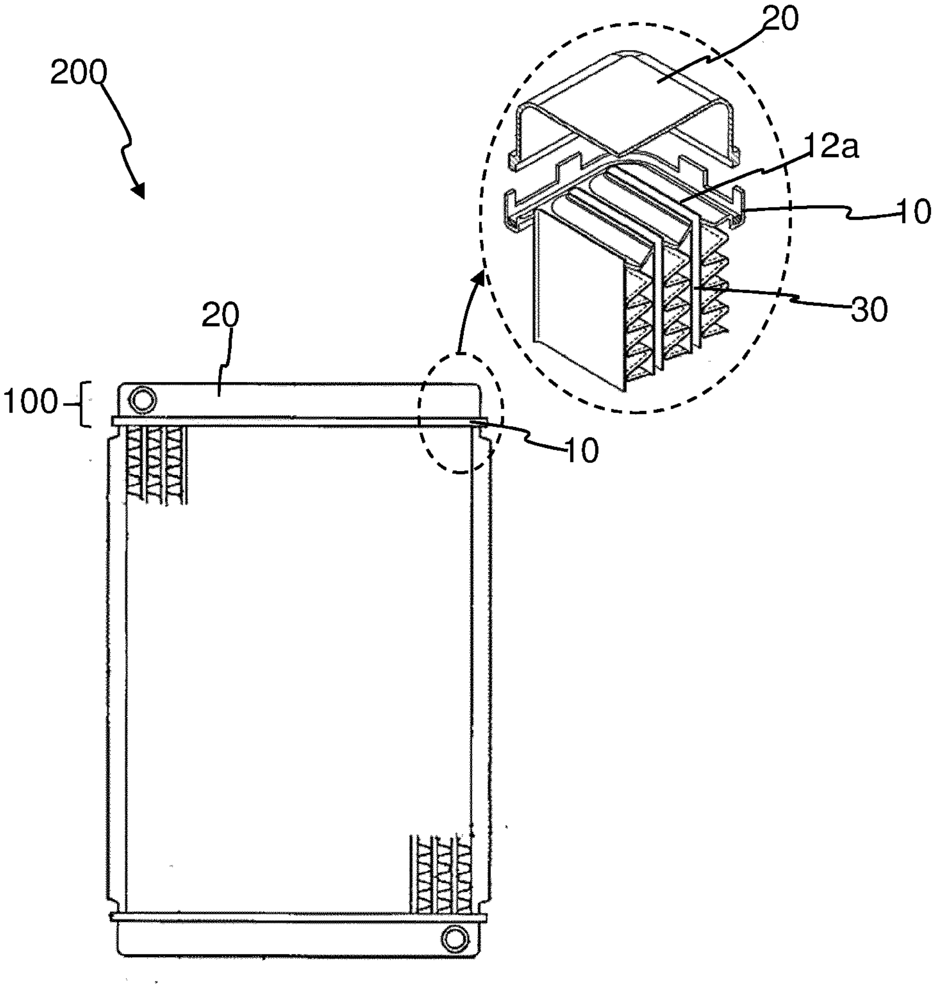

FIG. 1

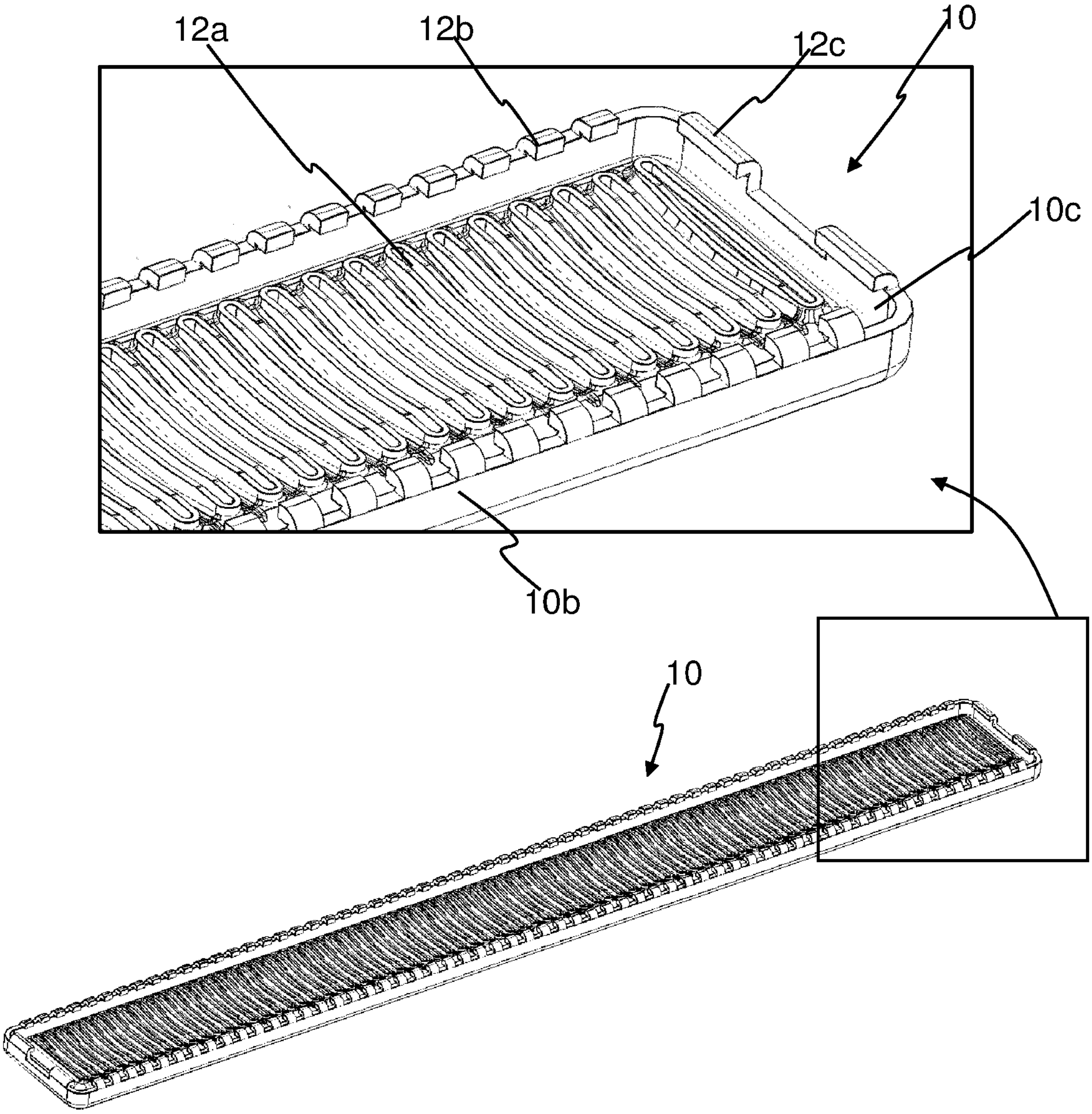

FIG. 2

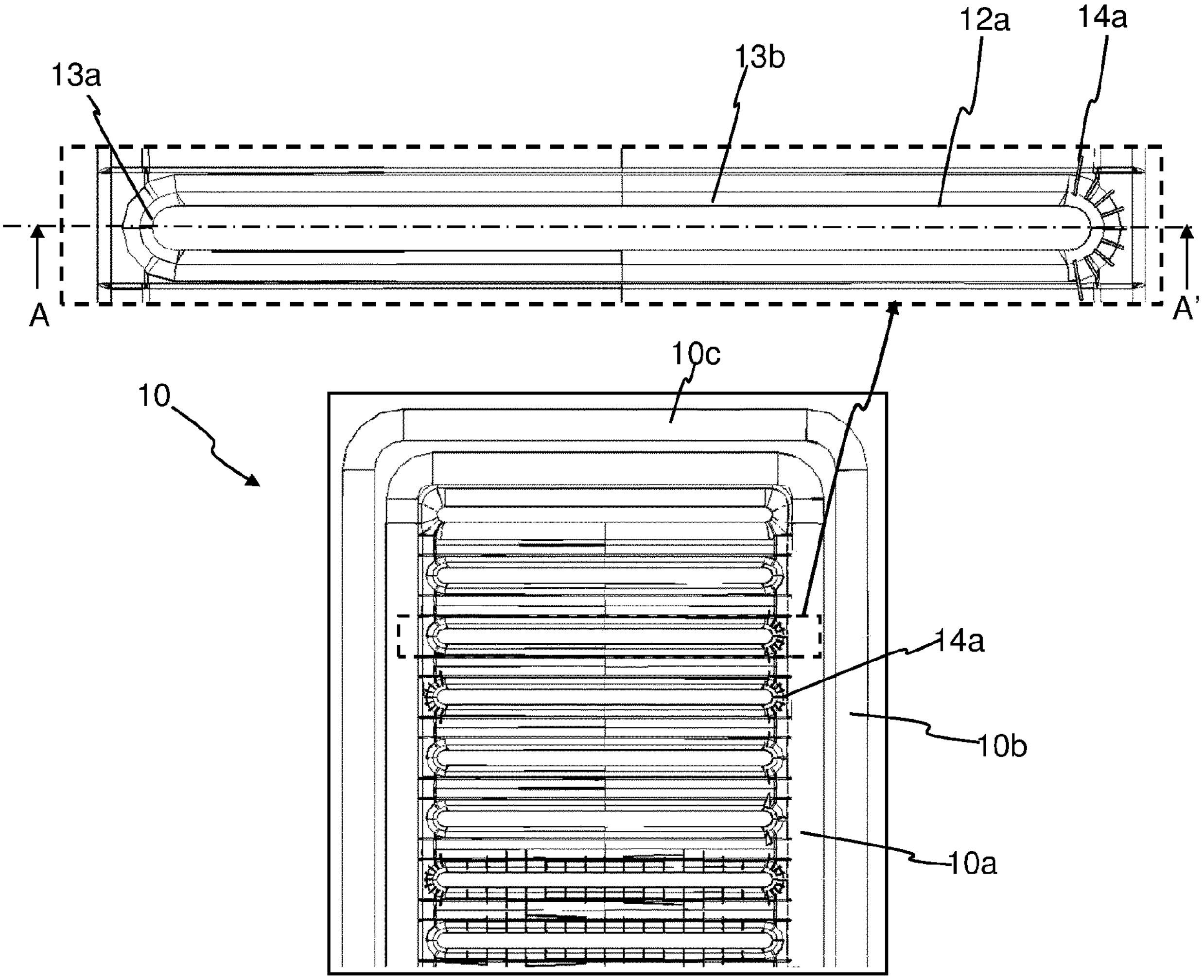

FIG. 3

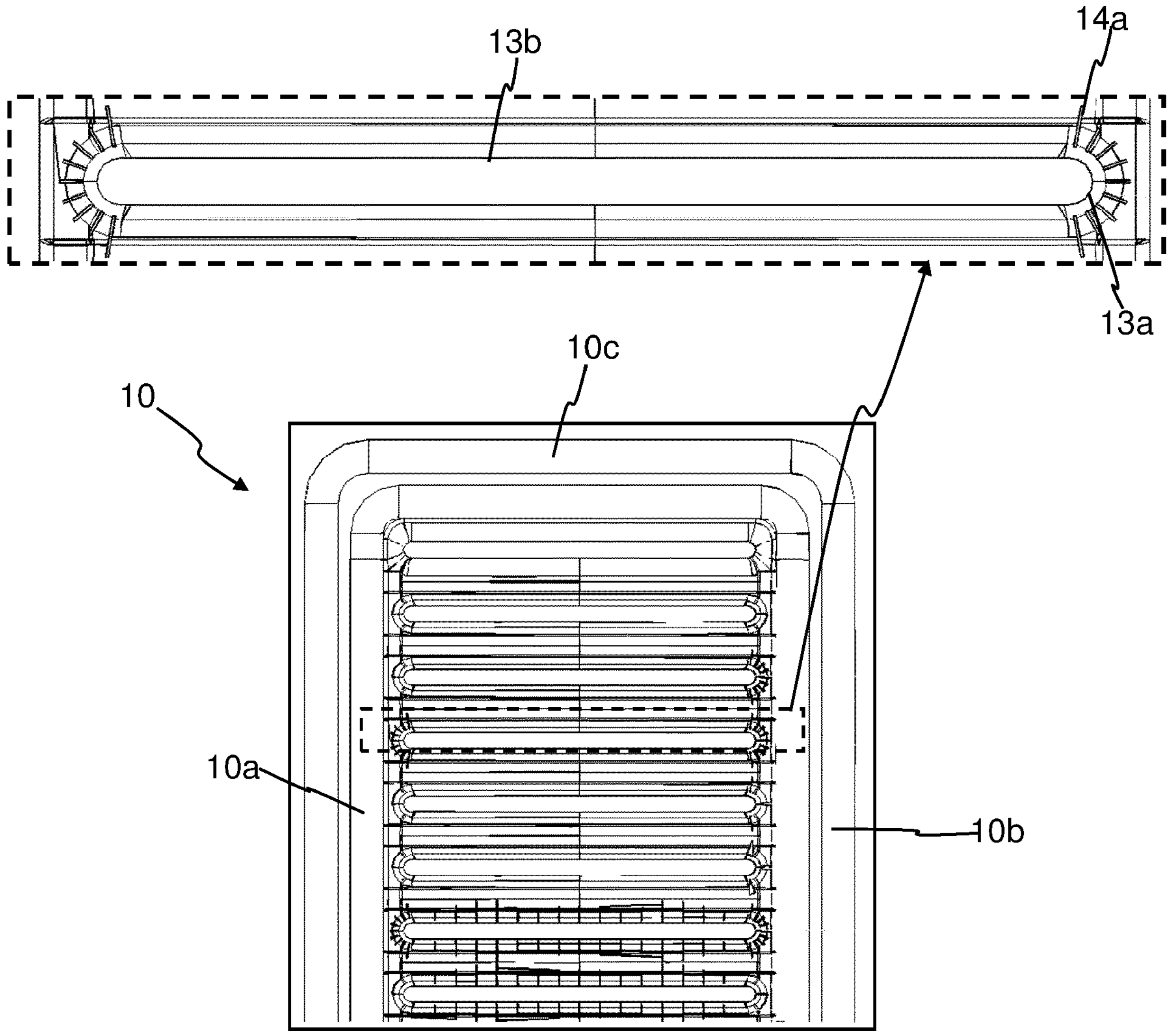

FIG. 4

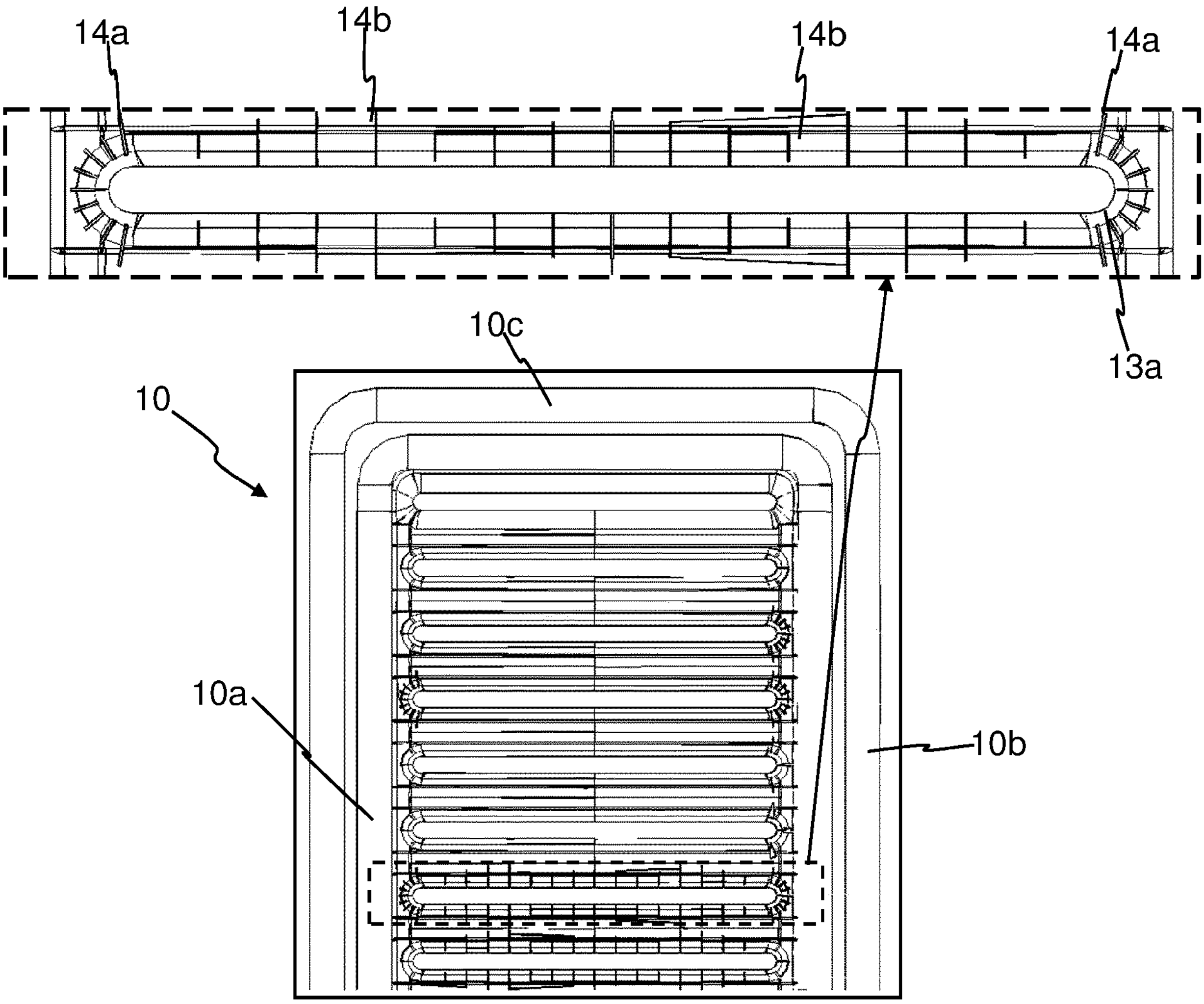

FIG. 5

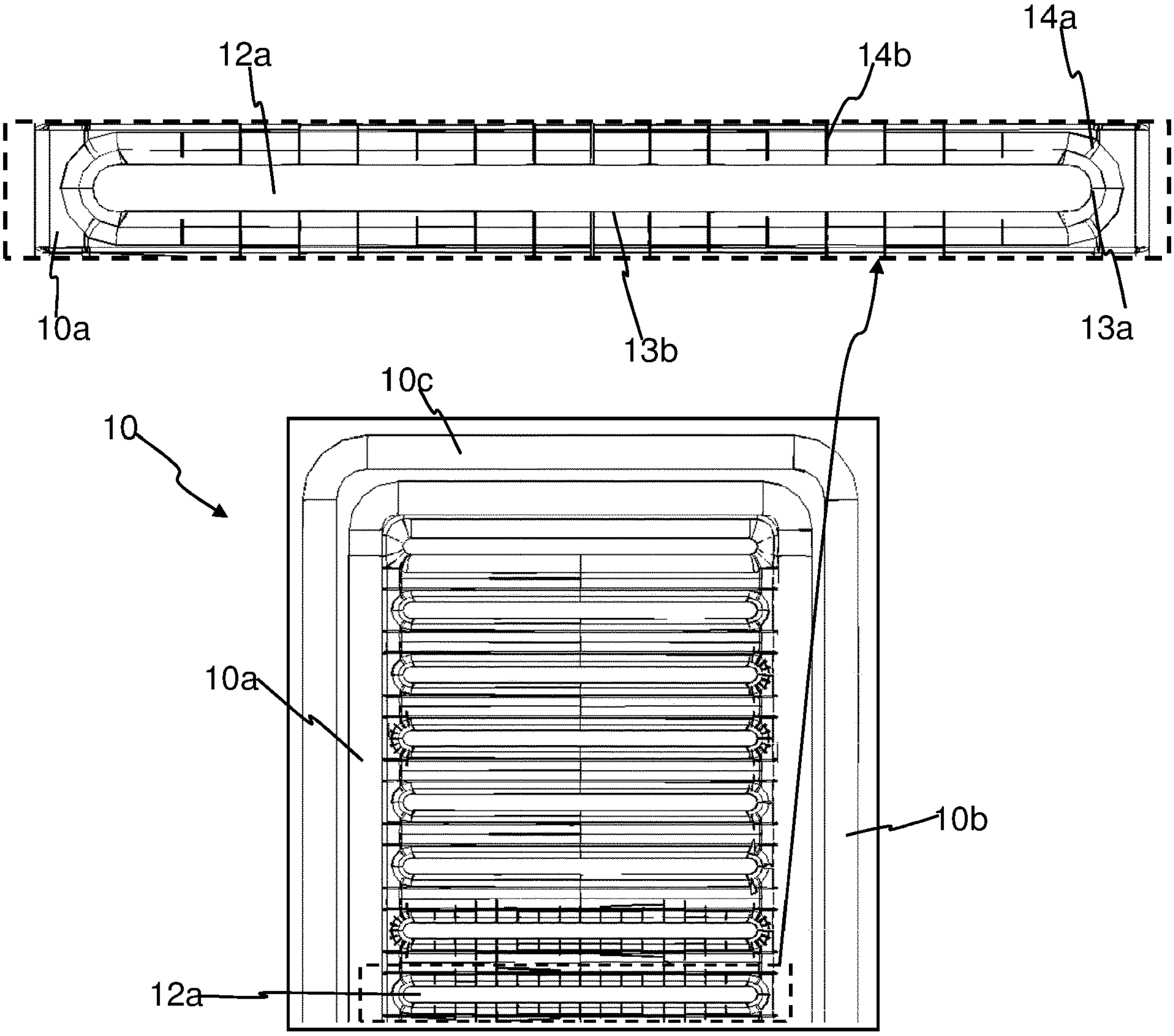

FIG. 6

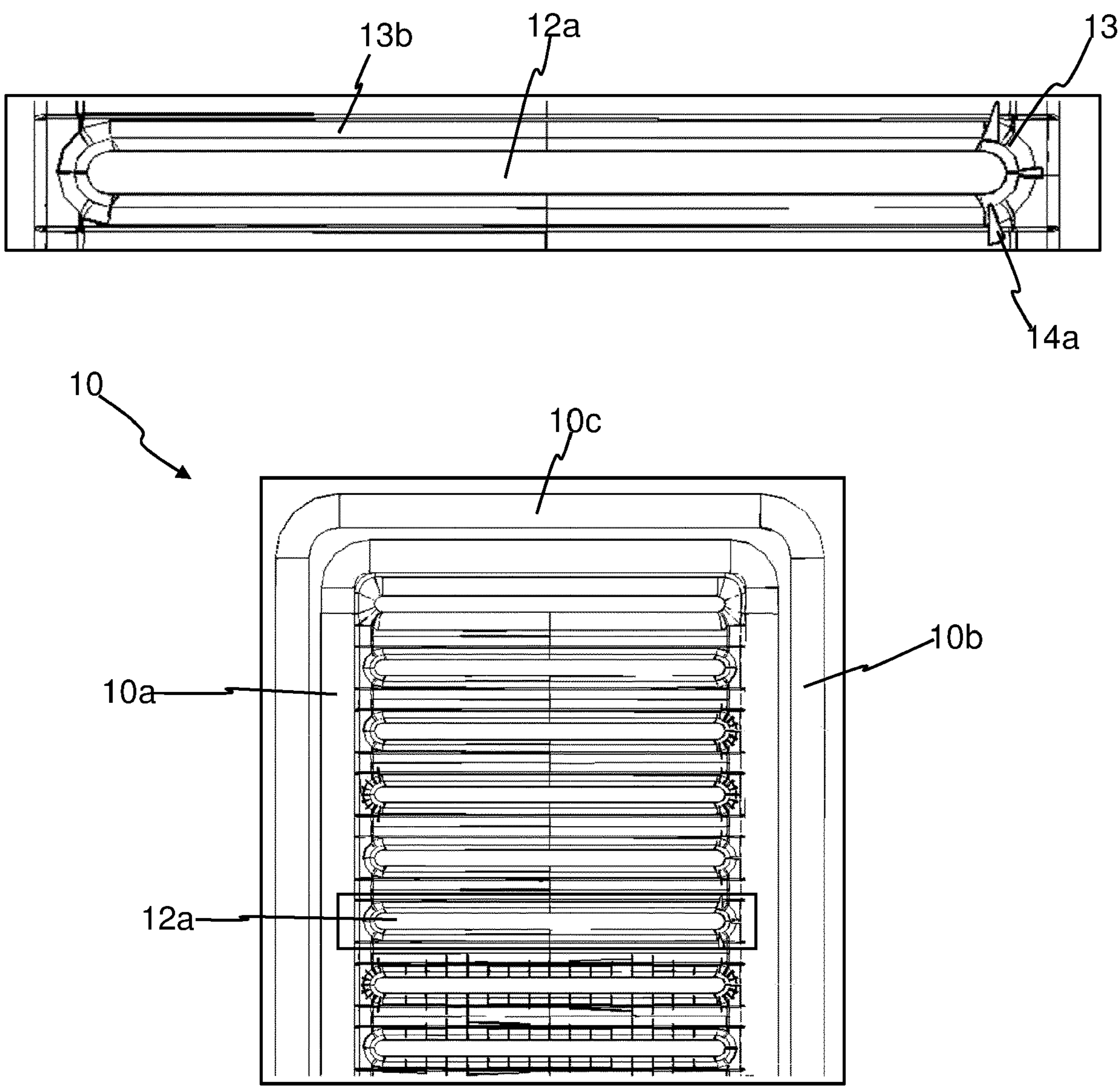

FIG. 7

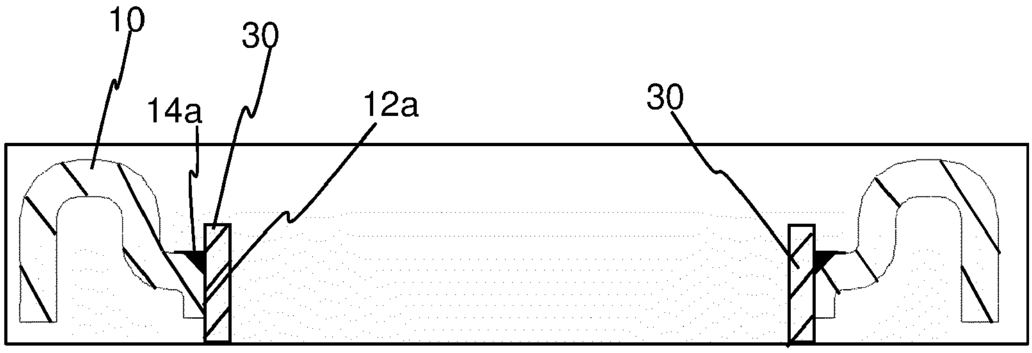

FIG. 8

Europäisches Patentamt
European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 23 17 7158

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 A	US 2006/137855 A1 (DAFFRON THOMAS [US]) 29 June 2006 (2006-06-29) * the whole document * -----	1-7,9, 10,12-15 8,11	INV. F28F9/18 F28D1/053 F28F9/02
A	US 10 386 129 B2 (DENSO MARSTON LTD [GB]) 20 August 2019 (2019-08-20) * abstract; figures 1-25 * -----	1-15	
A	EP 2 167 895 B1 (MODINE MFG CO [US]) 16 May 2012 (2012-05-16) * the whole document * -----	1-15	
A	DE 42 32 018 C2 (THERMAL WAERME KAELTE KLIMA [DE]) 22 September 1994 (1994-09-22) * figures 1-8 * -----	1,14	
			TECHNICAL FIELDS SEARCHED (IPC)
			F28F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	24 October 2023	Bloch, Gregor

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

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24-10-2023

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