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(54) **Heat Exchanger and method of assembly thereof**

(57) Method of assembling a tank (14) and a header plate (16) of a heat exchanger (10) comprising the steps of providing a tank (14) with an outer peripheral foot portion (32) and a header plate (16) having edges with a plurality of tabs (50) extending towards the tank (14), providing each transverse wall (24) of the tank (14) with at least one positioning extension (60) and providing

each transverse edge (56) of the header plate (16) with a pair of positioning tabs (64, 66) for complementary engagement them with a corresponding tank's extension (60), pressing the header plate (16) onto the tank (14) such that they are interlocked in a transverse direction (T) by positioning the extensions (60) in-between said positioning tabs, and clinching the tabs (50) inwardly over the foot portion (32) of the tank opening (30).

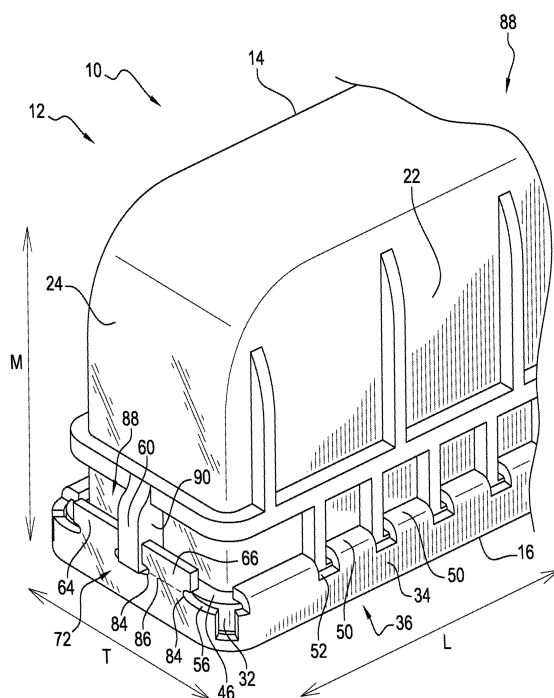


Fig. 2

Description

TECHNICAL FIELD

[0001] This invention relates to heat exchangers and more particularly to sealing junctions in a heat exchanger and a method of assembly thereof.

BACKGROUND OF THE INVENTION

[0002] Heat exchangers equip the vast majority of motor vehicles powered by an internal combustion engine. Heat exchangers may be used for engine cooling and for passenger's climate control. Most heat exchangers include a tank and a header plate. It has become common practice to manufacture the tank from a plastic material and the header from a heat conductive metal material such as aluminum. The plastic tank is mechanically joined to the header plate. It is vital that the junction between the tank and header plate be leak-free and durable in spite of the corrosive fluid that flows through the heat exchanger.

[0003] Generally the tank opening is rectangular and so is the header plate. The header plate is provided with a peripheral groove in which is placed a gasket and when placed in position, the walls of the plastic tank come in the groove, against the gasket, sealing the tank-header plate interface. During the process the tank is kept in position by the corners of the header plate. The walls of the tank are also provided with a foot portion that is peripheral to the opening and, to permanently fix the header plate on the tank, tabs, extending along the outer edge of the header are bent over the foot portion. Prior to bending, the tabs extending from the edges of the header plate are straight and, the bending forces applied on the tabs enable a right angle bending of the tabs.

[0004] To ensure the leak free requirement, Ahaus et al, in US 6,082,446, disclose a design of the plastic tank provided with compression stop devices ensuring that the gasket will not be over-compressed.

[0005] In the most recent developments, the header plate is provided with partially pre-bent tabs. When the plastic tank is positioned over the header plate, the tank is axially pressed against the header plate, compressing the gasket for sealing purposes. The partially pre-bent tabs of the header plate are then further bent over a shoulder of the plastic tank thus grabbing said tank and permanently fixing together the tank and the header plate.

[0006] An issue with these pre-bent tabs is that the final bending is done thanks to transverse forces orthogonal to the axial compression direction from the tank to the header plate. Consequently, these transverse forces applied on the header plate may generate small transverse displacements of the header plate relative to the tank degrading the quality and the sealing performance of the assembly.

[0007] It is an object of the present invention to propose a method of assembly of the tank and the header plate

that forbids transverse shifting of the parts during assembly.

[0008] It is a further object of the invention to propose a heat exchanger that is leak free.

SUMMARY OF THE INVENTION

[0009] In carrying out the above object and other objects, features, and advantages, the present invention provides a method for assembling a tank and a header plate of a heat exchanger. The method comprises the steps of:

providing a tank having walls defining an axial opening in the bottom with an outer peripheral foot portion comprising longitudinal and transverse sections, providing a header plate being designed to cover the opening and having longitudinal and transverse edges and a plurality of lateral tabs extending axially from the longitudinal edges towards the tank, the header plate being provided with holes for receiving fluid circulation tubes,

the method further comprises the steps of:

providing each transverse wall of the tank with at least one positioning extension longitudinally protruding,

providing each transverse edge of the header plate with at least one pair of positioning tabs extending axially from said transverse edge towards the tank, each pair defining in-between its two positioning tabs an intermediate space having a shape allowing complementary engagement with a corresponding tank's extension,

positioning the header plate facing the opening such that each extension is being aligned with a corresponding intermediate space,

pressing axially the header plate onto the tank such that the header plate and the tank are interlocked in a transverse direction by positioning the extensions into said spaces, each positioning tab being in contact with the corresponding face of the corresponding extension, thus advantageously prohibiting any further transverse displacement of the header plate relative to the tank, and

clinging the lateral tabs inwardly over the foot portion of the tank opening in order to fix the header plate onto the tank in the interlocked position.

[0010] The method further comprises the step of clinching the transverse tabs inwardly over the foot portion of the tank opening, after the clinching step applied to the lateral tabs, in order to further secure the fixation of the header plate to the tank in the interlocked position.

[0011] Additionally, the process further comprise the

step of pre-bending the lateral tabs prior to the pressing step such that each tab extends from the longitudinal edge through an outwardly bent first portion to a second portion inwardly bent relative to the first portion so that, when axially pressing the header plate onto the tank, the foot portion passes between the free extremities of the lateral tabs. The clinching step applied to the lateral tabs is done by bending inwardly the first portion.

[0012] Furthermore, the process may comprise the step of operating transversal notches in positioning tabs in order to pre-determine the location where the tab will bend and in order to ease the clinching of said tabs.

[0013] The invention is also related to a heat exchanger for a vehicle having a fluid tank and a header plate. The tank has walls defining an axial opening in the bottom with an outer peripheral foot portion comprising longitudinal and transverse sections. The header plate covers the opening and puts the tank in fluid communication with cooling tubes. The header plate has longitudinal and transverse edges, and a plurality of lateral tabs extending axially from the longitudinal edges towards the tank, the lateral tabs being bent over the foot portion thus fixing the assembly. Each transverse wall of the tank is further provided with at least one extension longitudinally protruding and each transverse edge of the header plate is further provided with at least one pair of positioning tabs extending axially from said transverse edge towards the tank, each pair defining in-between its two positioning tabs an intermediate space having a shape allowing complementary engagement with a corresponding tank's extension. The header plate is positioned onto the tank such that the header plate and the tank are interlocked in a transverse direction by positioning the extensions into said spaces. Each positioning tab is in contact with the corresponding face of the corresponding extension, thus prohibiting any further transverse displacement of the header plate relative to the tank. The lateral tabs are clinched inwardly over the foot portion of the tank opening in order to fix the header plate onto the tank in the interlocked position.

[0014] Also, the positioning tabs may be clinched over the foot portion for further fixing the header plate onto the tank.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The present invention is now described by way of example with reference to the accompanying drawings in which:

Figure 1 is an isometric view of a heat exchanger as per the invention.

Figure 2 is an isometric view of a tank and header plate assembly as per a first embodiment.

Figure 3 is a side view of a tank and a header facing each other, prior to be assembled together.

Figure 4 is a side view along the longitudinal direction of the assembly of Figure 1.

Figure 5 is an isometric view of a tank and header plate assembly as per a second embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] In the following description, similar elements could be designated with the same reference numbers.

[0017] A heat exchanger 10, as shown on Figure 1, used in a motor vehicle comprises two tank-header plate assemblies 12, each comprising a tank 14 a header plate 16 and a gasket 20, the assemblies 12 being interconnected by flat tubes 48 where a cooling fluid circulates. Cooling fins are interposed between the tubes to increase the thermal transfer.

[0018] To ease the description that follows a direct orthogonal system including longitudinal direction L, transverse direction T and mounting direction M is utilized.

[0019] The initial step of the process of making the tank-header plate assembly 12, consists in providing the tank 14, the header plate 16 and the gasket 20.

[0020] Detailed on Figures 2 to 5, the tank 14 comprises two longitudinal walls 22, and two transverse walls 24. The walls 22, 24, define an inside volume 28 for receiving a cooling fluid. The walls 22, 24, also define a rectangular opening 30 surrounded by a peripheral foot portion 32 of the walls 22, 24.

[0021] The tank 14 is usually molded from plastic but other materials can be utilized as well.

[0022] The header plate 16 is designed to be fixed onto the tank 14, over the opening 30. The header plate 16 is made of metal and it has the size and shape of the opening 30 surrounded by the peripheral foot portion 32. As better shown on Figure 2, the header plate 16 comprises a header face 18 surrounded by a peripheral side wall 34 extending in the mounting direction M from the edges of the header face 18. The header face 18 is provided with a plurality of slots 36, which are usually rectangular or oblong, for connecting the flat tubes 48 within which the cooling fluid circulates.

[0023] When presented to the tank 14, the slots 36 are only facing the opening 30 and the sealing surface 38 that surrounds the slots 36 by being adjacent to the side wall 34 faces the lower face 40 of the foot portion 32. The side wall 34 is adjusted for complementary engagement of the foot portion 32.

[0024] The sealing surface 38 aims at receiving the gasket 20 and, can either be designed and made flat, as represented on the Figures, thus minimizing the overall dimensions of the header plate 16, or may be provided with a continuous channel (not represented) within which the gasket 20 can be placed.

[0025] Whenever possible a cured-in-place gasket may advantageously be utilized as an alternative to the separate gasket 20 represented on Figure 1. In such a case the gasket would be formed and vulcanized directly on the lower face 40 of the foot portion 32.

[0026] As shown on Figures 2 and 5, the header plate 16 is further provided with a plurality of lateral tabs 50

extending from the longitudinal edges 52 of the sidewall 34. The lateral tabs 50 extend in the mounting direction M and are designed for being bent over the upper face 46 of the foot portion 32.

[0027] For purposes of mutual positioning in the transverse direction T, the tank 14 and the header plate 16 are provided with complementary features. The tank 14 has a longitudinal positioning extension 60, protruding from each of its transverse walls 24, while the header plate 16 is provided with pairs of positioning tabs 64, 66, extending along each of its transverse edges 56. The intermediate space 72, between the two positioning tabs 64, 66, has the shape allowing a complementary engagement with a corresponding tank's extension 60.

[0028] More specifically, each positioning extension 60 has two lateral faces 90, the in-between distance in the transverse direction T being equal to the width of the intermediate space 72 thus, when engaged, the positioning extension 60 is in contact with the two positioning tabs 64, 66.

[0029] The complementary profiles of the positioning extensions 60 and of the intermediate spaces 72 may be further described in alternative options. The lateral faces 90 may be parallel, as presented in the Figures, or may be slightly biased (not represented) closer by the lower face 40 of the foot portion 32 than by the upper face 46 so, when presented to the corresponding intermediate space 72, the engagement is eased and when fully engaged the positioning extension 60 is in contact with the two positioning tabs 64, 66. Furthermore, one of the positioning extensions 60 may be larger than the other one so the largest extension can only fit into the largest intermediate space thus, creating an orientation key for the header plate 16 relative to the tank 14.

[0030] Also, as represented on Figure 3 for the lateral side but also possible for the transverse side, the header plate 16 may be designed without side wall 34, the lateral tabs 50 extending directly from the edges 52, of the header face 18.

[0031] As per Figures 2 to 5, all tabs may extend straightly in the mounting direction M, as represented for the positioning tabs 64, 66, but may preferably be pre-bent prior to the assembly step of the process, as represented on Figure 3 for the lateral tabs 50. The pre-bent lateral tabs 50 extend from the longitudinal edge 52 of the header plate 16 to an outwardly bent first portion 78 then to a second portion 80 inwardly bent relative to the first portion 78 until a free extremity 82 inwardly oriented.

[0032] The positioning tabs 64, 66, may also straightly extend from the header plate 16 or may, similarly to the lateral tabs 50, be pre-bent.

[0033] In the case of pre-bent positioning tabs 64, 66, it is mandatory that the pre-bending does not alter the engagement of the positioning extensions 60 in their corresponding intermediate spaces 72 during the assembling step of the process.

[0034] In the case of pre-bent tabs the space between the free ends 82 of the tabs must be sufficient to enable

the tank 14 to pass in-between them for being properly positioned vis-à-vis the header plate 16.

[0035] As represented on Figure 5, the positioning tabs 64, 66, are preferably provided with notches 84 that determine a weaker section 86 of the tab where the final bending will naturally occur. The tabs may be provided with a pair of symmetrical notches 84. To create the weaker section 86 in the tab multiple other alternatives are possible such as a single notch or a transverse continuous groove internally or externally operated.

[0036] The notches 84 are operated on straight positioning tabs 64, 66, but may as well be operated on pre-bent tabs. Similarly (not represented), lateral tabs 50 may as well be provided with notches 84.

[0037] The gasket 20 is designed to continuously follow the sealing surface 38 adjacent to the side wall 34, in order to be just between the header face 18 and the lower face 40 of the foot portion 32. The gasket 20 is usually made of a rubber type material not alterable by the cooling fluid.

[0038] Once the tank 14 the header plate 16 and the gasket 20 are provided as individual components, the subsequent step of the process is to position them relative to each other.

[0039] The gasket 20 is positioned in the header plate 16 on the sealing surface 38 or, as alternatively described, in the channel made for the purpose. In place the gasket 20 surrounds the slots 36.

[0040] Afterward, the tank 14 is presented to the header plate 16 and gasket 20 such that the positioning extensions 60 are aligned with their corresponding intermediate spaces 72. Subsequently, the tank 14 is pressed in the mounting direction M on the header plate 16, thus engaging the positioning extensions 60, into their corresponding intermediate spaces 72. The gasket 20 is compressed between the lower face 40 of the foot portion 32 and the sealing surface 38 of the header plate 16. The engagement of the positioning extensions 60, into the intermediate spaces 72, creates a transverse interlock 88 that prevents any further transverse displacement of the tank 14 relative to the header plate 16 thus advantageously ensuring a perfect positioning during the following steps of the process and during the life of the final product.

[0041] Furthermore and similarly to the transverse interlock 88, the tank 14 and header plate 16 may be provided with a lateral interlock (not represented) preventing lateral displacements of the tank 14 relative to the header plate 16. Lateral interlock could be advantageously implemented in case of pre-bent transverse tabs 64, 66. Such a lateral interlock would comprise a transverse positioning extension, protruding from each of its lateral walls 22, while the header plate 16 would be provided with pairs of positioning tabs extending along each of its longitudinal edges 52, the intermediate space between the two positioning tabs having the shape allowing a complementary engagement with a corresponding tank's extension.

[0042] The following step of the process consists in permanently fixing the header plate 16 onto the tank 14 by bending the lateral tabs 50 over the upper face 46 of the foot portion 32. This operation is done by applying on the lateral tabs 50 forces F inwardly oriented.

[0043] In the case of straight tabs with notches 84 the bending naturally occurs in the weak section 86 of the tabs bringing part of the tabs over the upper face 46 of the foot portion 32.

[0044] In the case of pre-bent tabs the bending occurs in the first portion 78 of the tabs, as represented for the lateral tabs 50 on the sequence Figure 2 - Figure 3. Said first portion 78 being outwardly pre-bent is, under the inwardly oriented force F, straighten thus moving the second portion 80 of the tabs 50 over the upper face 46 of the foot portion 32.

[0045] In any alternatives, thanks to the interlock 88, the bent lateral tabs 50 permanently fix the header plate 16 onto the tank 14 in the desired position.

[0046] The assembly may have been designed so the lateral tabs 50 are sufficient to fix the header plate 16 onto the tank 14. In this case, as represented on Figure 2, the positioning tabs 64, 66, are designed straight with or without notches 84. Alternatively, should for instance the transverse dimension be important and further fixation be required on said transverse direction T, the positioning tabs 64, 66, are, as represented on Figure 5, bent over the upper face 46 of the foot portion 32 in a final step of the process.

[0047] Similarly to the lateral tabs 50, the bending of the transverse tabs 64, 66, occurs by applying inwardly oriented forces on said positioning tabs 64, 66. The interlock 88 engaged in the previous step of the process remains active during and after bending the positioning tabs 64, 66.

[0048] Alternatively, according to the design of the tank-header assembly 12, the header plate 16 may, in addition to the positioning tabs 64, 66, be provided on its transverse edges 56 with additional fixation tabs similar in design to the lateral tabs 50.

[0049] To simplify the description, the process has been described in focusing exclusively on the assembly of the tank 14 and the header plate 16. It is usual to initially braze together the metallic flat tubes cooling fins and header plates, so creating a single metallic part. Once this is done, the subsequent step is to assemble a gasket 20 and the plastic tank on the header plate.

[0050] The interlock 88 has a further advantage. Should a diagnosis be required, the correct positioning of the extensions 60, in their corresponding intermediate space 72, is an easy visual check during the manufacturing process as well as during the life of the product.

Claims

1. A method of assembling a tank (14) and a header plate (16) of a heat exchanger (10) comprising the

steps of:

providing a tank (14) having walls (22, 24,) defining an axial opening (30) in the bottom with an outer peripheral foot portion (32) comprising longitudinal and transverse sections, providing a header plate (16) being designed to cover the opening (30) and having longitudinal and transverse edges (52, 56) and a plurality of lateral tabs (50) extending axially from the longitudinal edges (52) towards the tank (14), the header plate (16) being provided with holes for receiving fluid circulation tubes,

characterized in that the method further comprises the steps of:

providing each transverse wall (24) of the tank (14) with at least one positioning extension (60) longitudinally protruding, providing each transverse edge (56) of the header plate (16) with at least one pair of positioning tabs (64, 66) extending axially from said transverse edge (56) towards the tank (14), each pair defining in-between its two positioning tabs an intermediate space (72) having a shape allowing complementary engagement with a corresponding tank's extension (60),

positioning the header plate (16) facing the opening (30) such that each extension (60) is being aligned with a corresponding intermediate space (72),

pressing axially the header plate (16) onto the tank (14) such that the header plate (16) and the tank (14) are interlocked in a transverse direction (T) by positioning the extensions (60) into said spaces (72), each positioning tab (64, 66) being in contact with the corresponding face of the corresponding extension (60), thus prohibiting any further transverse displacement of the header plate (16) relative to the tank (14), and

clinging the lateral tabs (50) inwardly over the foot portion (32) of the tank opening (30) in order to fix the header plate (16) onto the tank (14) in the interlocked position.

2. Process as set in claim 1 further comprising the step of:

clinging the transverse tabs (64, 66) inwardly over the foot portion (32) of the tank opening (30), after the clinching step applied to the lateral tabs (50), in order to further secure the fixation of the header plate (16) to the tank (14) in the interlocked position.

3. Process as set in any of the preceding claim further

comprising the step of:

pre-bending the lateral tabs (50) prior to the pressing step such that each tab (50) extends from the longitudinal edge (52) through an outwardly bent first portion (78) to a second portion (80) inwardly bent relative to the first portion (78) so that, when axially pressing the header plate (16) onto the tank (14), the foot portion (32) passes between the free extremities (82) of the lateral tabs (50), and wherein the clinching step applied to the lateral tabs (50) is done by bending inwardly the first portion (78).

4. Process as set in any of the claim 2 or 3 further comprising the step of:

operating transversal notches (84) in positioning tabs (64, 66) in order to pre-determine the location where the tab will bend and in order to ease the clinching of said tabs.

5. A heat exchanger (10) for a vehicle having a fluid tank (14) and a header plate (16), the tank (14) having walls (22, 24) defining an axial opening (30) in the bottom with an outer peripheral foot portion (32) comprising longitudinal and transverse sections,

the header plate (16) covering the opening (30) and putting the tank (14) in fluid communication with cooling tubes, the header plate (16) having longitudinal and transverse edges (52, 56), and a plurality of lateral tabs (50) extending axially from the longitudinal edges (52) towards the tank (14), the lateral tabs (50) being bent over the foot portion (32) thus fixing the assembly and

characterized in that

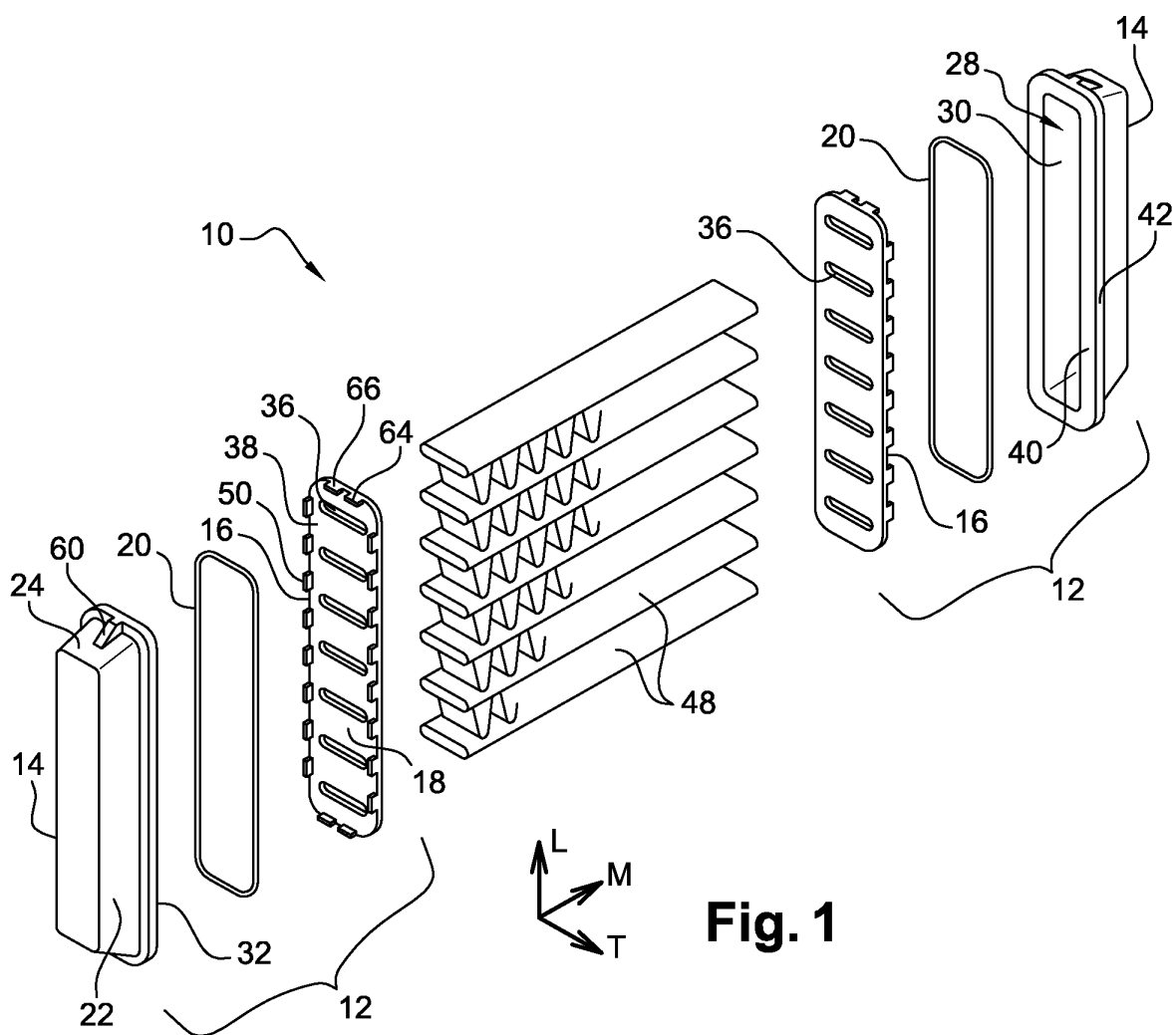
each transverse wall of the tank (24) is further provided with at least one extension (60) longitudinally protruding,

each transverse edge (56) of the header plate (16) is further provided with at least one pair of positioning tabs (64, 66) extending axially from said transverse edge (56) towards the tank (14), each pair defining in-between its two positioning tabs an intermediate space (72) having a shape allowing complementary engagement with a corresponding tank's extension, the header plate (16) is positioned onto the tank (14) such that the header plate (16) and the tank (14) are interlocked in a transverse direction (T) by positioning the extensions (60) into said spaces (72), each positioning tab (64, 66) being in contact with the corresponding face of the corresponding extension (60), thus prohibiting any further transverse displacement of the header plate (16) relative to the tank (14),

the lateral tabs (50) are clinched inwardly over the

foot portion (32) of the tank opening in order to fix the header plate (16) onto the tank (14) in the interlocked position.

6. A heat exchanger (10) a set in claim 5 wherein the positioning tabs (64, 66) are clinched over the foot portion (32) further fixing the header plate (16) onto the tank (14).



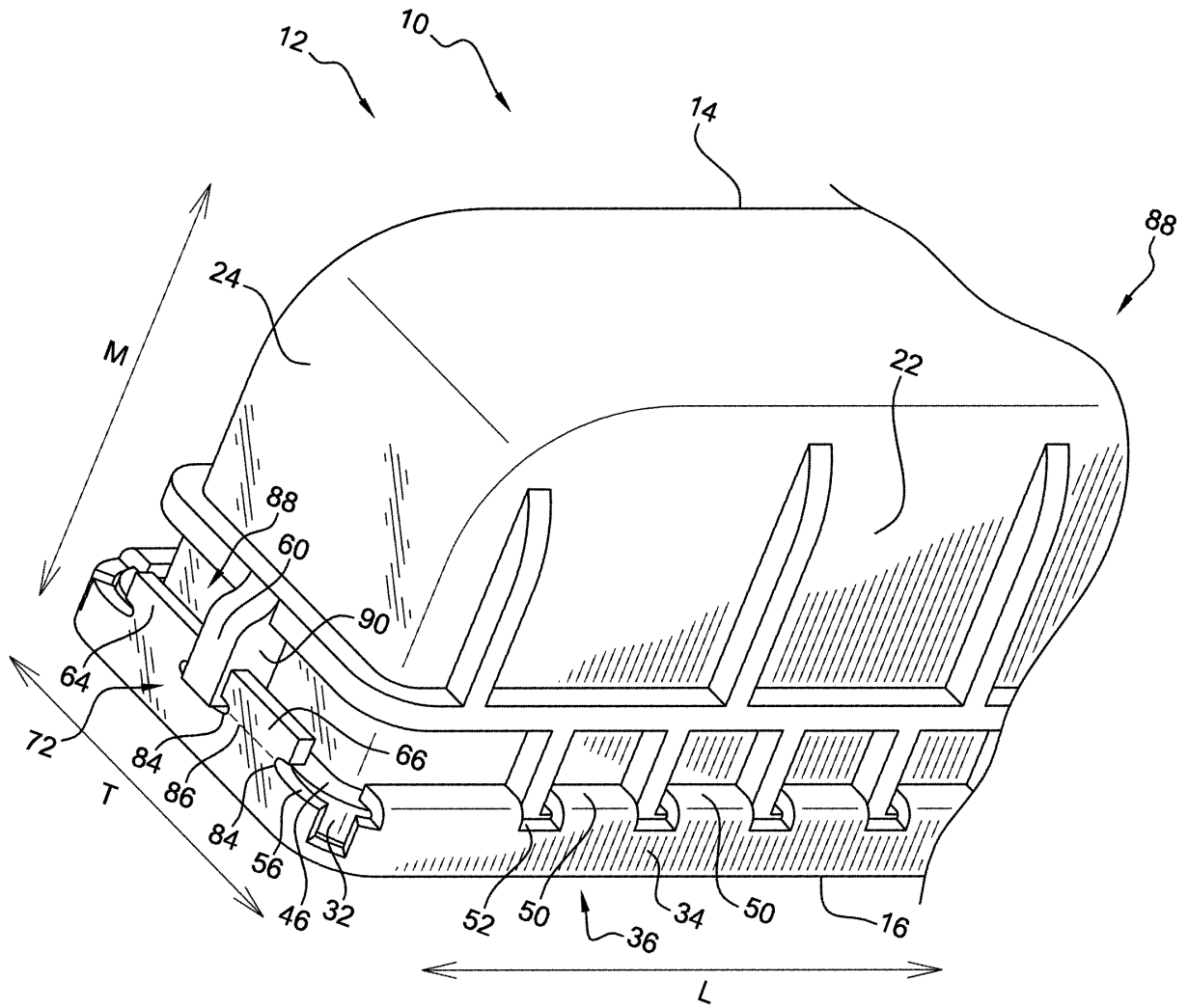


Fig. 2

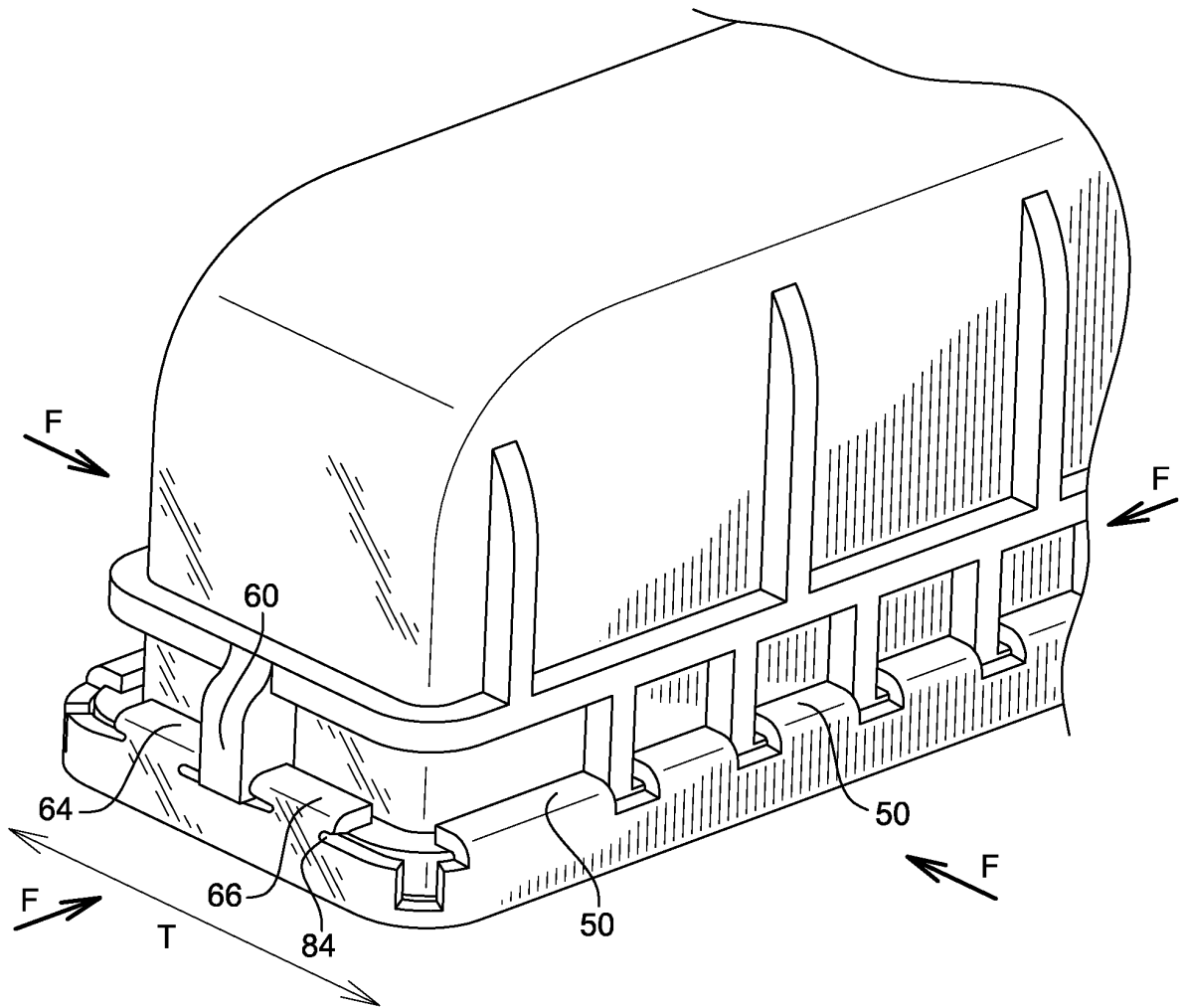


Fig. 5



EUROPEAN SEARCH REPORT

Application Number
EP 10 18 1160

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	EP 1 921 413 A1 (JOAO DE DEUS & FILHOS S A [PT]) 14 May 2008 (2008-05-14) * paragraphs [0011], [0015]; figures 1-8 *	1-3,5,6	INV. F28F9/02
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A	US 2002/023734 A1 (WAGNER WILLIAM W [US]) 28 February 2002 (2002-02-28) * paragraph [0039] - paragraph [0041]; figure 1 *	1-6	
			TECHNICAL FIELDS SEARCHED (IPC)
			F28F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 31 March 2011	Examiner Martínez Rico, Celia
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			

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EPO FORM 1503 03.82 (P04C01)

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

EP 10 18 1160

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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31-03-2011

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 1921413	A1	14-05-2008	NONE	
DE 20307881	U1	23-09-2004	NONE	
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REFERENCES CITED IN THE DESCRIPTION

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