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(54) Heat exchanger with a manifold plate

(57) Heat exchanger (10) comprising a collector box (18) and at least one longitudinal row (R1, R2) of heat exchange tubes (12), said tubes (12) being connected to the bottom face of the collector box (18), said collector box (18) being connected to a first fluid source through a connection device (48) and being made up of stacked plates including a distribution plate (25) comprising at least one row of distribution slots (36) for distribution of the first fluid into the tubes (12), characterized in that the collector box (18) further comprises a manifold plate (23) comprising a main longitudinal portion essentially flat having at least one longitudinal recessed portion (72, 74, 76, 78) forming a manifold channel which is in communication with the distribution slots (36) of the distribution plate (25) downwardly and with the connection device (48).

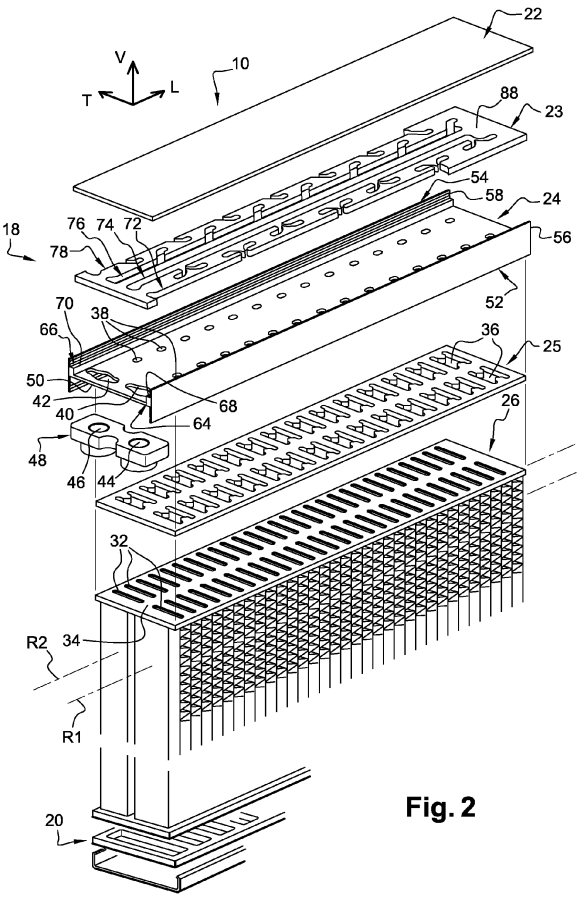

Fig. 2

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Description

TECHNICAL FIELD

[0001] The present invention relates generally to heat exchangers for motor vehicles.

BACKGROUND OF THE INVENTION

[0002] The present invention relates more particularly to a heat exchanger such as an evaporator comprising a collector box and at least one longitudinal row of heat exchange tubes through which a first fluid such as a refrigerant fluid can flow and around which a second fluid such as air can flow, said tubes being connected to the bottom face of the collector box, said collector box being connected to a first fluid source through a connection device and being made up of stacked plates including a distribution plate comprising at least one row of distribution slots for distribution of the first fluid into the tubes.

[0003] Such a heat exchanger is particularly adapted to multi layers collector box assemblies for two phases flow products with high pressure withstanding, wherein the heat exchanger comprises two rows of tubes and wherein the collector box comprises an inlet and an outlet manifold connected accordingly to the tubes and to the connection device which has corresponding inlet and outlet ports. Such a heat exchanger is disclosed for example in WO2009/124858.

[0004] Despite the already good results provided by the existing solution, it is still necessary to improve the fluid circulation in the collector box in order to ensure an optimized homogenization of the refrigerant flow and in order to avoid potential pressure drops or efficiency loss in the heat exchanger. It should be done by still maintaining, or increasing, high pressure withstanding capability of the heat exchanger and without increasing the manufacturing costs.

SUMMARY OF THE INVENTION

[0005] An object of the invention is to solve the above mentioned problems.

[0006] This object is achieved by a heat exchanger of the above mentioned type characterized in that the collector box further comprises a manifold plate comprising a main longitudinal portion essentially flat having at least one longitudinal recessed portion forming a manifold channel which is in communication with the distribution slots of the distribution plate downwardly and with the connection device.

[0007] Thanks to the invention, the refrigerant distribution is improved. More particularly, the refrigerant pressure and the dry-out due to high mass velocity is decreased.

[0008] The manifold plate according to the invention is particularly easy to manufacture and to assemble with the other plates. It is easy to design the manifold channel and to define different cross sections for the manifold channel depending for example on the longitudinal location of the section with regards to the connection device.

[0009] Thanks to the invention, the compactness of the heat exchanger can be improved and the heat exchange surface can be increased with regards to the overall volume of the heat exchanger.

[0010] Additionally, the heat exchanger according to the invention can be easily adapted to different types of refrigerant fluid.

[0011] According to other features of the invention:

- the heat exchanger comprises a cover plate which is tightly fitted to the upper face of the manifold plate in order to tightly close upwardly the recessed portion;
- the recessed portion comprises a cut-out portion along a longitudinal edge of the manifold plate for guiding the refrigerant fluid longitudinally from the connection device towards the different distribution slots, said cut-out portion being tightly closed upwardly by the cover plate;
- the recessed portion comprises a slit portion which is opened in the upper and lower faces of the manifold plate, the maximum thickness of the slit portion corresponding to the thickness of the manifold plate main longitudinal portion, said slit portion being tightly closed upwardly by the cover plate;
- the recessed portion comprises a longitudinal slit for guiding the refrigerant fluid longitudinally from the connection device towards the different distribution slots;
- the manifold plate comprising two manifold channels, a first one comprising a cut-out portion and a second one comprising a slit portion;
- at least one of the stacked plates is provided at its side edges with parallel lateral flanges extending at least partially along the longitudinal edges of the other plates and being crimped over the other plates for clinching the plates together;
- an intermediate plate is stacked between the manifold plate and the distribution plate, said intermediate plate comprising intermediate holes, each intermediate hole providing communication between the manifold channel and at least one distribution slot;
- the connection device comprising at least one inlet/outlet port, said recessed portion is connected to said inlet/outlet port through a connecting slot arranged in the intermediate plate;
- said manifold plate comprises at least two substantially parallel manifold channels which are connected to the same inlet/outlet port;
- said recessed portion comprises a main longitudinal portion and at least one auxiliary portion connected transversally to the main longitudinal portion, at least one distribution slot being in communication with the main longitudinal portion through the auxiliary portion;

- an intermediate hole is facing the auxiliary portion in order to connect said auxiliary portion with the corresponding distribution slot;
- the auxiliary portion is a slit portion;
- said heat exchanger comprising a first and a second rows of tubes, the manifold plate comprises at least one inlet manifold channel which is connected to the first row of tubes and at least one outlet manifold channel which is connected to the second row of tubes, the heat exchanger being provided with a diverter box opposed to the collector box with regards to the tubes in order to redirect the flow of refrigerant originating from the inlet manifold channel towards the outlet manifold channel.

[0012] The present invention also proposes a method of manufacturing such a heat exchanger, characterized in that it comprises the steps of:

- extruding the manifold plate,
- forming the recessed portion in the manifold plate,
- stacking the plates together,
- fixing the plates together.

[0013] The method further comprises the step of tightly fitting the cover plate to the upper face of the manifold plate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The present invention is now described by way of example with reference to the accompanying drawings in which:

- figure 1 is a perspective view showing schematically an evaporator according to a preferred embodiment of the present invention;
- figure 2 is an exploded perspective view showing schematically the evaporator of figure 1 equipped with a collector box comprising a manifold plate according to the preferred embodiment of the invention;
- figure 3 is a view similar to the one of figure 2 showing schematically the inlet flow path of the refrigerant fluid into the evaporator;
- figure 4 is a view similar to the one of figure 3 showing schematically the outlet flow path of the refrigerant fluid into the evaporator;
- figure 5 is an upper view showing schematically the manifold plate of the evaporator of figure 2;
- figure 6 is a view similar to the one of figure 2 showing schematically an alternative embodiment of an evaporator according to the present invention wherein the evaporator comprises only one row of tubes.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] In the following description, similar elements could be designated by the same reference numbers.

[0016] Figures 1 to 4 show an evaporator 10 for a motor vehicle air-conditioning system which is operated preferably with high pressure refrigerant. The refrigerant may be for example CO2 (R744 type) with an inlet pressure of approximately 30 bars.

[0017] This evaporator 10 is designed as a two rows flat-tube evaporator and has a multiplicity of flat tubes 12 arranged along two longitudinal rows R1, R2, a front row R1 on the front side of the evaporator 10 and a rear row R2 on the rear side of the evaporator 10. These flat tubes 12 can be designed as extruded multichannel flat tubes, which have a multiplicity of flow passages. All the flat tubes 12 have the same length along a vertical axis V and the same depth along a transverse axis T. Preferably, the flat tubes 12 are multiport extruded flat tubes.

[0018] In the following description, for the purpose of better understanding and without limiting purpose, we will use an orientation along the vertical axis V, the longitudinal axis L, and the transverse axis T, as can be seen on figure 1. Additionally, the transverse axis T will be orientated rearwardly which corresponds to an orientation from right towards left when considering figure 1.

[0019] Between the individual flat tubes 12 there are corrugated fins 16, which are acted on by ambient air in the direction of the arrow F, i.e. along a transverse axis.

[0020] The tubes 12 are fitted between an upper end member constituted of a collector box 18 and a lower end member constituted of a diverter box 20.

[0021] The collector box 18 according to the preferred embodiment of the invention comprises a stack of individual plates bearing against one another and including successively, downwardly speaking when looking at figures 1 to 4, a cover plate 22 at the top, a manifold plate 23, an intermediate plate 24, a distribution plate 25, and a header plate 26 at the bottom. Advantageously, all the plates 22, 23, 24, 25, 26 are extruded.

[0022] According to the embodiment shown, the header plate 26, in which a front row and a rear row of mounting slots 32 are arranged, is illustrated above the flat tubes 12, the two parallel rows of mounting slots 32 corresponding to the two rows R1, R2 of flat tubes 12. The mounting slots 32 are located one behind the other in the transverse direction and in each case leave between them webs 34 which separate two adjacent flat tubes 12 in the transverse direction. The total number of mounting slots 32 matches with the total number of flat tubes 12, each flat tube upper end 33 being inserted into the header plate 26 through a mounting slot 32.

[0023] The distribution plate 25, or diverter plate, is arranged above the header plate 26 and has distribution slots 36 for refrigerant passage arranged along the two rows R1, R2. According to the example shown, each distribution slot 36 has a substantially "H-shape" orientated transversally and allowing one distribution slot 36 to distribute the refrigerant into two longitudinally adjacent mounting slots 32 below the distribution plate 25, as illustrated by figure 3.

[0024] The intermediate plate 24 is arranged above

the distribution plate 25 and has intermediate holes 38 for refrigerant passage arranged along a front row axis A1 and a rear row axis A2 respectively. Each intermediate hole 38 is facing downwardly the central portion of an associated H-shape distribution slot 36 such that the refrigerant flowing into an intermediate hole 38, from the manifold plate 23, is distributed into the two legs of the associated H-shape distribution slot 36, each leg corresponding to an associated mounting slot 32 of the header plate 26.

[0025] The intermediate plate 24 also includes at its left longitudinal end, considering figures 2 to 4, an inlet and outlet connecting slots 40, 42 for the connection of the manifold plate 23 to inlet and outlet ports 44, 46. According to the embodiment shown, the inlet and outlet connecting slots 40, 42 are aligned with the intermediate holes 38 along the front row and rear row axes A1, A2 respectively. A connecting device constituted of a fitting block 48 is provided with the inlet and outlet ports 44, 46, and is fitted to the connecting slots 40, 42, bearing against the intermediate plate lower face 50.

[0026] Advantageously, the intermediate plate 24 is provided at its side edges with parallel lateral flanges 52, 54 extending along the longitudinal edges of the other plates 22, 23, 25, 26. Each lateral flange 52, 54 comprise an upper portion 56, 58 which is crimped over the upper plates 22, 23 and a lower portion 60, 62 which is crimped over the lower plates 25, 26, in order to clinch all the plates of the collector box 18 together before brazing them together. Preferably, the fitting block 48 is clinched with the lower plates 25, 26 thanks to the corresponding portions of the flanges 52, 54.

[0027] Two inner step portions 64, 66 extend along the upper portion 56, 58 of each of the lateral flanges 52, 54. Said step portions 64, 66 delimit transversally a complementary longitudinal housing for the manifold plate 23 and define a supporting surface 68, 70 for the cover plate 22.

[0028] According to the preferred embodiment, the manifold plate 23 is aimed at:

- distributing an inlet flow IF of refrigerant into the front row R1 of tubes 12 downwardly through successively the intermediate holes 38, the distribution slots 36, and the mounting slots 32, and
- collecting an outlet flow OF of refrigerant coming from the rear row R2 of tubes 12, said outlet flow OF circulating upwardly through successively the mounting slots 32, the distribution slots 36, and the intermediate holes 38, after having being redirected by the diverter box 20 at the bottom of the evaporator 10.

[0029] According to the invention, the manifold plate 23 comprises a main longitudinal portion essentially flat having at least one longitudinal recessed portion 72, 74, 76, 78 forming a manifold channel which is in communication with the distribution slots 36 of the distribution plate 25 downwardly and with the connection device 48.

[0030] According to the preferred embodiment, the manifold plate 23 has a first and second inlet manifold channels 72, 74 which are connected to the inlet port 44, through the corresponding connecting slot 40 of the intermediate plate 24, and which are connected to the front row R1 of intermediate holes 38 in order to transfer and distribute the inlet flow IF from the inlet port 44 to the tubes 12 of the front row R1. Each intermediate hole 38 of the intermediate plate 24 connects the corresponding manifold channel 72, 74 to a corresponding distribution slot 36 of the distribution plate 25.

[0031] As can be seen more particularly in figure 5, the first inlet manifold channel 72 is constituted of a cut-out portion having a main longitudinal portion, or longitudinal notch 80, which extends along the front longitudinal edge of the manifold plate 23, and having auxiliary portions, or auxiliary slits 82, which are connected transversally to the longitudinal notch 80. The end portion 84 of the auxiliary slits 82 are substantially aligned along the front row axis A1 of intermediate holes 36 so as to place in communication the intermediate holes 38 with the longitudinal notch 80 through the auxiliary slits 82. On figure 5, the intermediate holes 36 are represented with dashed lines.

[0032] The auxiliary slits 82 of the preferred embodiment are arranged by pairs so as to have two auxiliary slits 82 connected to the longitudinal notch 80 through a common junction 86.

[0033] One can note that the first inlet manifold channel 72 is delimited transversely by the longitudinal front edge of the manifold plate 23, on one side, and by the front step portion 64 of the intermediate plate 24, on the other side. The first inlet manifold channel 72 is tightly closed upwardly by the cover plate 22, said cover plate 22 being designed to cover the entire upper surface 88 of the manifold plate 23. Preferably, the cover plate 22 is entirely flat.

[0034] According to an alternative embodiment (not shown), the first inlet manifold channel 72 could be delimited transversely, on the other side, by a corresponding flange portion of the cover plate 22.

[0035] The second inlet manifold channel 74 is constituted of a slit portion which is opened in the upper and lower faces of the manifold plate 23, the maximum thickness of the slit portion corresponding to the thickness of the manifold plate 23. Said slit portion has a main longitudinal portion, or longitudinal slit 90, which extends in parallel to the longitudinal notch 80, and has auxiliary slits 82 similar to the auxiliary slits 82 of the first inlet manifold channel 74. Similarly, said auxiliary slits 82 are connected transversally to the longitudinal slit 90. The end portions 84 of the auxiliary slits 82 of the second inlet manifold channel 74 are substantially aligned along the front row axis A1 so as to place in communication the intermediate holes 38 with the longitudinal slit 90 through the auxiliary slits 82. Additionally, one could note that the end portions 84 of the auxiliary slits 82 of both inlet manifold channels 72, 74 are aligned along the same front row axis A1.

[0036] The slits 90, 82 of the second inlet manifold channel 74 are also tightly closed upwardly by the cover plate 22.

[0037] Advantageously, according to the preferred embodiment, the manifold plate 23 has a first and second outlet manifold channels 76, 78 which are connected to the outlet port 46, through the corresponding connecting slot 42 of the intermediate plate 24, and which are connected to the rear row R2 of intermediate holes 38 in order to collect and transfer the outlet flow OF from the tubes 12 of the rear row R2 to the outlet port 46.

[0038] As shown on figures 2 to 5, the outlet manifold channels 76, 78 are substantially similar to the inlet manifold channels 76, 78, the first outlet manifold channel 76 being made of a longitudinal slit 92 connected to auxiliary slits 94, while the second outlet manifold channel 78 is made of a longitudinal notch 96 connected to auxiliary slits 94. In the present embodiment, the auxiliary slits 94 differ from the ones mentioned with the inlet manifold channels 72, 74 by the fact that they are not arranged by pairs but are distributed substantially regularly along the rear row axis A2. Of course, the end portions 98 of the auxiliary slits 94 of the outlet manifold channels 76, 78 are substantially aligned along the rear row axis A2 for connection of the outlet manifold channels 76, 78 to the rear row R2 of intermediate holes 38.

[0039] According to alternative embodiments (not shown), there could be only one inlet manifold channel 72, 74 and/or one outlet manifold 76, 78, each one of them being formed of either a cut-out portion or a slit portion.

[0040] According to the present embodiment, the inlet flow IF path is diverted at the bottom part of the evaporator 10 thanks to the diverter box 20 which is aimed to redirect the flow coming downward through the front row R1 tubes 12 towards the rear row R2 tubes 12 in the upward direction as if the evaporator 10 was formed from individual U-tubes. An example of a similar diverter box 20 is disclosed in US 2005/0039901 in connection with figure 1 and paragraphs [74] and [75].

[0041] According to an alternative embodiment, the diverter box 20 could be omitted by providing the evaporator 10 with U-tubes instead of straight flat tubes 12.

[0042] Now, a method of manufacturing the evaporator 10 according to the present invention will be described.

[0043] The manifold plate 23 is extruded and the recessed portions 72, 74, 76, 78 are formed in the manifold plate 23. This could be done by various methods, for example by cut-off and/or by a stamping process. The manifold plate 23 could also be molded directly with the recessed portions 72, 74, 76, 78.

[0044] The header plate 26 is fitted onto the flat-tube ends 33. Then, the distribution plate 25, the intermediate plate 24, the fitting block 48, the manifold plate 23, and the cover plate 22 are stacked on top of the header plate 26.

[0045] Then the plates 22, 23, 24, 25, 26 are fixed together by crimping over the lateral flanges 52, 54.

[0046] The different plates constituting the diverter box 20 at the bottom of the evaporator 10 are assembled in a similar way.

[0047] After the evaporator 10 has therefore been assembled, it is soldered to form a fixed block in a soldering furnace.

[0048] It is also possible firstly to assemble the collector box 18 and the evaporator 20, and then to connect it to the flat tubes 12.

[0049] According to an alternative embodiment which is shown on figure 6, the evaporator 10 according to the invention could have only one row of tubes 12. In such an embodiment, the collector box 18 is provided with only one inlet port 44, the outlet port 46 being arranged in the bottom part of the evaporator 10 which is provided with a substantially symmetrical outlet collector box 100 in replacement of the diverter box 20.

[0050] The outlet collector box 100 is preferably manufactured according to the teachings of the present invention. The outlet collector box 100 comprises a bottom manifold plate 102 with an outlet manifold channel 104 similar to one of the outlet manifold channels 76, 78 of the preferred embodiment. An associated bottom cover plate 108 is also provided to close the outlet manifold channel 104 of the bottom manifold plate 102.

[0051] According to the example shown on figure 6, the manifold plate 23 has only one inlet manifold channel 72 formed of a cut-out portion 80 and the bottom manifold plate 102 has only one outlet manifold channel 104 also formed of a cut-out portion 106.

[0052] The present alternative embodiment would have some technical advantages with regards to its transverse compactness and its simplified structure which would make it easy to manufacture.

[0053] One could note that a man skilled in the art could imagine various other alternative embodiments which have not been shown but would fall into the scope of protection of the attached claims. For example, different types of tubes 12 could be use instead of multi-port flat tubes, and the lateral flanges 52, 54 could be provided at the side edges of another plate such as the cover plate 22.

[0054] Of course, whereas the evaporator 10 has been described with a vertical orientation, a man skilled in the art could understand the invention accordingly even if the tubes are arranged along another direction such as an horizontal direction.

[0055] The present invention has been described in part on the basis of the example of an evaporator 10. However, it should be noted that the heat exchanger according to the invention is also suitable for other uses.

Claims

1. Heat exchanger (10), in particular for a motor vehicle, comprising a collector box (18) and at least one longitudinal row (R1, R2) of heat exchange tubes (12)

through which a first fluid such as a refrigerant fluid can flow and around which a second fluid such as air can flow, said tubes (12) being connected to the bottom face of the collector box (18), said collector box (18) being connected to a first fluid source through a connection device (48) and being made up of stacked plates including a distribution plate (25) comprising at least one row of distribution slots (36) for distribution of the first fluid into the tubes (12), **characterized in that** the collector box (18) further comprises a manifold plate (23) comprising a main longitudinal portion essentially flat having at least one longitudinal recessed portion (72, 74, 76, 78) forming a manifold channel which is in communication with the distribution slots (36) of the distribution plate (25) downwardly and with the connection device (48).

2. Heat exchanger (10) according to the preceding claim, **characterized in that** it comprises a cover plate (22) which is tightly fitted to the upper face (88) of the manifold plate (23) in order to tightly close upwardly the recessed portion (72, 74, 76, 78).

3. Heat exchanger (10) according to the preceding claim, **characterized in that** the recessed portion (72, 78) comprises a cut-out portion (80, 96) along a longitudinal edge of the manifold plate (23) for guiding the refrigerant fluid longitudinally from the connection device (48) towards the different distribution slots (36), said cut-out portion (80, 96) being tightly closed upwardly by the cover plate (22).

4. Heat exchanger (10) according to claim 2 or 3, **characterized in that** the recessed portion (72, 74, 76, 78) comprises a slit portion (82, 90, 92, 94) which is opened in the upper and lower faces of the manifold plate (23), the maximum thickness of the slit portion (82, 90, 92, 94) corresponding to the thickness of the manifold plate (23) main longitudinal portion, said slit portion (82, 90, 92, 94) being tightly closed upwardly by the cover plate (22).

5. Heat exchanger (10) according to the preceding claim, **characterized in that** the recessed portion (74, 76) comprises a longitudinal slit (90, 92) for guiding the refrigerant fluid longitudinally from the connection device (48) towards the different distribution slots (36).

6. Heat exchanger (10) according to anyone of claims 3 to 5, **characterized in that** the manifold plate (23) comprises two manifold channels (72, 74, 76, 78), a first one comprising a cut-out portion (80, 96) according to claim 3 and a second one comprising a slit portion (82, 90, 92, 94) according to claim 5.

7. Heat exchanger (10) according to anyone of the preceding claims, **characterized in that** at least one of the stacked plates (22, 23, 24, 25, 26) is provided at its side edges with parallel lateral flanges (52, 54) extending at least partially along the longitudinal edges of the other plates and being crimped over the other plates for clinching the plates (22, 23, 24, 25, 26) together.

8. Heat exchanger (10) according to anyone of the preceding claims, **characterized in that** an intermediate plate (24) is stacked between the manifold plate (23) and the distribution plate (25), said intermediate plate (24) comprising intermediate holes (38), each intermediate hole (38) providing communication between the manifold channel (72, 74, 76, 78) and at least one distribution slot (36).

9. Heat exchanger (10) according to the preceding claim, wherein the connection device (48) comprises at least one inlet/outlet port (44, 46), **characterized in that** said recessed portion (72, 74, 76, 78) is connected to said inlet/outlet port (44, 46) through a connecting slot (40, 42) arranged in the intermediate plate (24).

10. Heat exchanger (10) according to the preceding claim, **characterized in that** said manifold plate (23) comprises at least two substantially parallel manifold channels (72, 74, 76, 78) which are connected to the same inlet/outlet port (44, 46).

11. Heat exchanger (120) according to anyone of the preceding claims, **characterized in that** said recessed portion (72, 74, 76, 78) comprises a main longitudinal portion (80, 90, 92, 96) and at least one auxiliary portion (82, 94) connected transversally to the main longitudinal portion (80, 90, 92, 96), at least one distribution slot (36) being in communication with the main longitudinal portion (80, 90, 92, 96) through the auxiliary portion (82, 94).

12. Heat exchanger (10) according to the preceding claim in combination with claim 8, **characterized in that** an intermediate hole (38) is facing the auxiliary portion (82, 94) in order to connect said auxiliary portion (82, 94) with the corresponding distribution slot (36).

13. Heat exchanger (10) according to claim 11 or 12, **characterized in that** the auxiliary portion (82, 94) is a slit portion according to claim 4.

14. Heat exchanger (10) according to anyone of the preceding claims, wherein said heat exchanger (10) comprises a first and a second rows (R1, R2) of tubes (12), **characterized in that** the manifold plate (23) comprises at least one inlet manifold channel (72, 74) which is connected to the first row (R1) of tubes

(12) and at least one outlet manifold channel (76, 78) which is connected to the second row (R2) of tubes (12), the heat exchanger (10) being provided with a diverter box (20) opposed to the collector box (18) with regards to the tubes (12) in order to redirect the flow of refrigerant originating from the inlet manifold channel (72, 74) towards the outlet manifold channel (76, 78).

15. Method of manufacturing a heat exchanger (10) according to anyone of the preceding claims, **characterized in that** it comprises the steps of:

- extruding the manifold plate (23),
- forming the recessed portion (72, 74, 76, 78) in the manifold plate (23),
- stacking the plates together (22, 23, 24, 25),
- fixing the plates (22, 23, 24, 25) together.

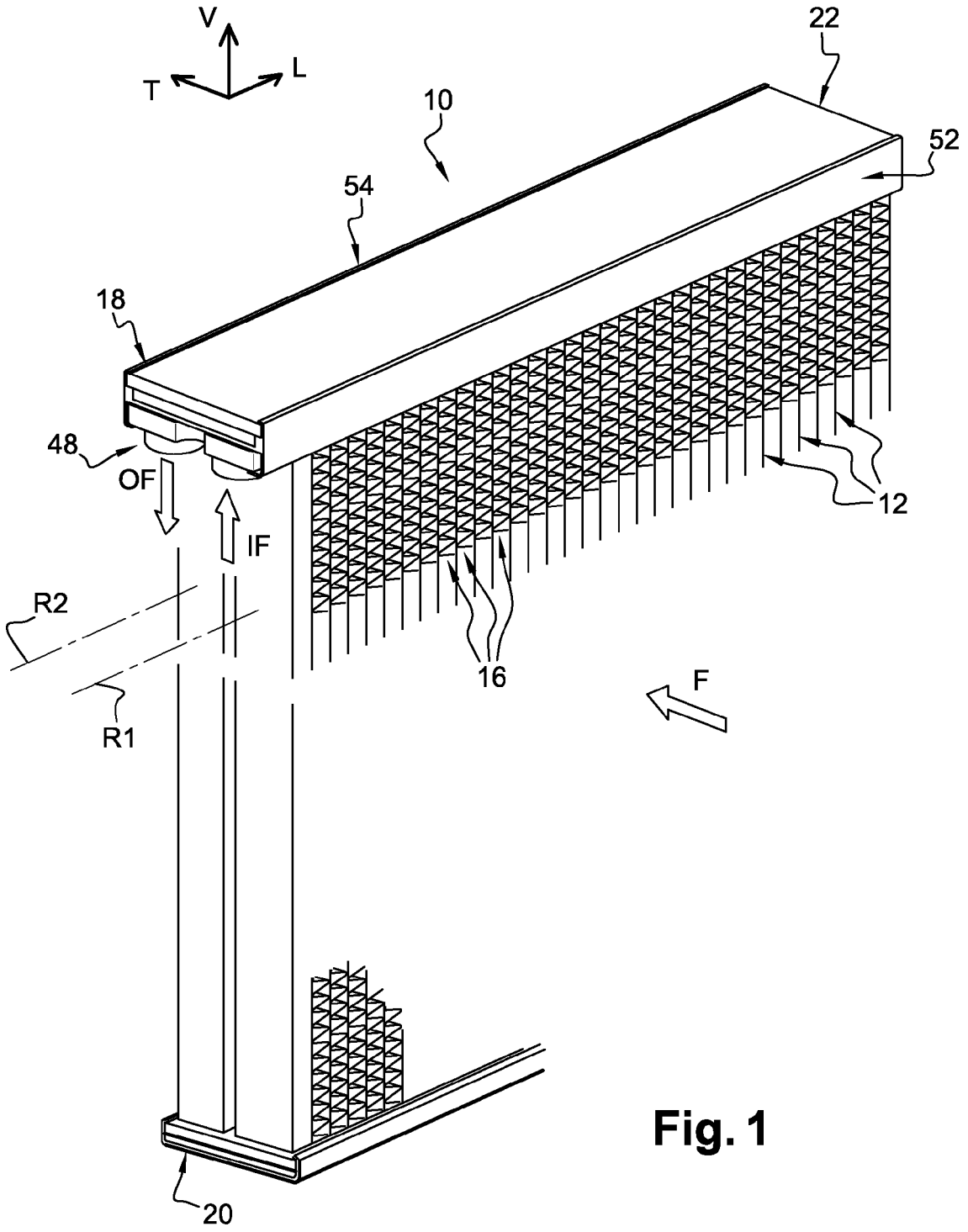

Fig. 1

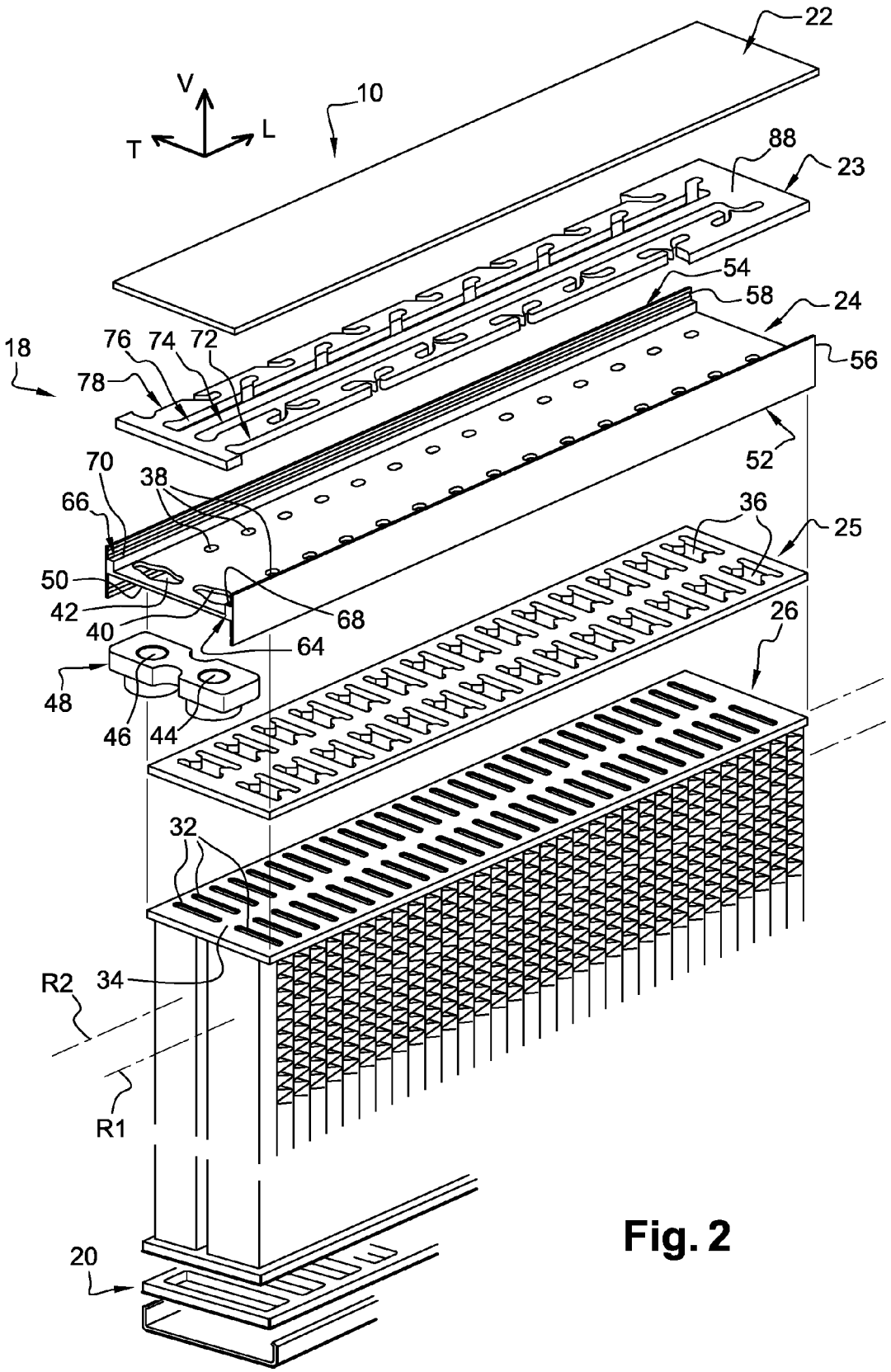
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Fig. 2

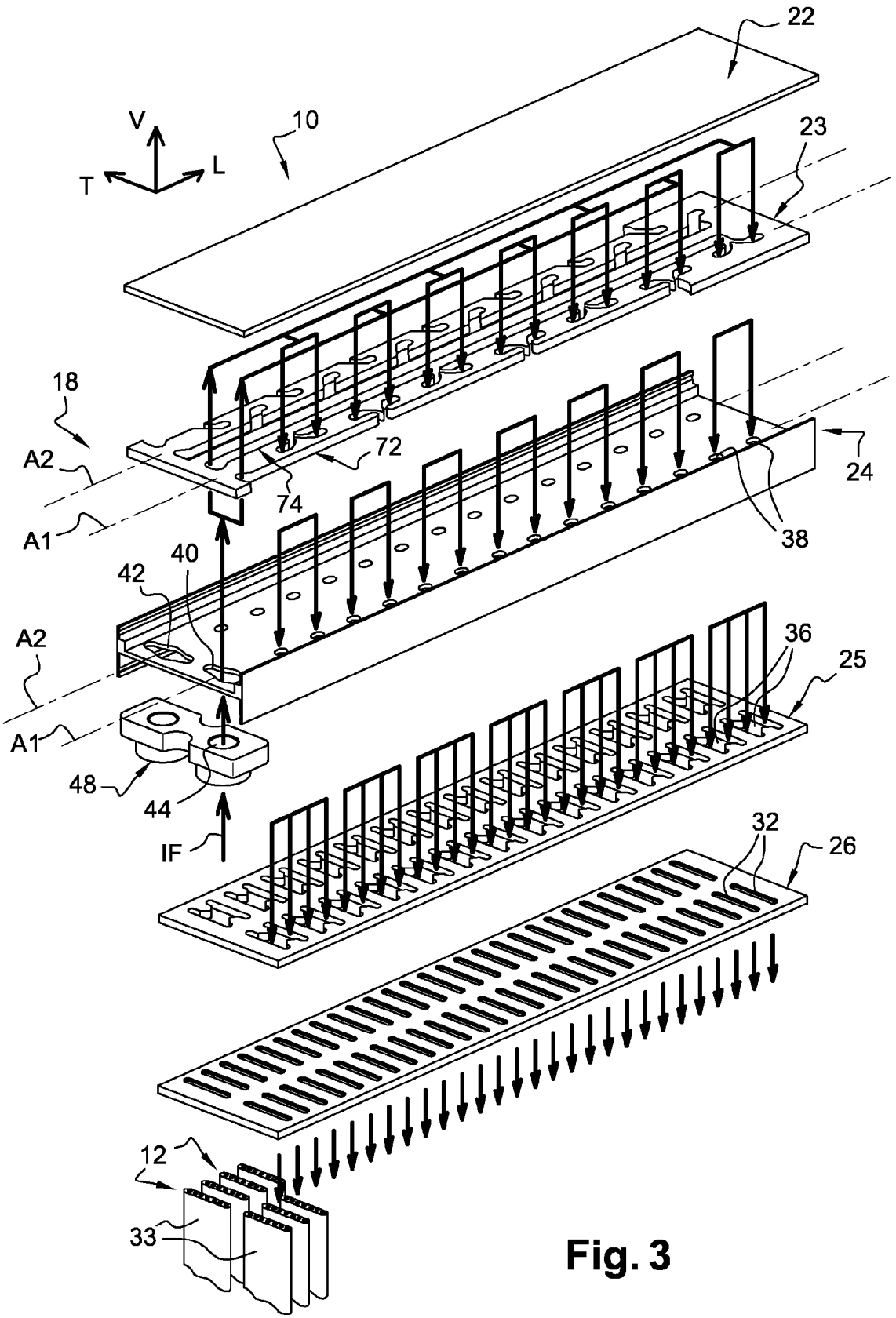

Fig. 3

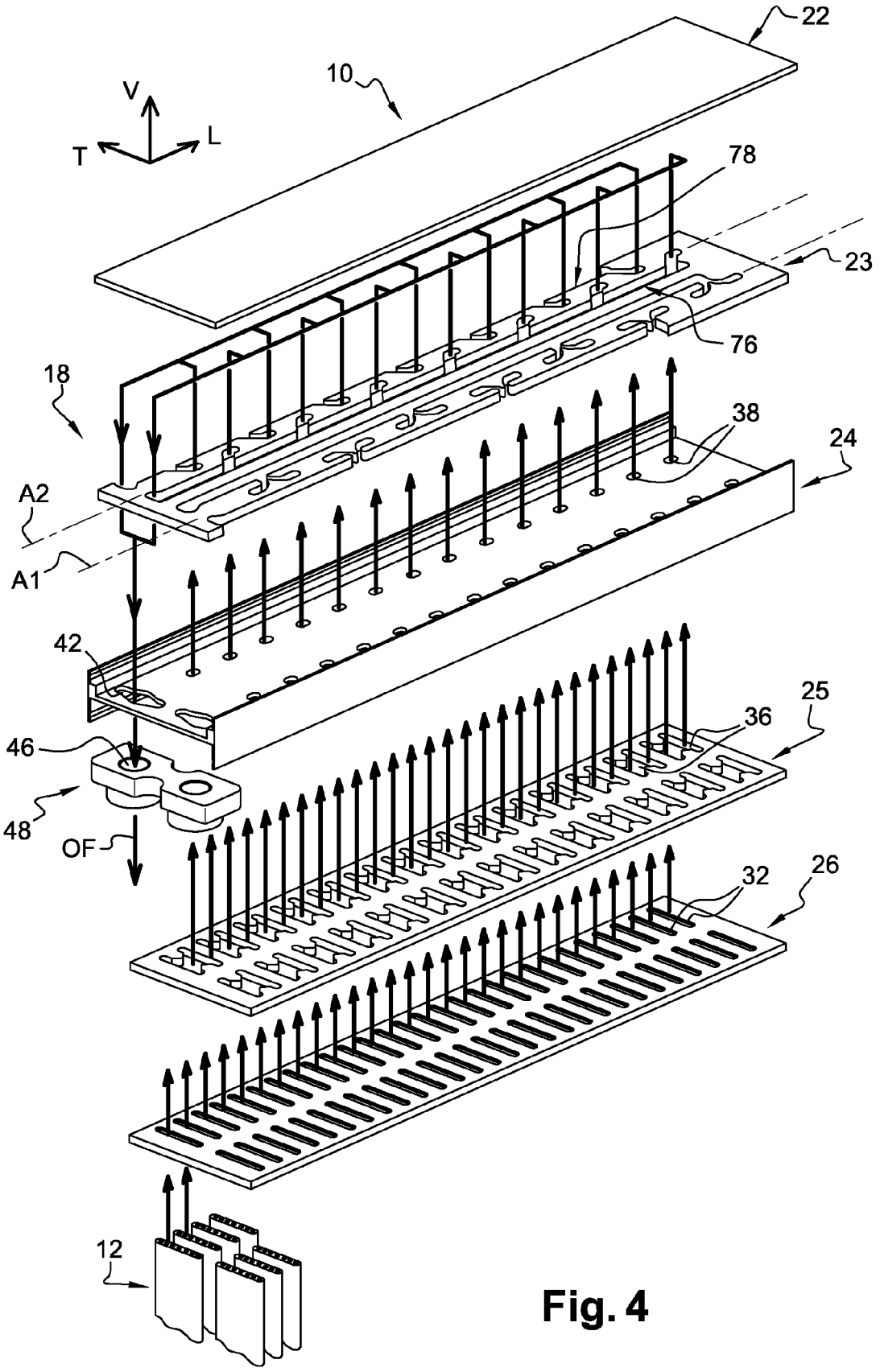

Fig. 4

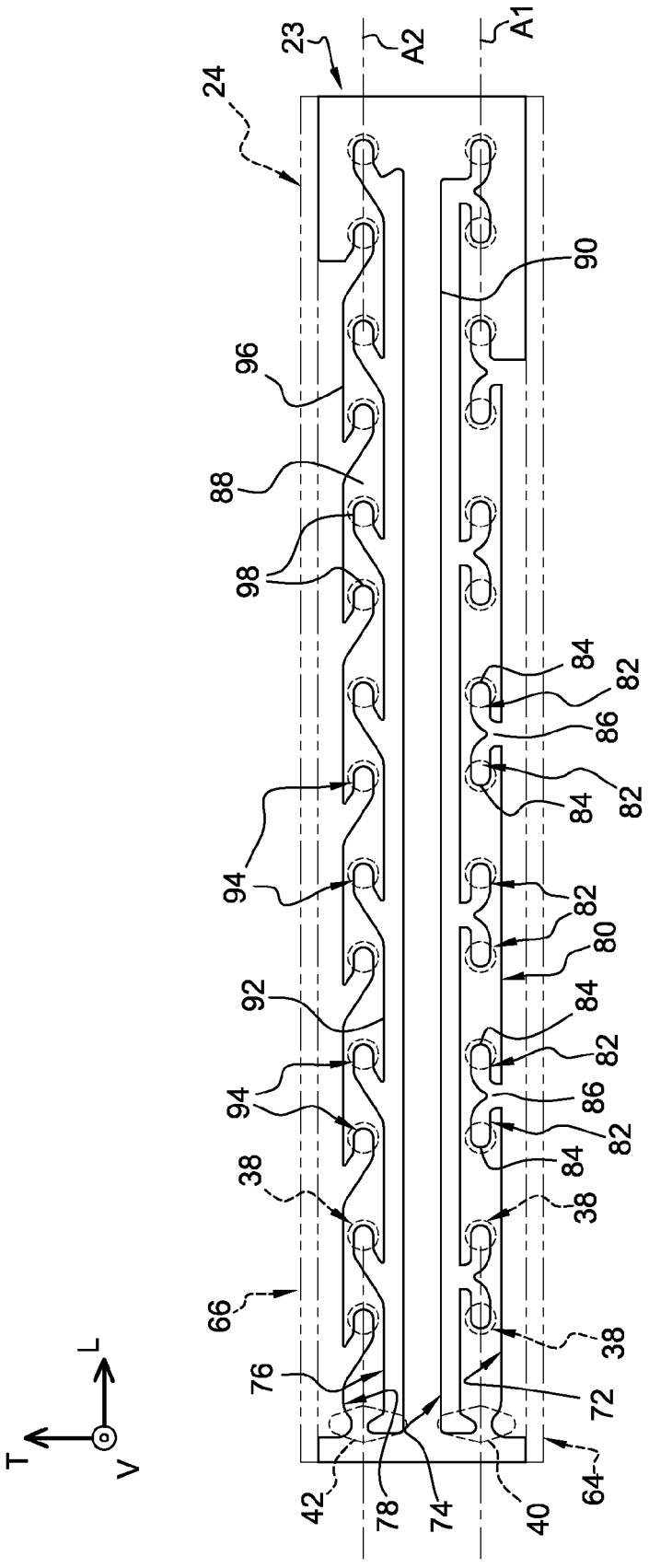

Fig. 5

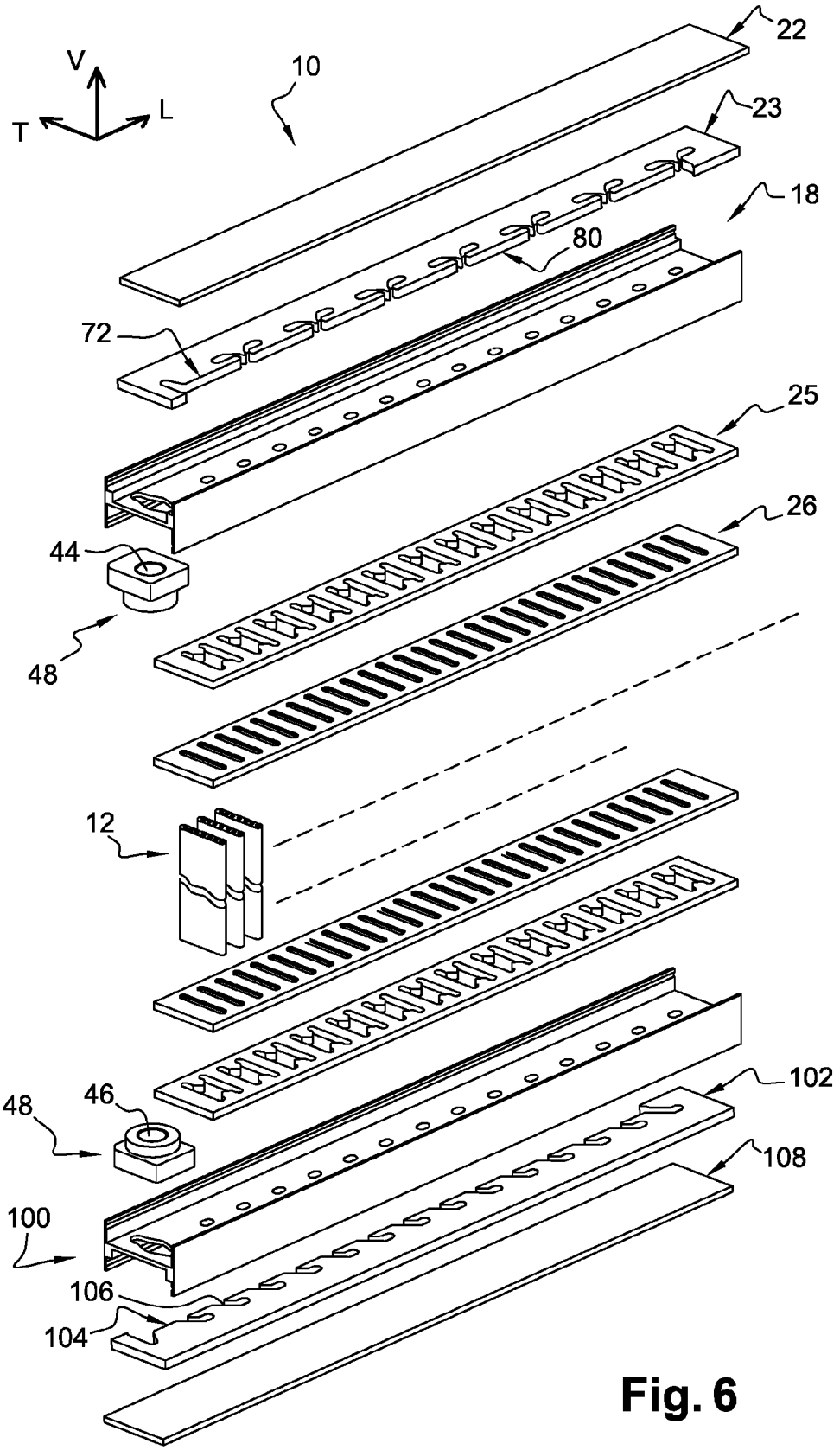

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 10 15 7289

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 Y	US 5 205 347 A (HUGHES GREGORY G [US]) 27 April 1993 (1993-04-27) * figures 1-3 * -----	1,2,4,5, 8 7	INV. F28D1/053 F28F9/02
X	JP 2005 188787 A (CALSONIC KANSEI CORP) 14 July 2005 (2005-07-14) * figures 1-11 * -----	1,10	
Y	WO 2009/124858 A1 (DELPHI TECH INC [US]; BIVER PHILIPPE [LU]; DAMOTTE HERVE [FR]) 15 October 2009 (2009-10-15) * figures 1-4 * -----	7	

TECHNICAL FIELDS SEARCHED (IPC)
F28D F28F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 November 2010	Martínez Rico, Celia

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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