



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.06.2018 Bulletin 2018/25

(51) Int Cl.:
F28F 9/02 (2006.01) F28D 1/053 (2006.01)

(21) Application number: **16398010.5**

(22) Date of filing: **13.12.2016**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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(54) **FLOW DEVIATOR IN END TANKS OF HEAT EXCHANGERS FOR THERMAL STRESS REDUCTION**

(57) A heat exchanger comprising:
a core (30; 30') comprising a plurality of parallel tubes (31; 31'),
a header plate (11; 11') having a plurality of openings, into which ends of the tubes (31; 31') are inserted, and
a header tank (10; 10') joined to the header plate (11; 11') and cooperating with the header plate (11; 11') to form a fluid inlet chamber (43; 43'), said header tank (10; 10') comprising at least one fluid inlet duct (41; 41') communicating with the fluid inlet chamber (43; 43') and an interface section (19; 19') at which the header tank (10; 10') is joined to the header plate (11; 11'), wherein the

interface section (19; 19') has a hollow, substantially rectangular cross-section defined by a plurality of walls (10a, 10e, 10c, 10d; 10a', 10b', 10c', 10d') of the header tank (10; 10').

At least one flow deviating projection (51, 52; 51'), protruding into the fluid inlet chamber (43; 43'), is formed on at least one corner between adjacent walls of the header tank (10; 10') at the interface section (19; 19') thereof, said flow deviating projection (51, 52; 51') restricting fluid flow to at least one tube (31; 31') of the core (30; 30') adjacent to said corner.

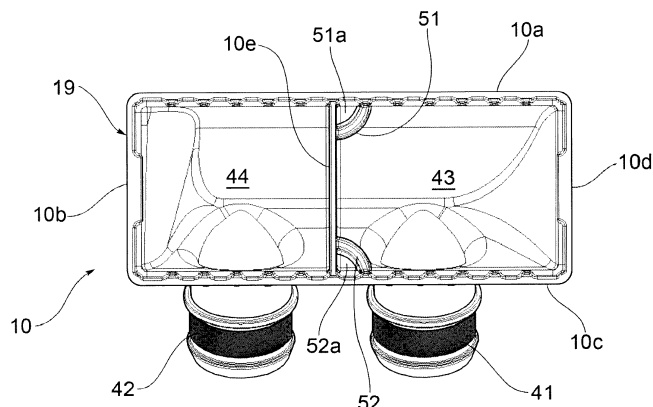


FIG.2

Description

[0001] The present invention relates generally to heat exchangers, particularly for automotive applications.

[0002] Heat exchangers are subjected to varying temperatures, sometimes quick temperature changes occur. These thermal loads affect the durability of the part.

[0003] This problem is especially problematic for U-flow heat exchangers on the area that separates the inlet (hot) and outlet (cold) flows. Thermal stresses can lead with time to the formation of failures such as leaks.

[0004] An aim of the present invention is to provide a measure to reduce thermal stresses in particular areas of heat exchangers.

[0005] Accordingly, the invention proposes a heat exchanger comprising:

a core comprising a plurality of parallel tubes, a header plate having a plurality of openings, into which ends of the tubes are inserted, and a header tank joined to the header plate and cooperating with the header plate to form a fluid inlet chamber, said header tank comprising at least one fluid inlet duct communicating with the fluid inlet chamber and an interface section at which the header tank is joined to the header plate, wherein the interface section has a hollow, substantially rectangular cross-section defined by a plurality of walls of the header tank,

wherein at least one flow deviating projection, protruding into the fluid inlet chamber, is formed on at least one corner between adjacent walls of the header tank at the interface section thereof, said flow deviating projection restricting fluid flow to at least one tube of the core adjacent to said corner.

[0006] The flow deviating projection is a feature added to the geometry of the fluid inlet chamber of the header tank. This feature reduces the mass flow of a fluid, and therefore the heat transfer on specific areas of the core, and therefore involves a thermal stress reduction on these areas.

[0007] Flow deviating features may be applied to different configurations of heat exchangers, such as U-flow heat exchangers, I-flow heat exchangers or multi-flow heat-exchangers.

[0008] Some preferred, but non-limiting, embodiments of the invention will now be described, with reference to the attached drawings, in which:

- Figure 1 is a front elevation view showing a U-flow heat exchanger;
- Figure 2 is a plan view of a header tank of the heat exchanger of Figure 1;
- Figure 3 is a perspective view showing a detail of the header tank of Figure 2;
- Figure 4 is a front elevation view of the header tank of Figure 2;

- Figure 5 is a cross-sectioned view taken along the line V-V of Figure 4;
- Figure 6 is a cross-sectioned view taken along the line VI-VI of Figure 5;
- Figure 7 is a cross-sectioned view taken along the line VII-VII of Figure 5;
- Figure 8 is a diagram showing fluid velocity distribution at the cross-section of Figure 7;
- Figure 9 is a plan view showing a header plate of the heat exchanger of Figure 1;
- Figure 10 is a front elevation view showing a I-flow heat exchanger;
- Figure 11 is a plan view showing a header tank of the heat exchanger of Figure 10; and
- Figure 12 is a plan view showing a header plate of the heat exchanger of Figure 10.

[0009] Figure 1 shows a U-flow heat exchanger, globally designated with 1, comprising an inlet/outlet header tank 10 and a return tank 20. Each tank 10, 20 is joined to a respective header plate 11, 21. The heat exchanger 1 further comprises a core 30 comprising a plurality of parallel flat tubes 31 extending between the header tanks 10, 20. Each tube 31 has opposite ends inserted into openings or slots formed in one or the other of the header plate 11, 12, respectively.

[0010] The inlet/outlet header tank 10 comprises a fluid inlet duct 41 and a fluid outlet duct 42. A fluid, for example air, water, glycol, ecc., is designed to flow from the fluid inlet duct 41 in the inlet/outlet tank 10 to the return tank 20 through a first section of the core 30, and then flow back to the fluid outlet duct 42 in inlet/outlet tank 10 through a second section of the core 30, as indicated by the arrows in Figure 1. A further fluid, for example air, is designed to flow perpendicularly to the core 30 and through gaps between the tubes 31, and exchange heat with the fluid flowing into the tubes 31.

[0011] With reference also to Figure 2, the inlet/outlet header tank 10 comprises a plurality of external walls 10a, 10b, 10c, 10d. The inlet/outlet header tank 10 cooperates with its respective header plate 11 to form a fluid inlet chamber 43 and a fluid outlet chamber 44, communicating with the fluid inlet duct 41 and the fluid outlet duct 42, respectively. A separation wall 10e, extending between opposite external walls 10a, 10c, is formed within the inlet/outlet header tank 10 to fluidically separate the fluid inlet chamber 43 from the fluid outlet chamber.

[0012] The header plate 11 is joined to the inlet/outlet header tank 10 at the level of a section 19 of the latter, which is indicated herein as interface section. This interface section 19 has a hollow, substantially rectangular cross-section defined by the external walls 10a, 10b, 10c, 10d of the inlet/outlet header tank. A portion of the interface section 19 having a hollow, substantially rectangular cross-section defined by the external walls 10a, 10c, 10d and the separation wall 10e can be identified as well in Figure 2.

[0013] With reference also to Figures 3 to 7, two flow

deviating projections 51, 52, protruding into the fluid inlet chamber 43, are formed in respective corners between the separation wall 10e and the external walls 10a and 10c, respectively, at the interface section 19 of the inlet/outlet header 10. In the illustrated embodiment, the flow deviating projections 51, 52 are hollow projections with cavities 51 a, 52a, and are formed as $\frac{1}{4}$ circle arc-shaped walls protruding from the separation wall 10e and the external walls 10a and 10c, respectively. However, other shapes are possible. Furthermore, the flow deviating projections can also be solid structures, i.e. without cavities therein.

[0014] With reference also to Figures 8 and 9, the flow deviating projections 51, 52 are dimensioned to cover - when viewed in plan view - respective end parts B1, B2 of the cross-section of at least one tube 31 adjacent to the corners at which the flow deviating projections 51, 52 are located. In this way, fluid flow to the tube(s) 31 located at positions axially aligned with the end parts B1, B2 is restricted. The dashed line in Fig. 9 represents the position of the partition wall 10e of the header tank 10.

[0015] Reduction of fluid flow in the tubes(s) 31 located on the hot side of the heat exchanger, close to the interface between hot side (first section) and cold side (second section) of the core, entails a reduction of the local thermal stresses. In fact, it has been measured that the most severe temperature gradients are found in areas located at the interface between the hot side and the cold side, close to the inlet/outlet header tank 10'. Placing flow deviating projections 51, 52 at the corners of the inlet section of the inlet/outlet header tank 10', close to the interface between hot side and cold side, will reduce fluid flow velocity in these areas. Figure 8 shows that the fluid flow velocity in a tube area L located below the flow deviating projection 51 is generally lower than the fluid flow velocities in tube areas H1 and H2 which does not have flow deviating features above them. Reducing fluid flow velocity entails heat transfer reduction in the involved areas, entailing thereby a reduction of the local thermal stresses.

[0016] Figure 10 shows a I-flow heat exchanger, globally designated with 1', comprising an inlet header tank 10' and an outlet header tank 20'. Each tank 10', 20' is joined to a respective header plate 11', 21'. The heat exchanger 1' further comprises a core 30' comprising a plurality of parallel flat tubes 31' extending between the header tanks 10', 20'. Each tube 31' has opposite ends inserted into openings or slots formed in one or the other of the header plate 11', 12', respectively.

[0017] The inlet header tank 10' comprises a fluid inlet duct 41' and the outlet header tank 20' comprises a fluid outlet duct 42'. A fluid, for example air, water, glycol, ecc., is designed to flow from the fluid inlet duct 41' in the inlet tank 10' to the fluid outlet duct 42' in the outlet header tank 20' through the core 30', as indicated by the arrow in Figure 10. A further fluid, for example air, is designed to flow perpendicularly to the core 30' and through gaps between the tubes 31', and exchange heat with the fluid

flowing into the tubes 31'.

[0018] With reference also to Figure 11, the inlet header tank 10' comprises a plurality of external walls 10a', 10b', 10c', 10d'. The inlet header tank 10' cooperates with its respective header plate 11' to form a fluid inlet chamber 43' communicating with the fluid inlet duct 41'.

[0019] The header plate 11' is joined to the inlet header tank 10' at the level of a section 19' of the latter, which is indicated herein as interface section. This interface section 19' has a hollow, substantially rectangular cross-section defined by the external walls 10a', 10b', 10c', 10d' of the inlet header tank.

[0020] With reference also to Figure 11, at least one flow deviating projection 51 (sketched with dashed lines in Fig. 11) protruding into the fluid inlet chamber 43' can be formed in at least one respective corner between adjacent external walls 10a' and 10b', 10b' and 10c', 10c' and 10d', and 10d', at the interface section 19' of the inlet header 10'. These flow deviating projections 51' can be hollow projections with cavities, and be formed as $\frac{1}{4}$ circle arc-shaped walls protruding from the external walls adjacent thereto. However, other shapes are possible. Furthermore, the flow deviating projections can also be solid structures, i.e. without cavities therein.

[0021] With reference also to Figure 12, the flow deviating projections 51 are dimensioned to cover - when viewed in plan view - respective end parts B1', B2', B3', B4' of the cross-section of at least one tube 31' adjacent to the corners at which the flow deviating projections 51' are located. In this way, fluid flow to the tube(s) 31' located at positions axially aligned with the end parts B1', B2', B3', B4' is restricted.

[0022] Placing flow deviating projections 51' at the corners of the inlet section header tank 10' has similar effects on reduction of local thermal stresses as explained in connection with Figure 8 above.

[0023] Furthermore, flow deviating projections can be used also in multi-flow heat exchangers, i.e. heat exchangers having different core sections, in which a fluid can make subsequent passages from one header tank to the other, and vice versa. In these heat exchangers header tanks are divided in different fluid flow chambers by means of separation walls, similarly to the U-flow heat exchanger described above. Analogously to the U-flow heat exchanger, one or two flow deviating projections can be formed in respective corners between a separation wall and external walls of the header tank, in the hot (inlet) chamber of the header tank.

Claims

1. A heat exchanger comprising:

- a core (30; 30') comprising a plurality of parallel tubes (31; 31'),
- a header plate (11; 11') having a plurality of openings, into which ends of the tubes (31; 31')

are inserted, and
 a header tank (10; 10') joined to the header plate
 (11; 11') and cooperating with the header plate
 (11; 11') to form a fluid inlet chamber (43; 43'),
 said header tank (10; 10') comprising at least
 one fluid inlet duct (41; 41') communicating with
 the fluid inlet chamber (43; 43') and an interface
 section (19; 19') at which the header tank (10;
 10') is joined to the header plate (11; 11'), where-
 in the interface section (19; 19') has a hollow,
 substantially rectangular cross-section defined
 by a plurality of walls (10a, 10e, 10c, 10d; 10a',
 10b', 10c', 10d') of the header tank (10; 10'),

characterised in that at least one flow deviating pro-
 jection (51, 52; 51'), protruding into the fluid inlet
 chamber (43; 43'), is formed on at least one corner
 between adjacent walls of the header tank (10; 10')
 at the interface section (19; 19') thereof, said flow
 deviating projection (51, 52; 51') restricting fluid flow
 to at least one tube (31; 31') of the core (30; 30')
 adjacent to said corner.

2. A heat exchanger according to claim 1, wherein the
 heat exchanger is a I-flow heat exchanger, and said
 at least one flow deviating projection (51') is formed
 on at least one corner of the fluid inlet chamber (43')
 between adjacent external walls (10a', 10b', 10c',
 10d') of the header tank (10').
3. A heat exchanger according to claim 1, wherein the
 heat exchanger is a U-flow or multi-flow heat ex-
 changer, and said at least one flow deviating projec-
 tion (51, 52) is formed on at least one corner of the
 fluid inlet chamber (43) between an external wall
 (10a, 10c) of the header tank (10) and a separation
 wall (10e) between the fluid inlet chamber (43) and
 an adjacent fluid flow chamber (44) of the header
 tank (10).

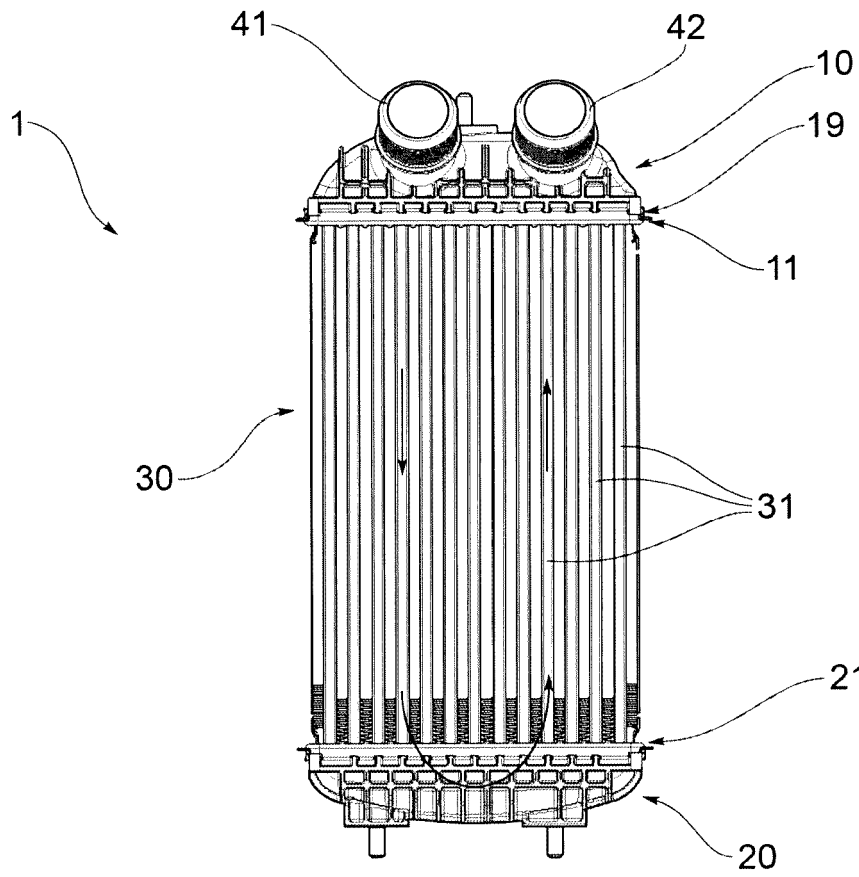


FIG.1

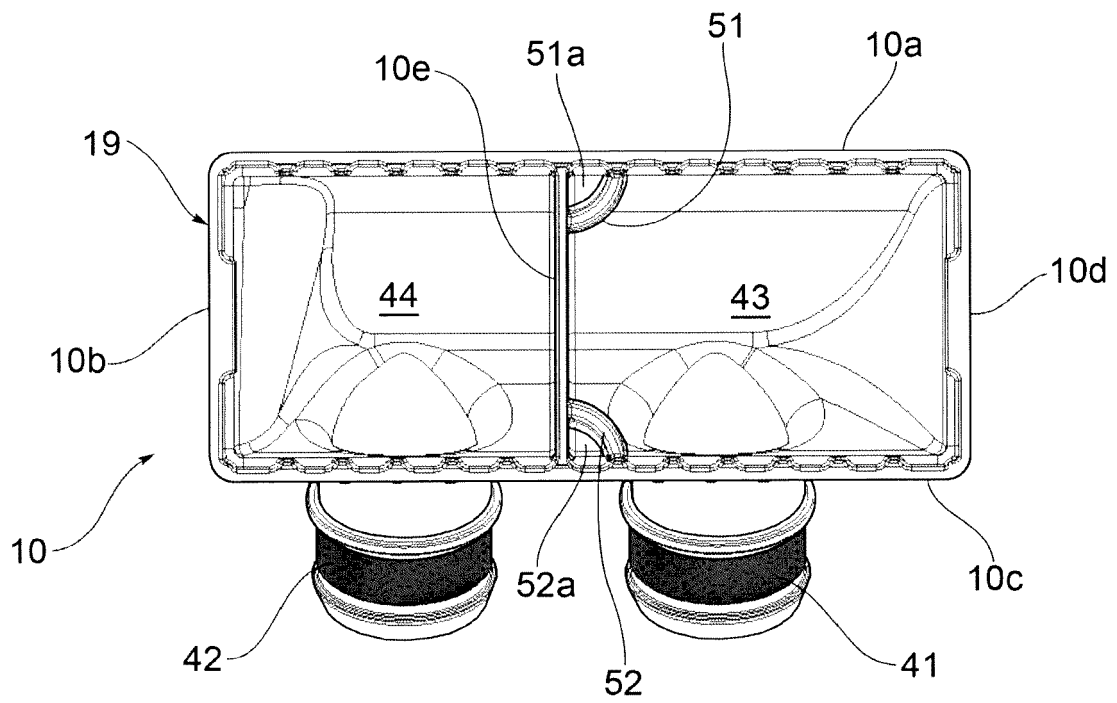


FIG.2

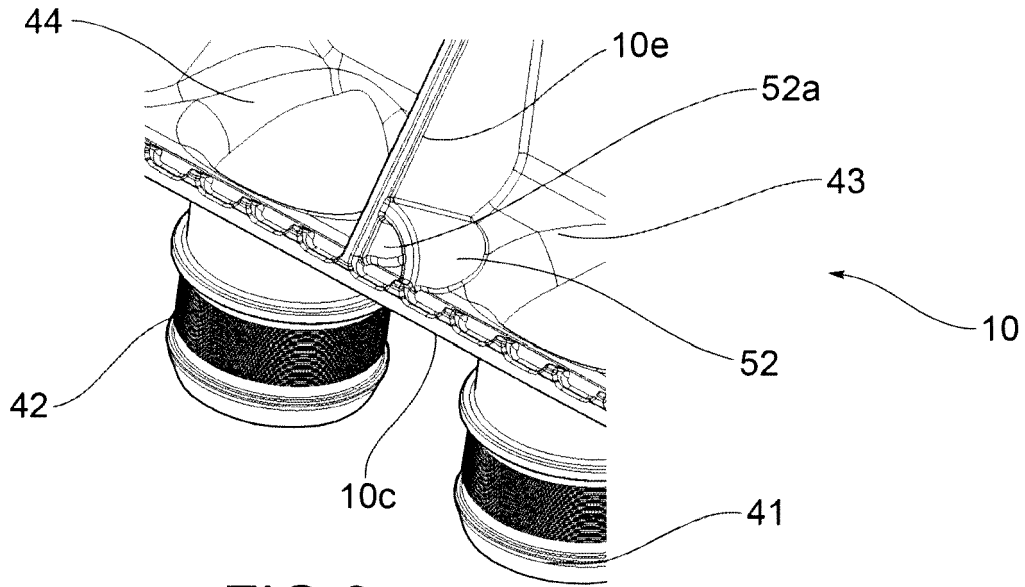


FIG. 3

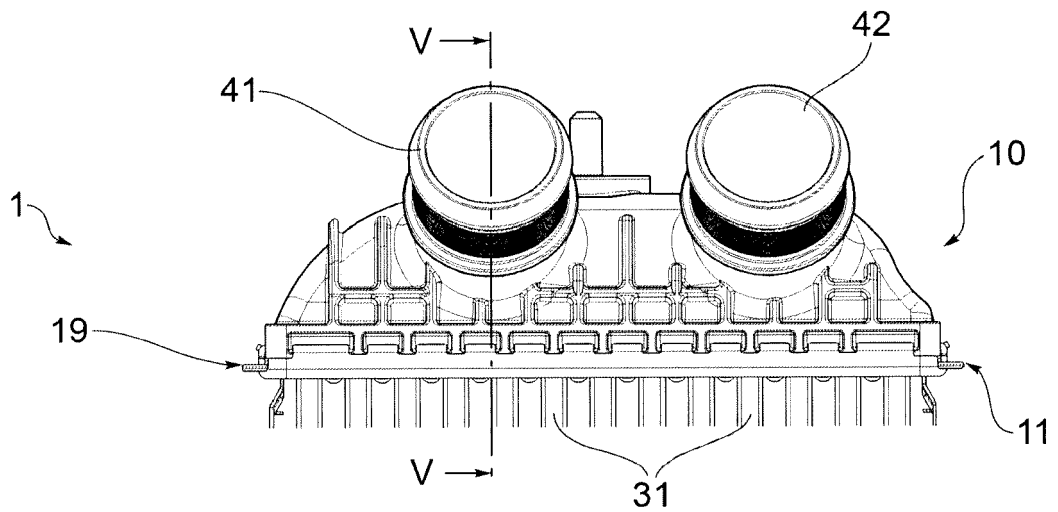


FIG. 4

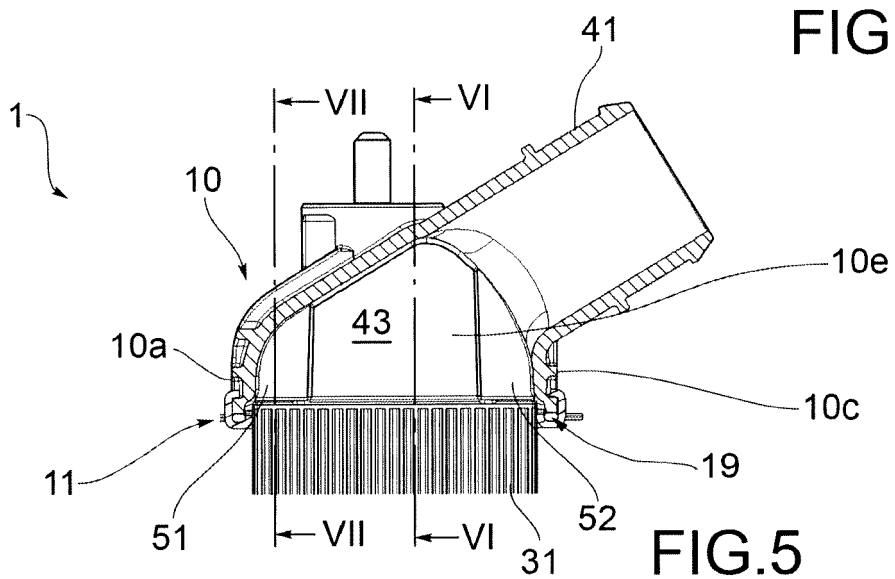


FIG. 5

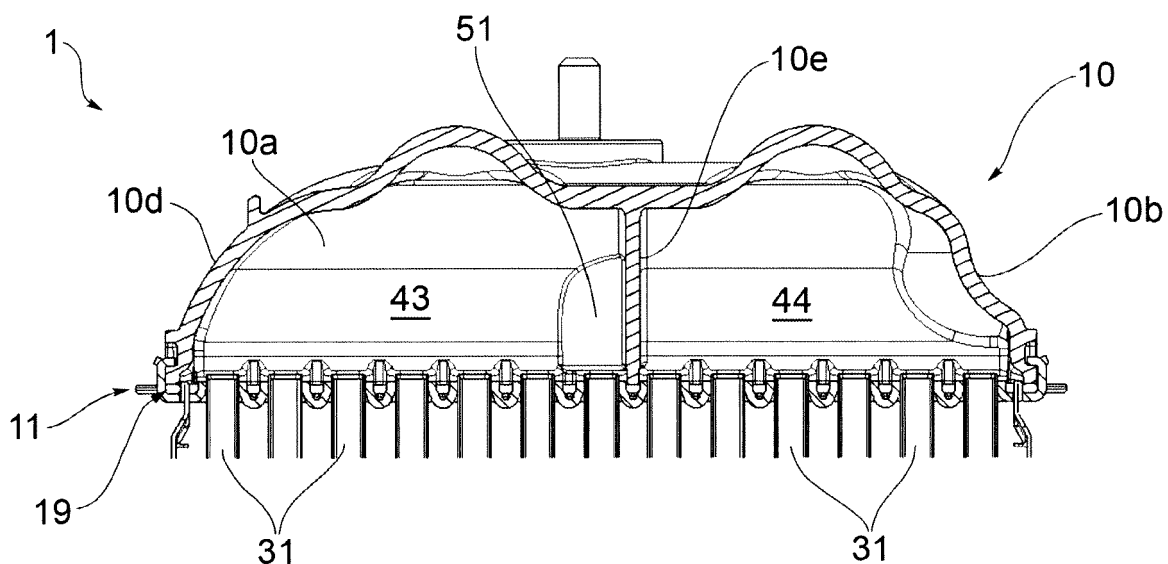


FIG. 6

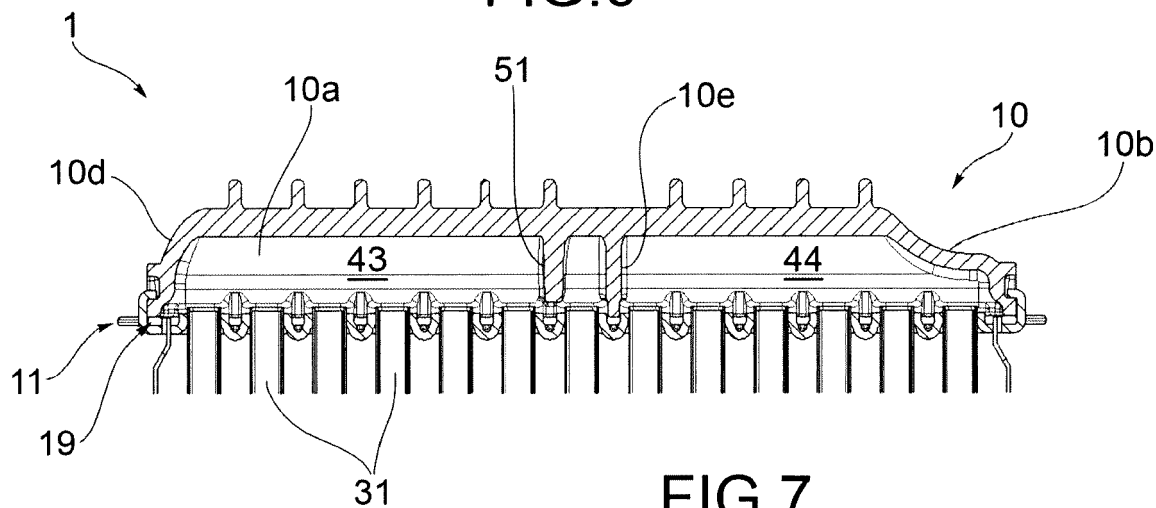


FIG. 7

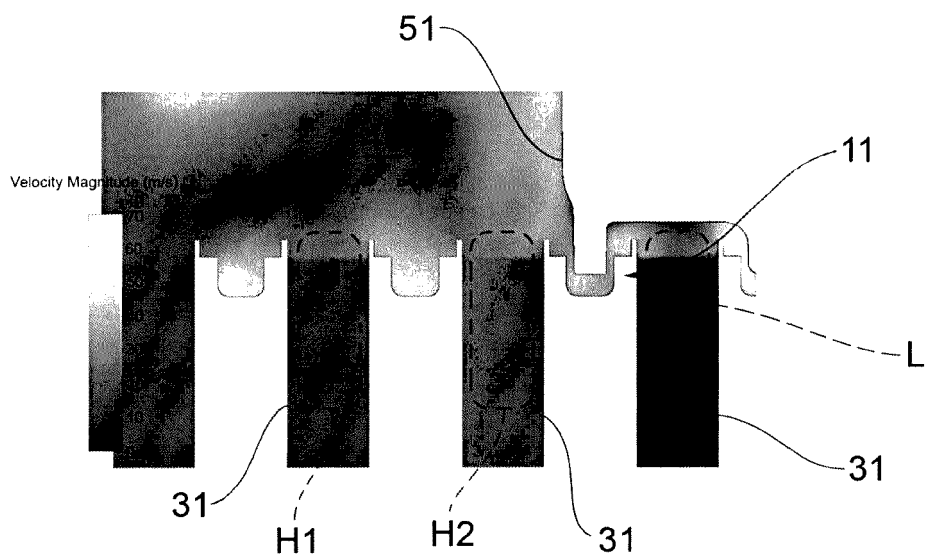


FIG. 8

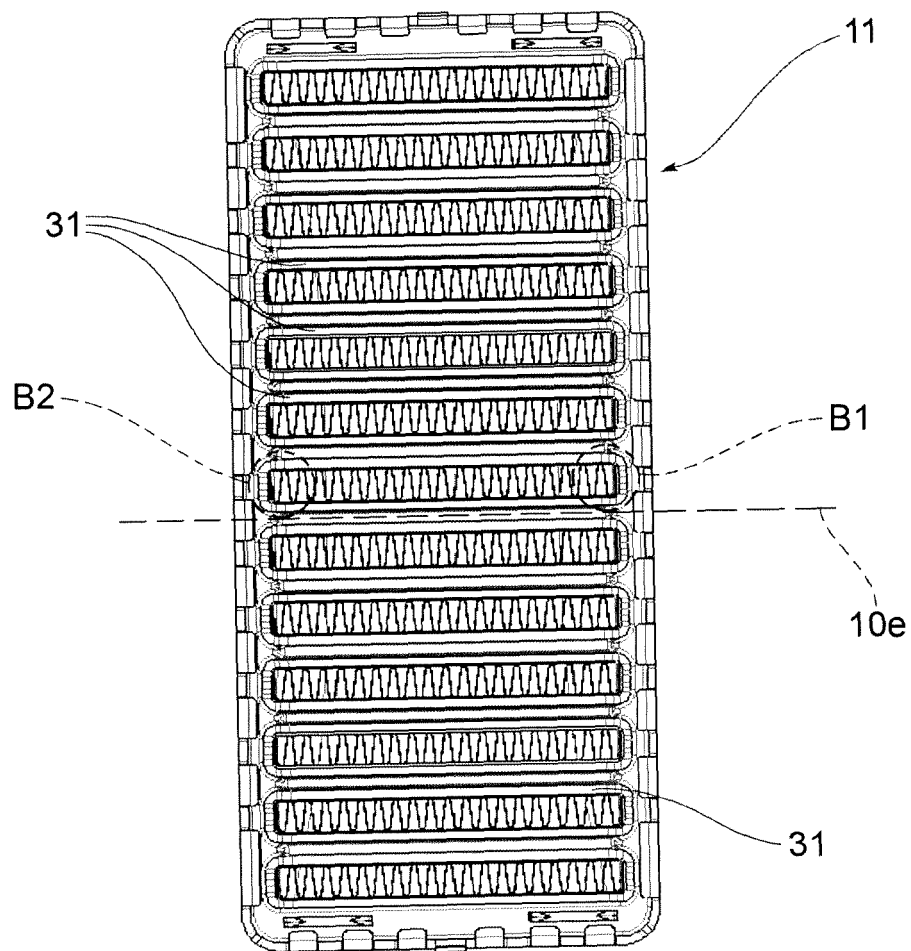


FIG. 9

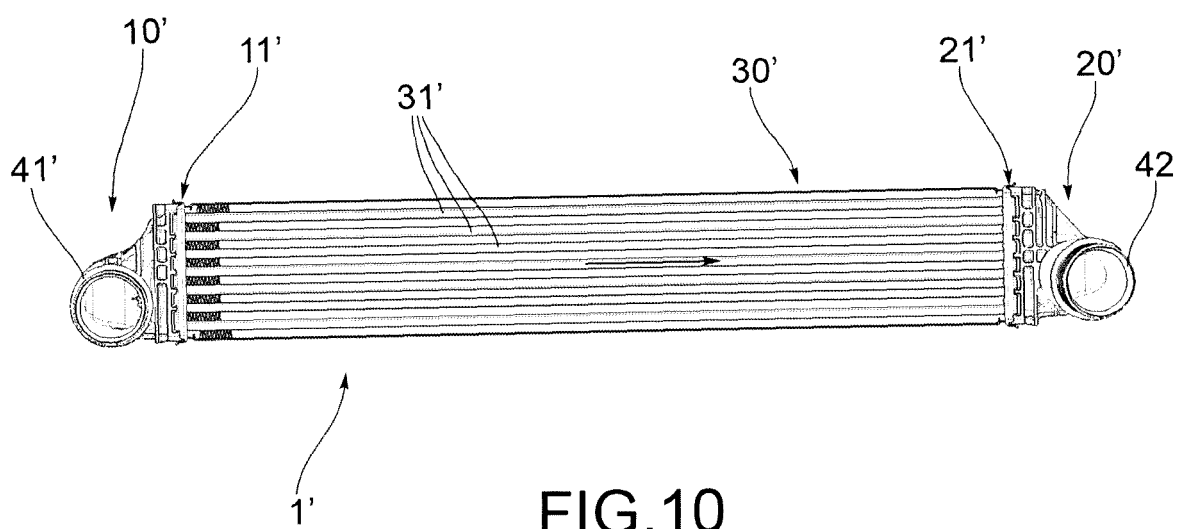


FIG. 10

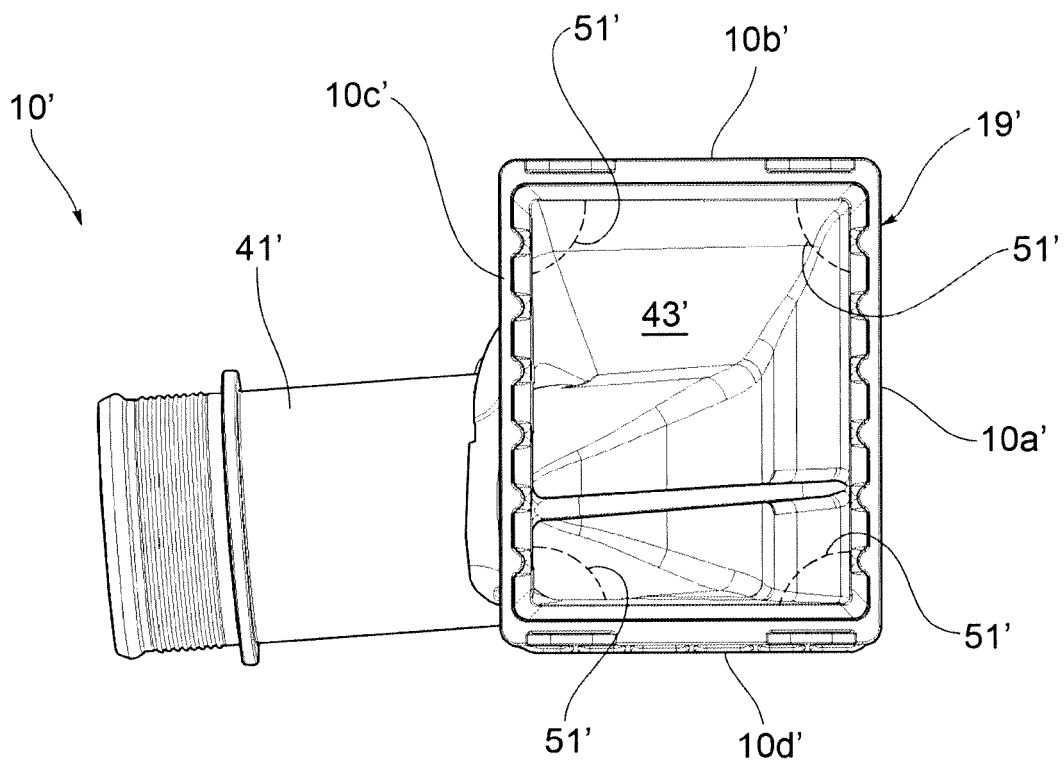


FIG.11

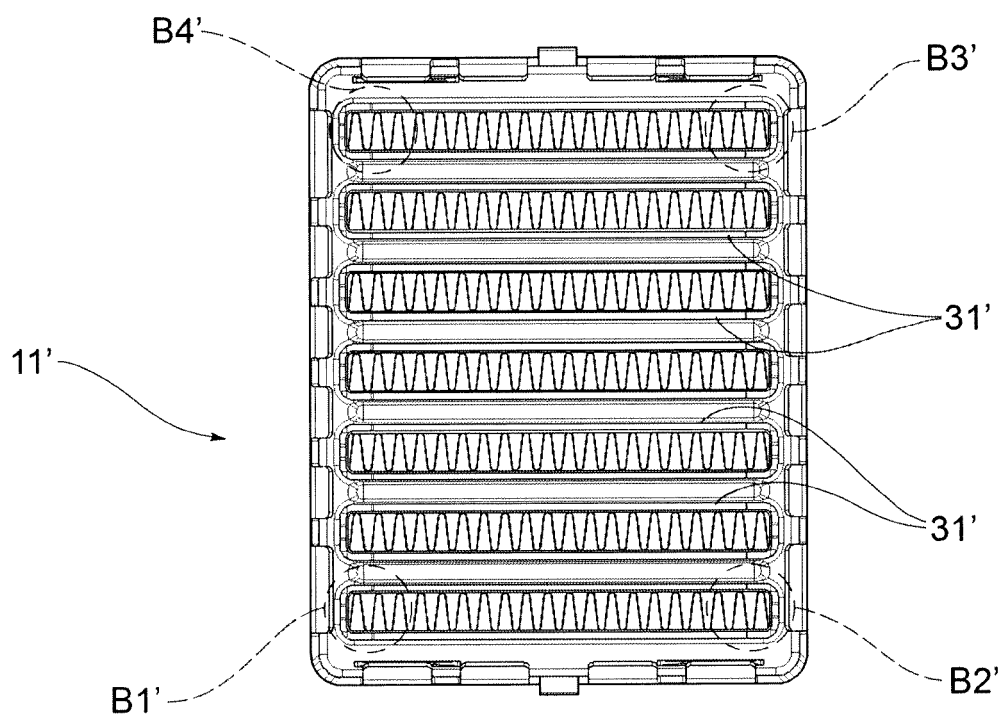


FIG.12



EUROPEAN SEARCH REPORT

Application Number
EP 16 39 8010

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 30 October 2017	Examiner Louchet, Nicolas
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			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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