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(54) **HEAT EXCHANGER**

(57) A heat exchanger (100) includes a housing (10) and a plurality of channel tubes (20). The housing (10) includes at least one first panel (10a) and a pair of oppositely disposed header plates (10b) with openings (12b). The channel tubes (20) are received in the end openings (12b) are for flow of a first fluid there-through and are disposed between the header plates (10b) to define fluid communication between end manifolds (30) corresponding to the pair of header plates (10b). At least one end channel tube (20e) is received and held in at least one of the openings (12b) disposed along at least one lateral side of the header plates (10b) to serve as side plate and configure enclosed structure of the housing (10) that receives a second fluid to be cooled.

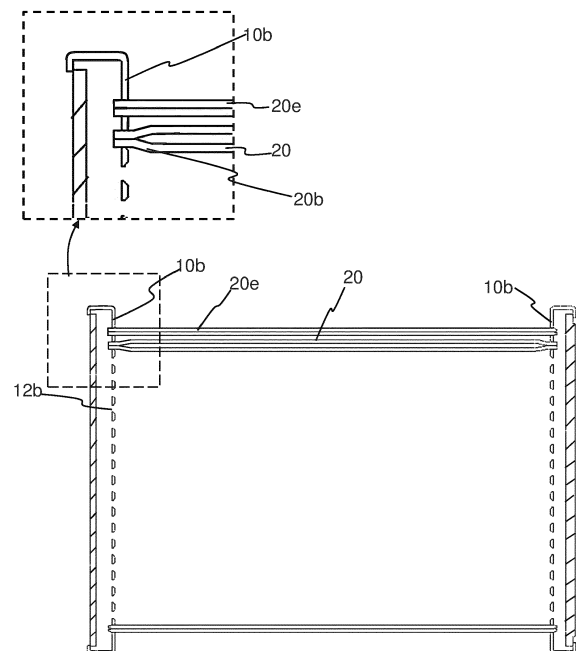


FIG. 7

Description

TECHNICAL FIELD

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

BACKGROUND

[0002] Generally, a heat exchanger, for example, a water chiller, particularly, a R744 water chiller includes a housing and a plurality of channel tubes disposed within the housing. The multi-channel tubes are for flow of a first fluid, particularly refrigerant there through and the housing defines an enclosure for receiving a second fluid, particularly, water therein and around the channel tubes. The housing is formed of a plurality of panels that are assembled together and connected to each other by a joining process, such as for example, brazing to define an enclosure. Particularly, the housing is formed by assembling one pair of opposite first panels, one pair of opposite second panels and a pair of header plates formed with openings. More specifically, one set of the first panel, the second panel and the header plate are disposed orthogonal to each other to form a portion of the housing. Another set of the first panel, the second panel and the header plate disposed orthogonal to each other forms the remaining portion of the housing that is substantially identical to the first portion of the housing. The first panel is formed with water boxes to define u-flow of a second fluid inside the housing. The housing includes an inlet and an outlet for ingress and egress of the first fluid to be cooled, for example, water with respect to the housing. The spaced apart headers support the channel tubes there-between, the refrigerant distributed to the channel tubes by a manifold flows through the channel tubes, such configuration enables heat exchange between the water flowing around the channel tubes and the refrigerant flowing through the channel tubes, thereby causing cooling of the water.

[0003] Generally, the second panels are in the form of plates that form the sides of the conventional water chiller. The second panels are held abutting the first panel and the header plates that are disposed orthogonal with respect to each other, and thereafter, the second panels, the first panels and the header plates are joined to each other by using a joining process, such as for example, but not limited to brazing. The second panel is required to be urged against and held in position with respect to the header plate. Also, the second panel is required to be urged against the corresponding first panels and maintained in that position for configuring proper joining there between. However, positioning of the second panel and maintaining the second panel with respect to the first panels and the header plates is inconvenient and dislocation of the second plate may lead to defective connection of the second panel with the first panel and the header

plate. Further, with such configuration of the second panels, the total number of dedicated components for specific purpose increases, particularly, second panels are required to be formed separately. Further, the second panels are required to match and cover the channel tubes. With the need for more number of dedicated components, the inventory and inventory costs is increased, thereby increasing the overall cost of the water chiller and rendering the water chiller expensive. None of the prior art addresses the problem due to joining defects caused due to second panel being loosely held with respect to the first panel and the header plate and due to the increase in the number of dedicated specific purpose components for forming the water chiller. Accordingly, there is a need of water chiller that is convenient to manufacture, prevents joining defects by securely holding the second panel in place during joining process and that eliminates the need for dedicated components for forming the water chiller to reduce the overall cost of the water chiller.

OBJECTS

[0004] An object of the present invention is to provide a water chiller that obviates the drawbacks associated with conventional water chiller and challenges faced in assembly and manufacturing of the conventional water chiller.

[0005] Another object of the present invention is to provide a water chiller that ensures secure holding of the components to be joined to form the water chiller by arresting movement thereof to avoid any defects during the joining process.

[0006] Yet another object of the present invention is to provide a water chiller that avoids dedicated components, thereby reducing manufacturing steps, inventory costs and eventually reducing the overall manufacturing costs of the water chiller.

SUMMARY

[0007] A heat exchanger is disclosed in accordance with an embodiment of the present invention. The heat exchanger includes a housing and a plurality of channel tubes. The housing includes at least one first panel and a pair of oppositely disposed header plates with multiple openings formed along lateral side of the header plates. The channel tubes are received in the openings formed on the header plates. The channel tubes are for flow of a first fluid there-through and are disposed between the header plates to define fluid communication between end manifolds corresponding to the pair of header plates. At least one end channel tube received and held in at least one of the openings disposed along at least one lateral side of the header plates serves as side plate and configures enclosed structure of the housing that receives a second fluid to be cooled. The heat exchanger of such configuration is convenient to manufacture, prevents

joining defects during joining process and limiting the number of components for forming the heat exchanger.

[0008] Generally, the first panel and the header plates are all disposed orthogonal to each other.

[0009] Particularly, the first panel and the header plates are joined by brazing, the channel tubes received in the openings are joined to the header plates by brazing, the end channel tubes are joined to the first panel by brazing.

[0010] Preferably, the end channel tubes are stamped at ends thereof to block fluid flow there through.

[0011] More specifically, two end channel tubes are received in at least one of the end openings disposed along at least one lateral sides of the header plates.

[0012] Preferably, two end channel tubes received in the corresponding opening are abutting each other along the length of the channel tubes.

[0013] Particularly, the first panel extends beyond at least one end channel tubes with an overhang portion of the first panel extending beyond the at least one end channel tube.

[0014] Further, the heat exchanger includes tabulators disposed between adjacent channel tubes including between at least one end channel tubes and the corresponding channel tube adjacent to the end channel tube.

[0015] Furthermore, at least one of the end channel tube and the corresponding openings is formed with engagement means to securely hold the end channel tube within the corresponding opening.

[0016] A method of assembling a heat exchanger is disclosed in accordance with an embodiment of the present invention. The method includes the step of assembling at least one first panel and pair of spaced apart header plates abutting with respect to each other. Subsequently, the method includes a step of receiving a plurality of channel tubes in openings formed along lateral sides of the header plates, wherein the channel tubes are for flow of a first fluid there through. The method further includes a step of stamping extreme ends of end channel tubes received and held in at least one opening disposed along at least one lateral sides of the header plates to prevent fluid flow there through. The end channel tubes serve as second panels that in conjunction with the first panel and the header plate define an enclosed structure that receives a second fluid around the channel tubes. The method subsequently includes the step of assembling tank covers to the corresponding header plates to configure manifolds. The method finally includes a step of joining the different elements of the heat exchanger by brazing

BRIEF DESCRIPTION

[0017] 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:

5 FIG. 1 illustrates an isometric view of a conventional heat exchanger, such as for example water chiller, particularly, a R744 type water chiller wherein first panels in conjunction with second panels and spaced apart header plates define an enclosed structure of a housing of the water chiller;

10 FIG. 2 illustrates a top view of the conventional water chiller of FIG. 1;

15 FIG. 3 illustrates a sectional view of the water chiller along section plane a-a' of FIG. 2;

20 FIG. 4 illustrates an isometric view of water chiller in accordance with an embodiment of the present invention, wherein end channel tubes with closed ends serve as second panels;

25 FIG. 5 illustrates a side view of the water chiller of FIG. 2;

30 FIG. 6 illustrates a sectional view of the water chiller along sectional plane A-A' of FIG. 5, also is illustrated an enlarged view depicting arrangement of the end channel tubes along width of the channel tubes;

35 FIG. 7 illustrates a sectional view of the water chiller along sectional plane B-B' of FIG. 5, also is illustrated an enlarged view depicting the end channel tubes acting as second panel orthogonal to first panel;

40 FIG. 8 illustrates an isometric sectional view of the water chiller of FIG. 4 depicting internal details thereof and depicting at least one end channel tube with closed ends serving as second panel; and

45 FIG. 9 illustrates the water chiller of FIG. 4 without one header plate depicting free ends of the channel tubes and end channel tubes;

50 FIG. 10 illustrates a pair of end channel tubes received in the openings disposed along lateral sides of the header plates to define the enclosed structure of the housing; and

55 FIG. 11 illustrates a block diagram depicting the steps involves in assembling the water chiller of FIG. 4.

DETAILED DESCRIPTION

[0018] The present invention is explained with example of a heat exchanger, for example, a water chiller and particularly, a R744 type of water chiller. The water chiller

includes a housing and a plurality of channel tubes received inside the housing. The housing is formed by pre-assembling and joining panels and spaced apart header plates and receiving the channels in openings formed on the header plate. The channel tubes are for flow of a first fluid there-through and are disposed between the header plates to define fluid communication between end manifolds corresponding to the pair of spaced apart header plates. The housing defines the enclosure for receiving a second fluid, particularly, water therein and around the channel tubes. The at least one end channel tube received and held in at least one of the end openings disposed along at least one lateral side of the header plates serves as second plate to configure enclosed structure of the housing that receives the second fluid to be cooled. Although, the present invention is explained with example of water chiller for use in a vehicle. However, the present invention is also applicable for any heat exchanger, particularly housing of the heat exchanger or any enclosed structure used in vehicular or non-vehicular environment, wherein the housing or enclosed structure is formed by assembling and joining panels and end channel tubes. Particularly, the present invention is applicable for enclosed structure, wherein it is required to maintain the elements forming the housing in position before joining thereof to create a robust connection between the elements. Also, the present invention is applicable where the enclosed structure is required to be formed without requiring dedicated components such as second panels to reduce inventory, inventory costs to reduce overall manufacturing costs and inconvenience involved in the manufacturing of the enclosed structure.

[0019] A conventional heat exchanger 1 is illustrated in FIG. 1- FIG. 3 and the same includes a housing 2 and a plurality of channel tubes 4 disposed within the housing. Each channel tube includes multiple channels and is formed by extrusion. The channel tubes 4 are for flow of a first fluid, particularly refrigerant there through and the housing 2 defines an enclosure for receiving a second fluid, particularly, water therein and around the channel tubes 4. The housing 2 is formed by assembling one pair of opposite first panels 2a, one pair of opposite second panels 2b and a pair of header plates 2c formed with openings that receive and support the channel tubes 4. More specifically, one set of the first panel 2a, the second panel 2b and the header plate 2c are disposed orthogonal to each other to form a portion of the housing 2.

[0020] Referring to the FIG. 4 - FIG. 6 of the accompanying drawings, a heat exchanger, for example a water chiller 100, particularly, a R744 type of water chiller in accordance with an embodiment of the present invention is illustrated. Particularly, FIG. 4 illustrates an isometric view of water chiller 100. FIG. 5 illustrates a side view of the water chiller 100. Referring to the FIG. 5, the water chiller 100 includes a housing 10 and a plurality of channel tubes 20 disposed within the housing 10.

[0021] The housing 10 includes at least one first panel 10a and a pair of spaced apart header plates 10b formed

with multiple openings 12b. The openings 12b are formed along lateral sides of the header plates 10b and are generally disposed parallel to each other. The at least one first panel 10a and the pair of header plates 10b are disposed orthogonal to each other and abutting each other. The first panel 10a further includes water boxes 12a to define return pass and u-flow of the second fluid inside the housing 10. Although, the first panel 10a and the header plates 10b are disposed orthogonal to each other, however, the first panel 10a and the header plates 10b can be disposed at an angle with respect to each other. Particularly, the present invention is not limited to the arrangement and orientation of the first panel 10a and the header plates 10b with respect to each other, as far as the first panel 10a and the header plates 10b in conjunction with end channel tubes 20e serving as second panels orthogonal to the first panel configure an enclosed structure for receiving and holding the fluid to be cooled. The channel tubes 20 and the first panels 10a are joined to the header plates 10b by a joining process such as for example, brazing. However, the present invention is not limited to any particular joining method and any other joining methods can be used for securing the channels and the first panels 10a to the header plates 10b.

[0022] In accordance with an embodiment of the present invention, the channel tubes 20 define fluid communication between a first manifold corresponding to a first header plate 10b and an intermediate manifold corresponding to a second header plate 10b opposite to the first header plate. With such configuration, the extruded channel tubes 20 with first fluid flowing there-through are arranged in a spaced apart configuration with respect to each other with second fluid around the channel tubes 20 for heat exchange between first fluid, particularly, the refrigerant flowing through the channel tubes 20 and second fluid around the channel tubes 20. In case the channel tubes 20 are configuring u-flow of the refrigerant inside the housing 10, the first manifold 30a includes a first portion 32a and a second portion 32b. The first portion 32a distributes refrigerant to either a first set of extruded channel tubes 20a or a portion 20a of the same extruded channel tube 20 to define a first pass for the refrigerant flow. The refrigerant collected in the intermediate manifold 30b is directed to a second set of extruded channel tubes 20b or remaining portion 20b of the same extruded channel tube 20 to define a return pass of the refrigerant, thereby defining the u-flow path of the refrigerant. In such case the refrigerant flows from the first set of extruded channel tubes to the second set of extruded channel tubes, the first and the second set of channel tubes are disposed along the same plane. The refrigerant after flowing through the return pass is collected in the second portion 32b. Such arrangement defines the refrigerant flow path within the water chiller 100. The housing 10 further includes an inlet 40a and outlet 40b, wherein the inlet 40a is for ingress of the refrigerant into the first portion 32a that distributes the refrigerant to the channel tubes 20 of the water chiller 100 for heat exchange with

the water in the housing 10. The outlet 40b is for the egress of the refrigerant from the second portion 32b that collects refrigerant from the channel tubes 20 of the water chiller 100 after heat exchange with the water in the housing 10.

[0023] The housing 10 further includes an inlet port 10e and an outlet port 10f for ingress of water around the channel tubes 20 received inside the housing 100. The water received in the housing 10 and flowing around the extruded channel tubes 20 rejects thermal energy to the refrigerant flowing through the extruded channel tubes 20 and is cooled in the process. Particularly, the hot water enters through the inlet port 10e, the water flows around the channel tubes 20, cools down by rejecting heat to the refrigerant and cooled water egresses through the outlet port 10f.

[0024] The channel tubes 20 received and held in the openings 12b are joined to the header plates 10b by the joining process such as for example, brazing. Thereafter, the tank covers are assembled to the respective header plates 10b to configure the manifolds 30. However, the present invention is not limited to any particular joining method and any other joining methods can be used for securing the channel tubes 20 to the header plates 10b and for securing the tank covers to the header plates 10b. Generally, the pre-assembled water chiller 100, with the first panels 10a assembled to the header plates 10b, the channel tubes 20 received and held in the openings 12b and the tank cover assembled to the header plates 10b are joined together by a single step joining process, particularly, by brazing in a brazing furnace.

[0025] At least one end channel tube 20e received and held in at least one of the end openings 12b formed along at least one lateral side of the header plates 10b serves as second plate to configure enclosed structure of the housing 10 that receives a second fluid, for example, water to be cooled. Particularly, referring to the FIG. 6 - FIG. 8, two end channel tubes 20e are received and held in at least one pair of the opposite openings 12b formed along at least one lateral sides of the header plates 10b. Preferably, two pairs of end channel tubes 20e, each pair received in end opposite openings 12b formed on the opposite header plates 12b and disposed on opposite lateral sides of the header plates 10b define the opposite second sides of the water chiller 100. More specifically, the two end channel tubes 20e received in the corresponding opening 12b are abutting each other along the length of the end channel tubes 20e. Preferably, each of the openings 12b along the lateral sides of the header plates 10b receives and holds two end channel tubes 20e. The end channel tubes 20e are almost similar in configuration with respect to the other channel tubes, except that the other channel tubes includes bends 20b formed on extreme ends thereof and the end channel tubes 20e are substantially straight as illustrated in FIG. 10. The bends 20b enable the extreme ends of the two adjacent channel tubes 20 to be received in respective opposite openings formed on the opposite header plates

10b, while still maintaining substantial portion of the adjacent channel tubes 20 spaced away from each other. Such configuration allow the second fluid flow between the adjacent channel tubes 20, thereby providing sufficient surface contact and improved heat exchange between first fluid flowing through the channel tubes 20 and second fluid flowing outside the channel tubes 20. With such configuration of the end channel tubes 20e acting as the second panel configuring the housing 10, the need for dedicated second panels for configuring the housing is avoided. Particularly, the end channel tubes 20e are formed along with the other channel tubes 20, by skipping the bending operation that is involves bending of the extreme ends. Also, the end channel tubes further involves one additional step of blocking the channels to prevent flow there through.

[0026] Further, such straight configuration of the end channel tubes 20e, enables the end channel tubes 20e to be maintained in abutting relation with respect to each other, thereby providing robustness to the entire housing 10 configured with the end channels 20e acting as second panel. The end channel tubes 20e serving as the side plates serves two purposes, firstly, the end channel tubes 20e acting as second panels are securely held in position in the openings 12b during the joining process. Accordingly, chances of dislocation of end channel tubes 20e are prevented during the joining process and a robust and leak-proof connection is formed between the end channel tubes and the header to configure the housing 10 when joined by the joining process. Secondly, with such configuration of the end channel tubes 20e serving as second panels the need for forming dedicated components, particularly, second panels is eliminated, thereby reducing inventory and inventory costs, thereby rendering the water chiller inexpensive and easy to manufacture.

[0027] The end channel tubes 20e are "dummy tubes" that have blocked ends to prevent fluid flow there-through. Preferably, the end channel tubes 20e are stamped at ends thereof to block fluid flow there through. With such configuration, the first manifold 30a distributes the first fluid to all the channel tubes 20 except the end channel tubes 20e. However, the present invention is not limited to any particular configuration of the end channel tubes 20e and method of blocking the end channel tubes 20 to prevent fluid flow there through. In accordance with an embodiment of the present invention, the first panel 10a extends beyond at least one end channel tube 20e with an overhang portion of the first panel 10a extending beyond the at least one end channel tube 20e. Further, the water chiller 100 includes tabulators 60 disposed between adjacent channel tubes 20 including between at least one end channel tubes 20e and the corresponding channel tube 20 adjacent to the end channel tube 20e.

[0028] Furthermore, at least one of the end channel tube 20 and the corresponding end openings 12b, particularly, the end channel tube 20 is formed with engagement means, for example, an engagement dimple 12d

as illustrated in FIG. 9, to securely hold the end channel tube 20e within the corresponding opening 12b. The engagement dimple 12d formed at the extreme end of the end channel tube 20 engages with corresponding slot formed on inside wall of the opening 12b to securely hold the end channel tube 20e within the corresponding opening 12b. However, the present invention is not limited any particular configuration of the end channel tubes 20e and the openings 12b and the engagement elements formed on the end channel tubes 20e and the opening 12b, as long as the end channel tubes 20e are securely held inside the openings 12b. The secure receiving of the end channel tubes 20e in the openings 12b prevents dislocation of the end channel tubes 20e and ensures secure connection between the end channel tubes 20e and the corresponding openings 12b after joining.

[0029] Also, is disclosed a method 200 of assembling a water chiller 100 in accordance with an embodiment of the present invention. FIG. 11 illustrates a block diagram depicting the various steps of the method 200 of assembling the water chiller 100. Particularly, the method 200 involves assembling a plurality of panels with header plates and joining these components by using any of the known joining processes, wherein at least one end channel tube with blocked ends serves as at least one of the panels configuring the housing of the water chiller. Although, the various steps of the method 200 are depicted by blocks in the flow diagram and any number of steps described as method blocks can be combined in any order or can be performed in parallel to employ the method 200, or an alternative method. Additionally, individual blocks may be deleted from the flow chart depicting the method without departing from the scope and ambit of the present invention. The method 200 is to be understood with reference to the following description along with the Fig. 9

[0030] Particularly, the method 200 of assembling a water chiller 100 is disclosed in accordance with an embodiment of the present invention. The method 200 includes a step 102 of assembling at least one first panel 10a and a pair of spaced apart header plates 10b abutting with respect to each other. Particularly, the pair of opposite first panels 10a are disposed between the pair of spaced apart header plates 10b. Subsequently, the method 200 includes a step 104 of receiving a plurality of channel tubes 20 in openings 12b formed along lateral sides of the header plates 10b, wherein the channel tubes 20 are for flow of a first fluid there through. The method 200 further includes a step 106 of receiving end channel tubes 20e with blocked ends, received and held in at least one opening 12b formed along at least one lateral sides of the header plates 10b to prevent fluid flow there through. The end channel tubes 20e are serving as second panels that in conjunction with the first panel 10a and the header plates 10b define an enclosed structure of the housing 10 for receiving a second fluid around the channel tubes 20. The method subsequently includes the step of assembling tank covers to the corresponding

header plates 10b to configure manifolds 30. The method 200 finally includes a step of joining the different elements of the water chiller 100 by a joining process such as for example brazing in brazing furnace. The step of joining involves joining the abutting surfaces of the tank cover to the corresponding header plates 10b, the channel tubes 20 received in the openings 12b to the header plates 10b, the turbulators 40 to the adjacent channel tubes 20, the first panel 10a to the header plates 10b and the end channel tubes 20e to the first panel 10a. The pre-assembled water chiller 100 with all components thereof assembled to each other are brazed together by a single step brazing process. However, the present invention is not limited to use of brazing for joining the different components of the water chiller and other joining processes can be used instead of brazing.

[0031] 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 housing (10) comprising:

- at least one first panel (10a);
- a pair of oppositely disposed header plates (10b) with multiple openings (12b) formed along lateral side of the header plates (10b),

- a plurality of channel tubes (20) received in the openings (12b) formed on the header plates (10b), the channel tubes (20) are for flow of a first fluid there-through and are disposed between the header plates (10b) to define fluid communication between end manifolds (30) corresponding to the pair of header plates (10b),

characterized in that at least one end channel tube (20e) received and held in at least one of the end openings (12b) disposed along at least one lateral sides of the header plates (10b) is adapted to serve as side plate to configure enclosed structure of the housing (10) that receives a second fluid to be cooled.

2. The heat exchanger (100) as claimed in any previous claim, wherein the first panel (10a) and the header plates (10b) are disposed orthogonal to each other.

3. The heat exchanger (100) as claimed in any of the preceding claims, wherein the first panel (10a) and the header plates (10b) are joined by brazing the channel tubes (20) received and held in the openings

(12b) are joined to the header plates (10b) by brazing, also, the end channel tubes (20e) are joined to the first panel (10a) by brazing.

4. The heat exchanger (100) as claimed in any of the preceding claims, wherein the end channel tubes are stamped at ends thereof to block fluid flow there through. 5
5. The heat exchanger (100) as claimed in any of the preceding claims, wherein two end channel tubes (20e) are received in at least one of the end openings (12b) disposed along at least one of lateral sides of the header plates (10b). 10
6. The heat exchanger (100) as claimed in the previous claim, wherein the two end channel tubes (20e) received in the corresponding opening (12b) are abutting each other along the length of the end channel tubes (20). 15 20
7. The heat exchanger (100) as claimed in any of the preceding claims, wherein the first panel (10a) extends beyond at least one end channel tubes (20e) with an overhang portion (10d) of the first panel (10a) extending beyond the at least one end channel tube (20e). 25
8. The heat exchanger (100) as claimed in any of the preceding claims further comprises turbulators (40) disposed between adjacent channel tubes (20), including between at least one end channel tubes (20e) and the corresponding channel tube (20) adjacent to the end channel tube (20e). 30 35
9. The heat exchanger (100) as claimed in any of the preceding claims, wherein at least one of the end channel tube (20e) and the corresponding openings (12b) is formed with engagement means (50) for securely holding the end channel tube (20e) within the corresponding opening (12b). 40
10. A method (200) of assembling a heat exchanger (100), the method (200) comprising: 45
 - a step (102) of assembling at least one first panel (10a) and pair of spaced apart header plates (10b) abutting with respect to each other;
 - a step (104) of receiving a plurality of channel tubes (20) in openings (12b) formed along lateral sides of the header plates (10b), the channel tubes (20) are for flow of a first fluid there through; 50
 - a step (106) receiving end channel tubes (20e) with blocked ends thereof in at least one end opening (12b) formed along at least one lateral sides of the header plates (10b) to prevent fluid flow there through; the end channel tubes (20e) 55

serving as second panels that in conjunction with the first panel (10a) and the header plate (10b) define an enclosure structure for receiving a second fluid around the channel tubes (20);

- a step (108) of assembling tank covers to the corresponding header plates (10b) to configure manifolds (30); and
- a step (110) of joining the different elements of the heat exchanger (100) by brazing.

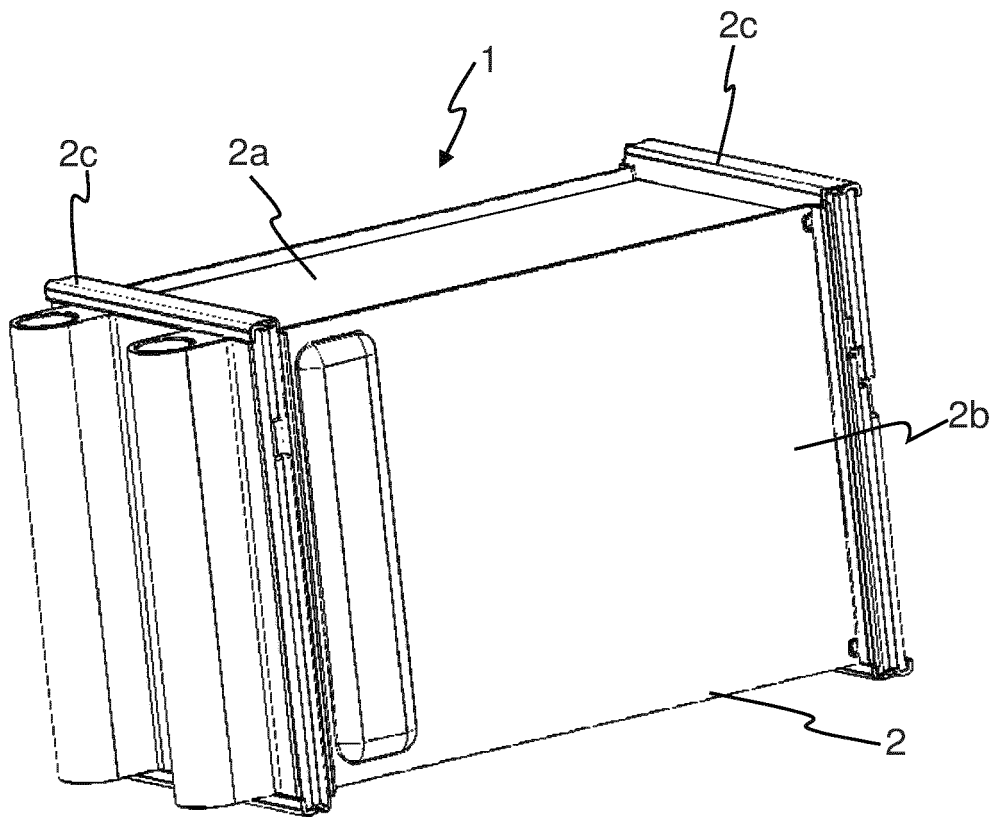


FIG. 1
(PRIOR ART)

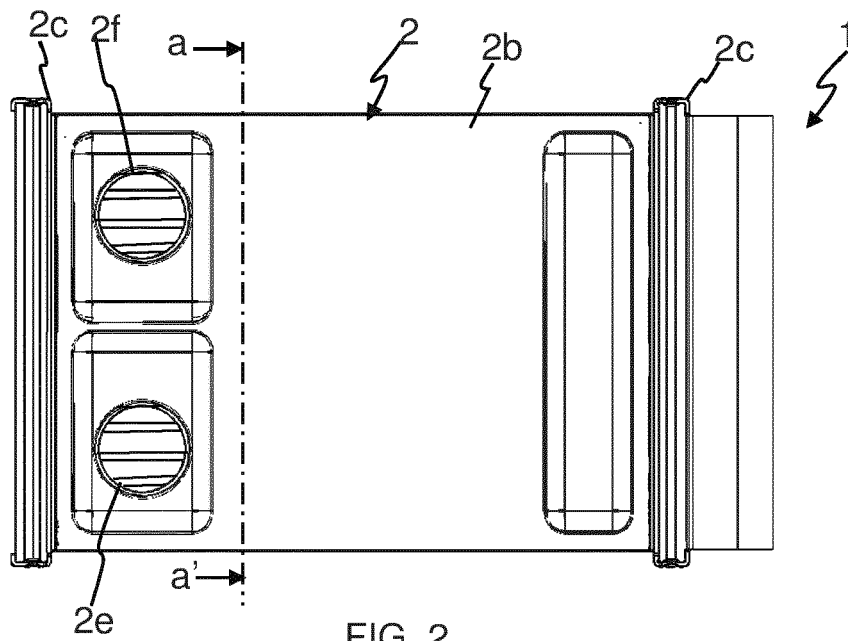


FIG. 2

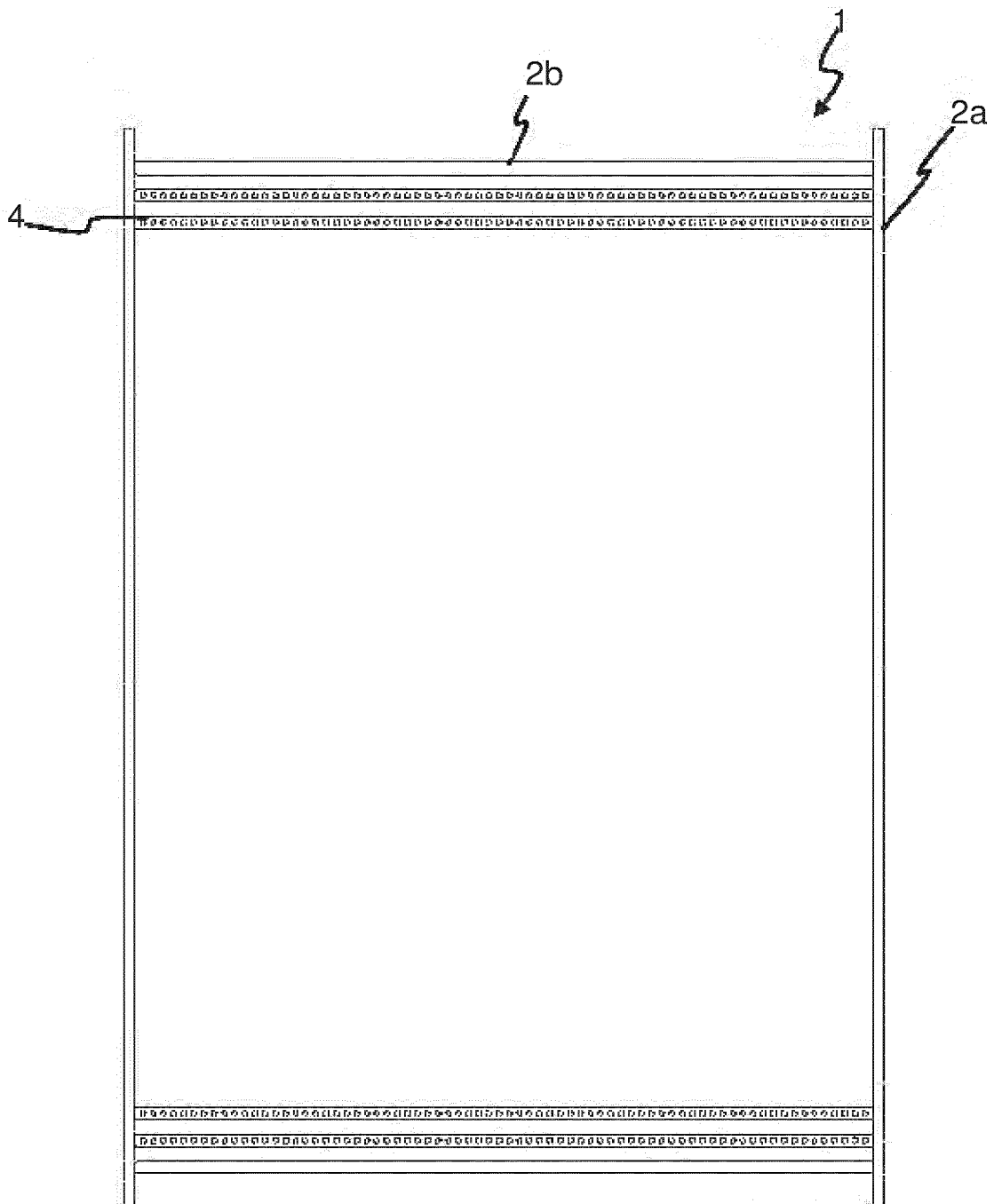


FIG. 3

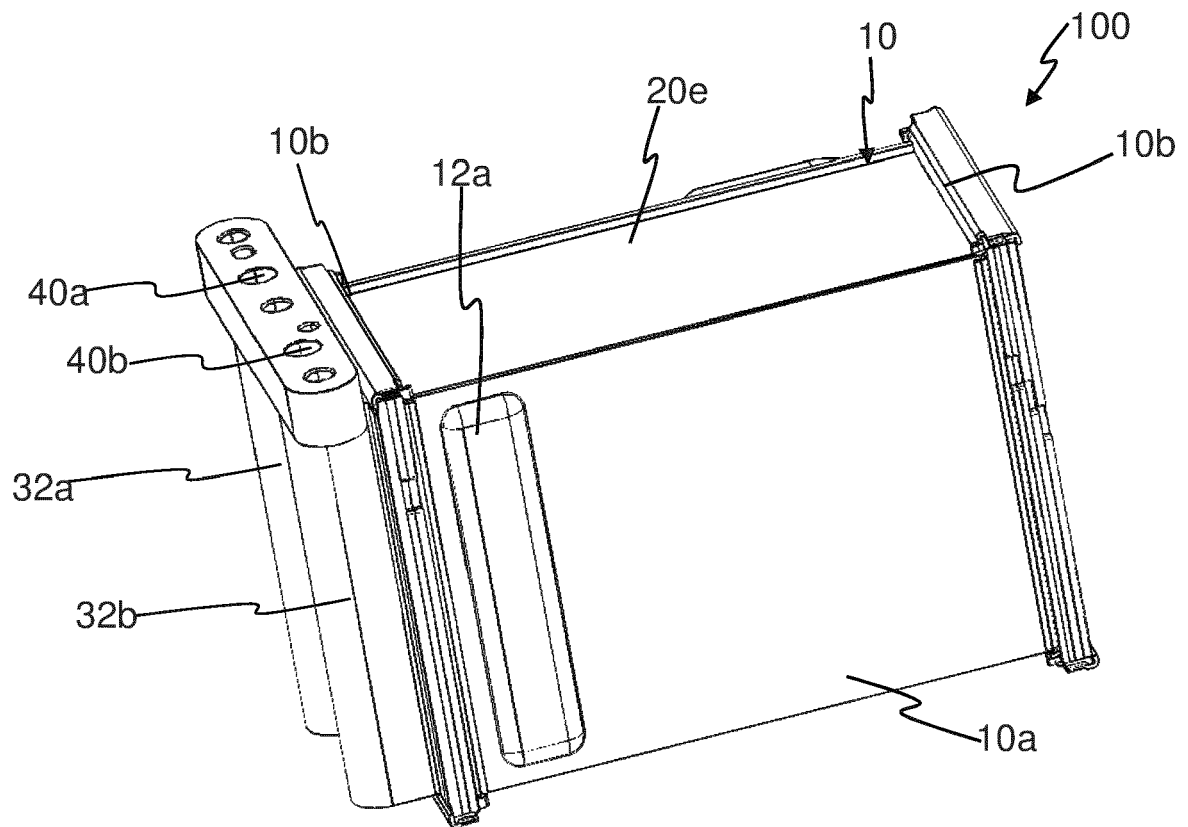


FIG. 4

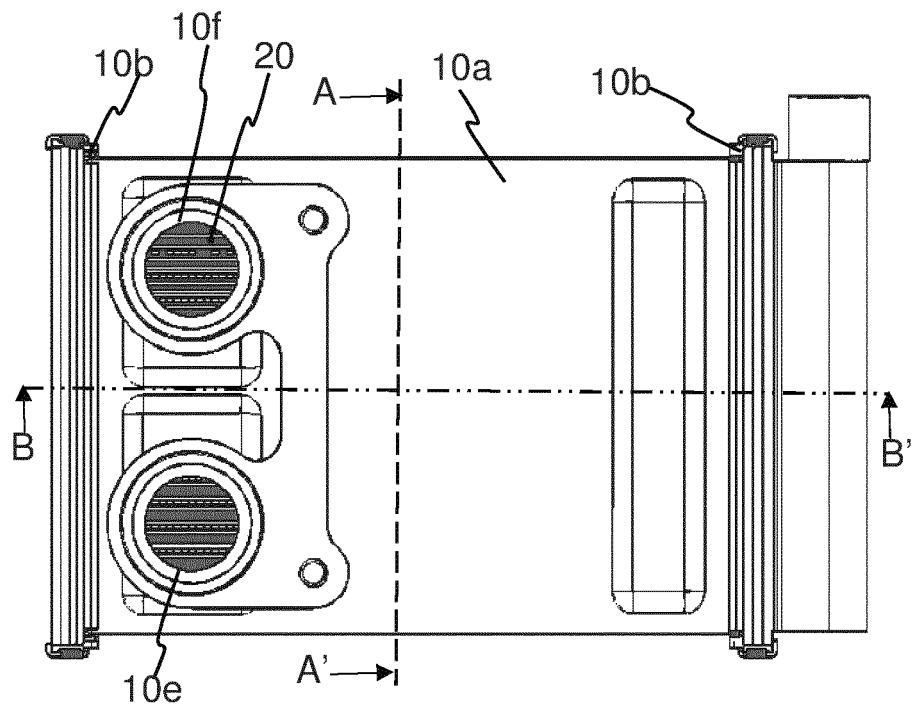


FIG. 5

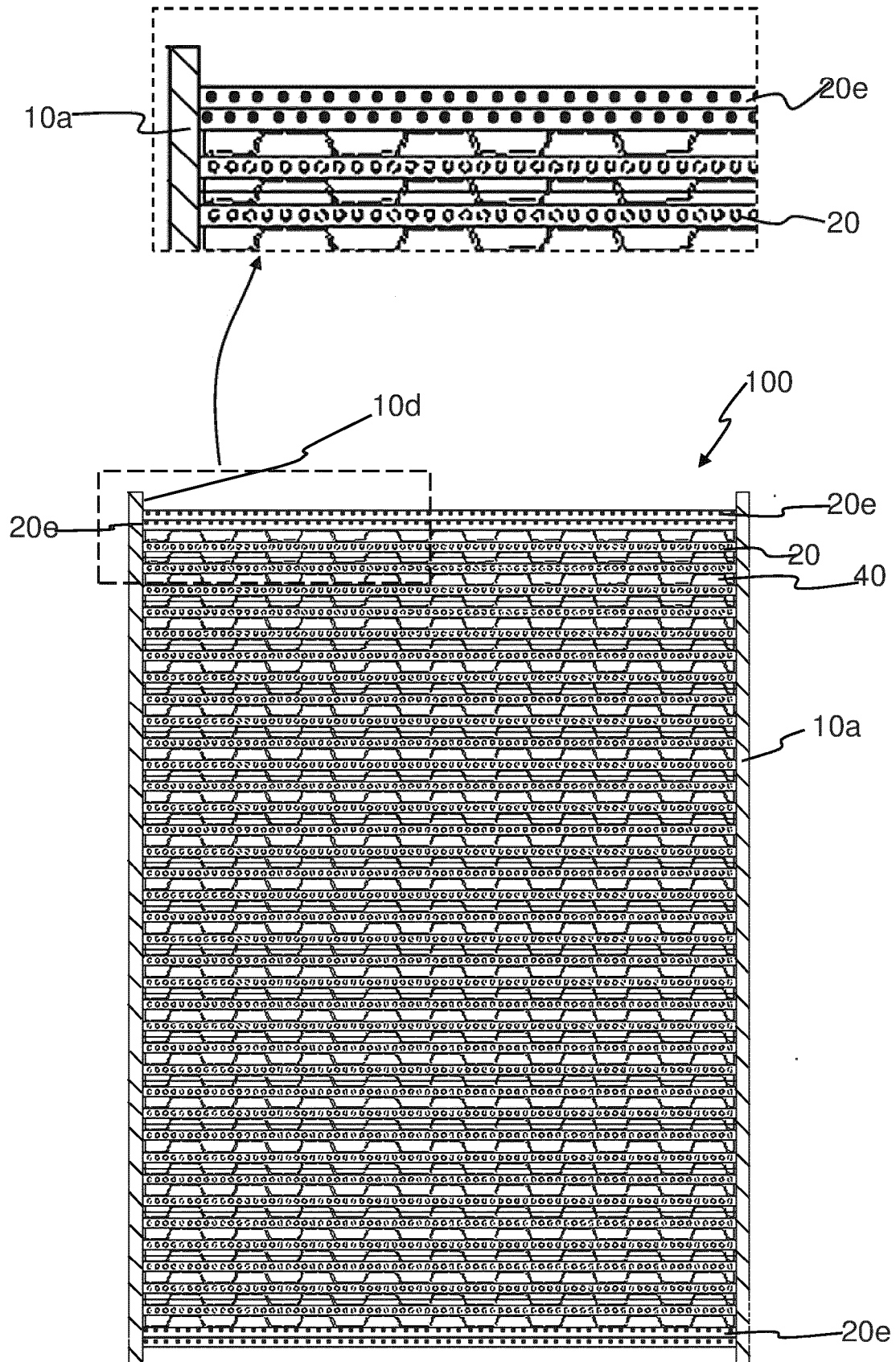


FIG. 6

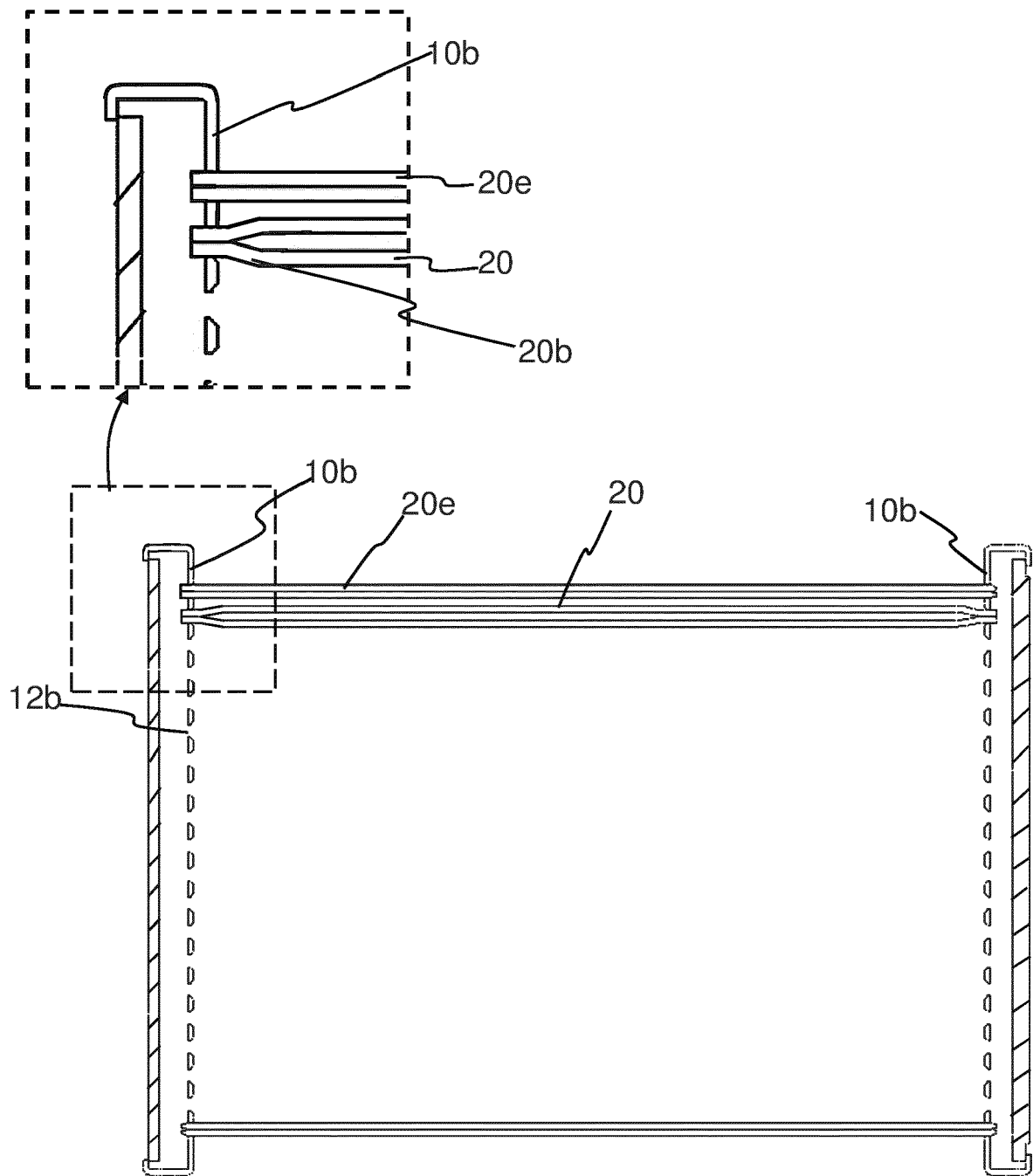


FIG. 7

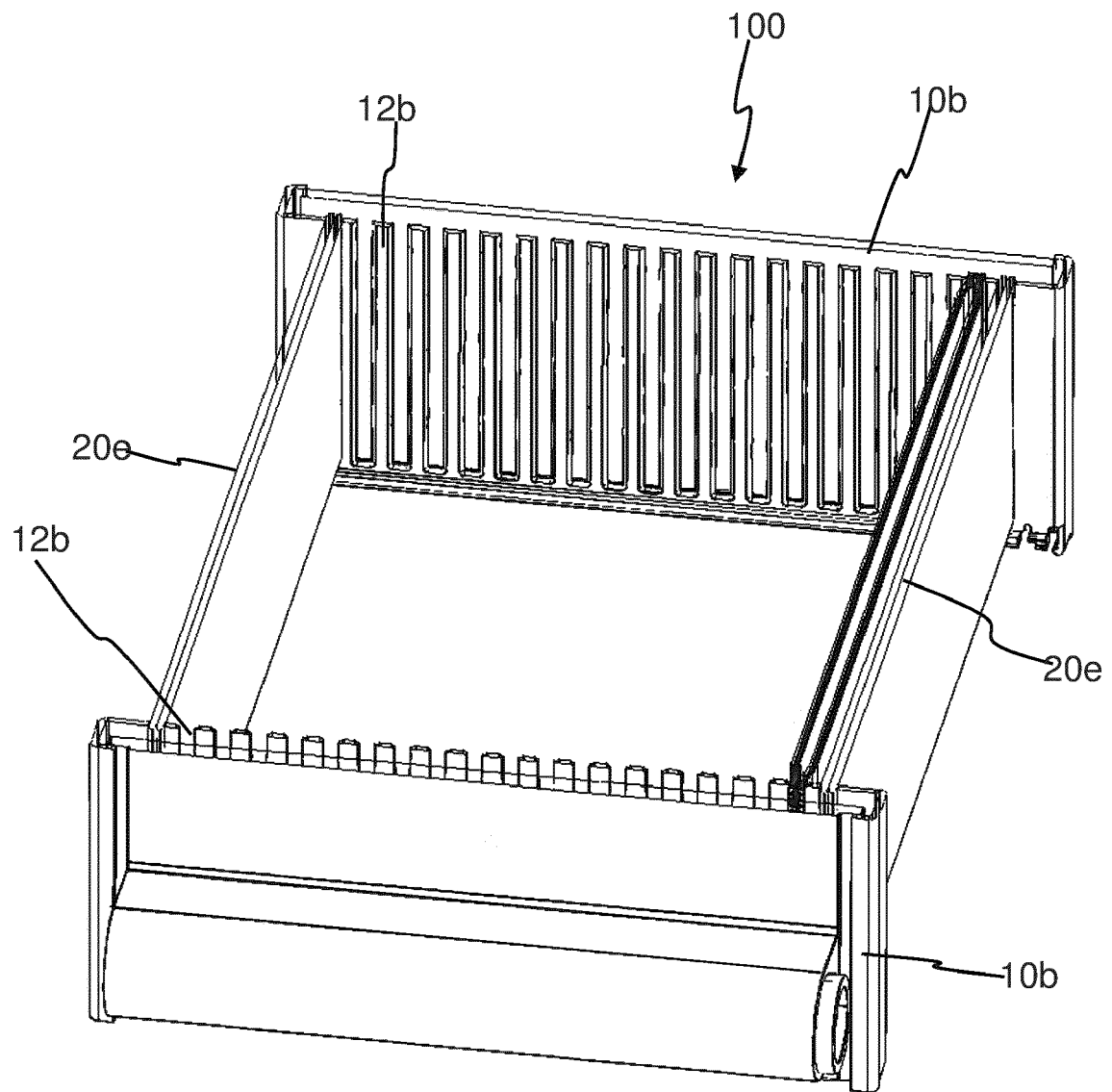


FIG. 8

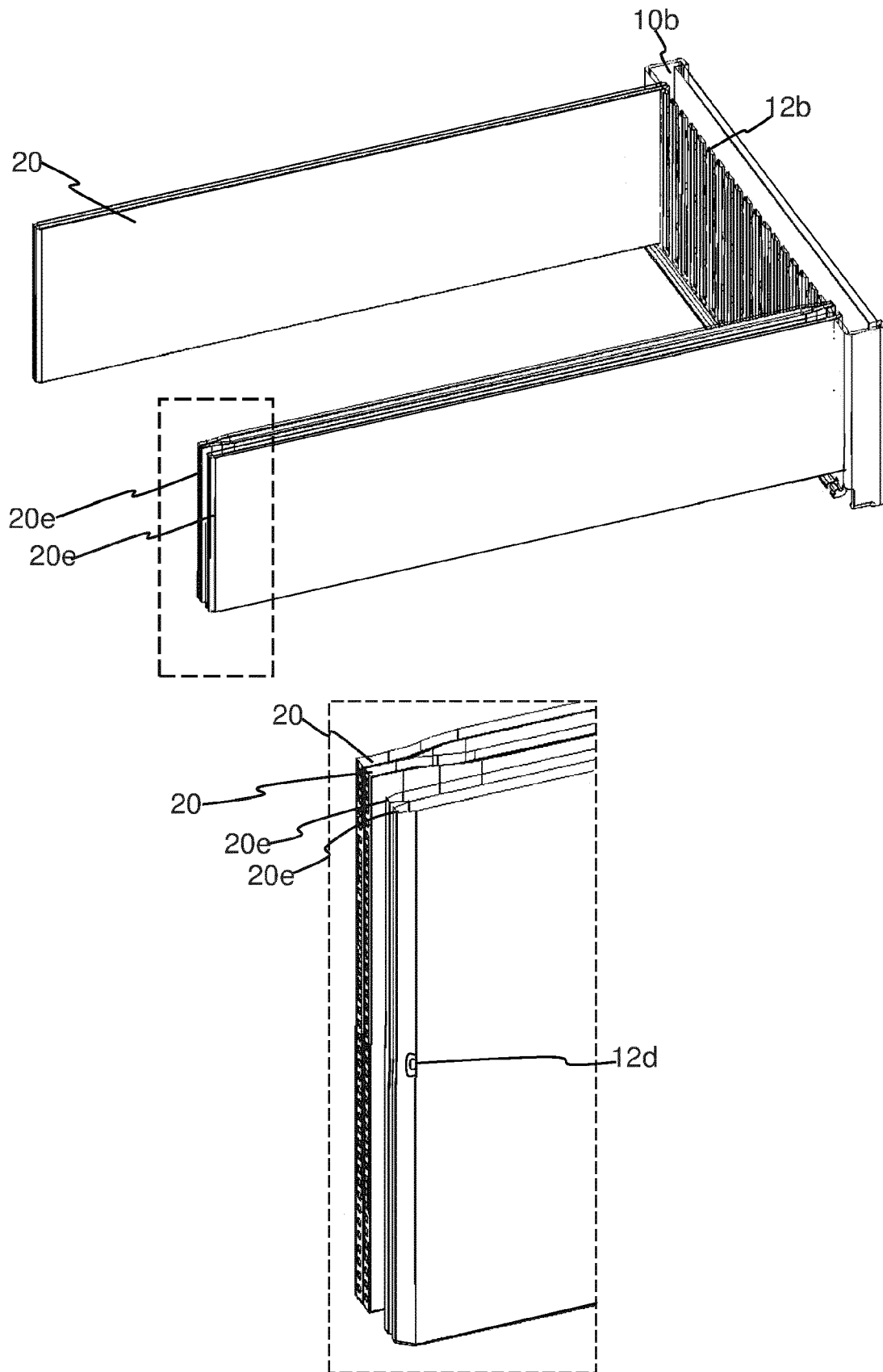


FIG. 9

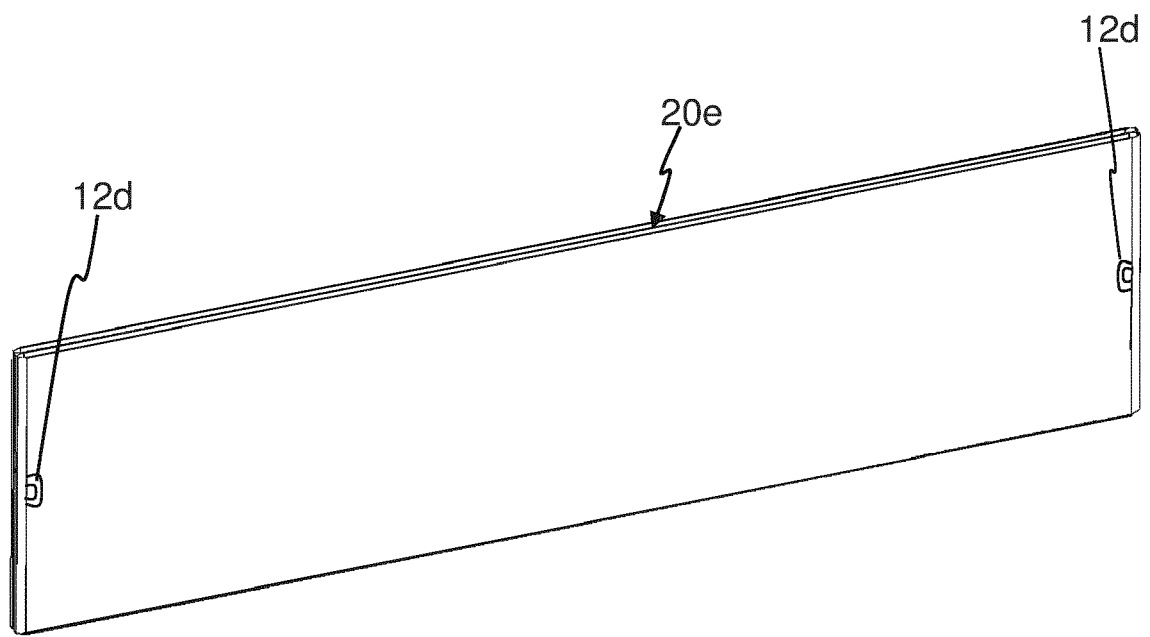


FIG. 10

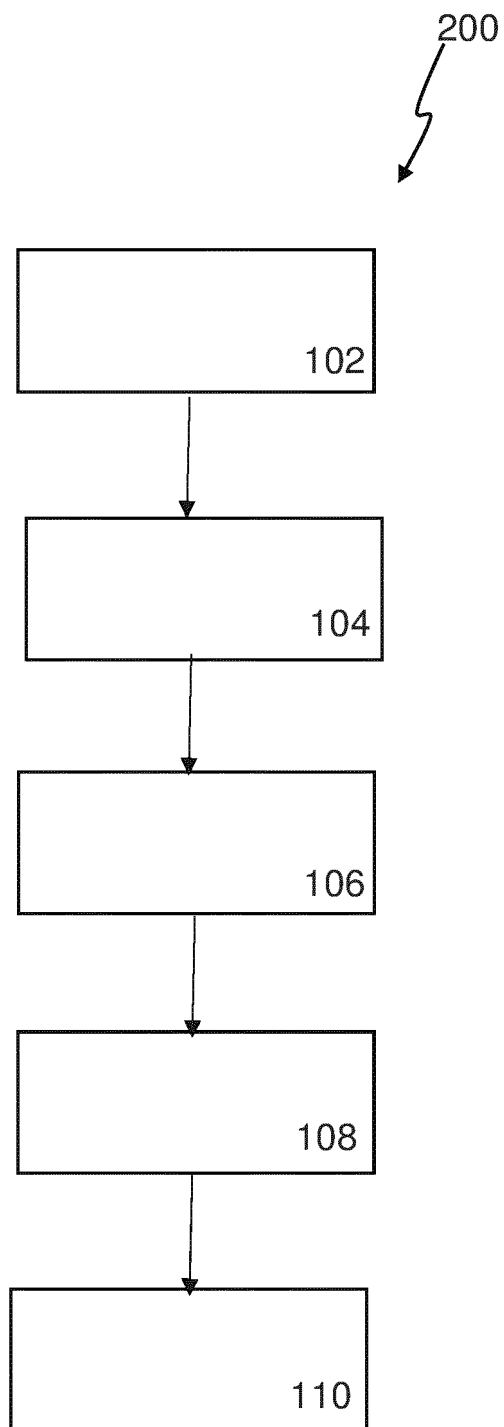


FIG. 11



EUROPEAN SEARCH REPORT

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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)
Y	US 2015/021004 A1 (MUI GARY K [US] ET AL) 22 January 2015 (2015-01-22) * figures *	1-10	INV. F28F9/18 F28F3/02 F28F9/00
Y	DE 10 2011 100629 A1 (BEHR GMBH & CO KG [DE]; MANN & HUMMEL GMBH [DE]) 8 November 2012 (2012-11-08) * figures *	1-10	F28F1/12 F28F1/02 F28D7/16 F28D9/00 F25B39/00
Y	EP 2 055 921 A1 (BEHR GMBH & CO KG [DE]; MECAPLAST GROUP [MC]) 6 May 2009 (2009-05-06) * figure 1 *	1-10	
Y	EP 3 252 421 A1 (VALEO SYSTEMES THERMIQUES [FR]) 6 December 2017 (2017-12-06) * figure 5 *	1-10	
Y	US 5 289 873 A (RYAN RICHARD P [US] ET AL) 1 March 1994 (1994-03-01) * figures *	1-10	TECHNICAL FIELDS SEARCHED (IPC)
Y	EP 0 748 997 A2 (GEN MOTORS CORP [US]) 18 December 1996 (1996-12-18) * figures *	1-10	F28D F28F F25B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 31 July 2023	Examiner Mellado Ramirez, J
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 23 15 6839

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
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31-07-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015021004 A1	22-01-2015	NONE	

DE 102011100629 A1	08-11-2012	CN 103547778 A	29-01-2014
		DE 102011100629 A1	08-11-2012
		US 2014130764 A1	15-05-2014
		WO 2012150358 A1	08-11-2012

EP 2055921 A1	06-05-2009	AT 547614 T	15-03-2012
		EP 2055921 A1	06-05-2009
		ES 2385013 T3	17-07-2012

EP 3252421 A1	06-12-2017	NONE	

US 5289873 A	01-03-1994	NONE	

EP 0748997 A2	18-12-1996	DE 69616877 T2	11-04-2002
		EP 0748997 A2	18-12-1996
		US 5607012 A	04-03-1997
