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(54) **Improved heat exchanger**

(57) Heat exchanger for an automotive vehicle, comprising a tank (4,5) and a beam of tubes (8,19), received at their extremities in openings of said tank where said tubes are linked to said tank through tube to tank junctions, some of said tube to tank junctions suffering thermal stress. At least some of the tubes involved in said tube to tank junctions suffering thermal stress have a higher mechanical resistance than the other tubes.

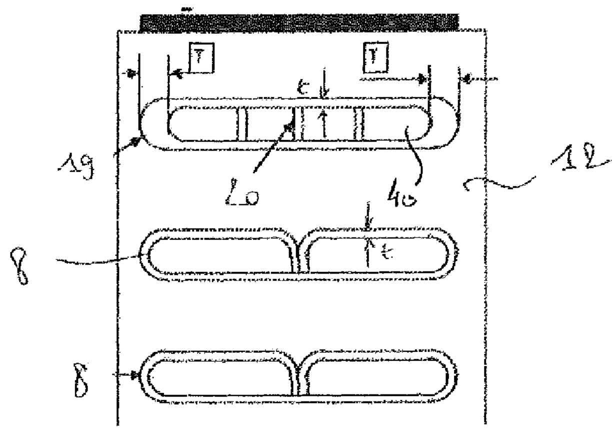

Fig.3

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Description

[0001] The invention concerns heat exchangers, and particularly heat exchangers for the automobile industry.

[0002] Typically, heat exchangers for automotive vehicles comprise a beam of tubes for circulating a heat exchange fluid, between two boxes also called tanks or collectors. The challenge in the design of heat exchangers is based on making the right trade-offs to ensure the best perfonnance/packaging/endurance ratio.

[0003] This is particularly the case in the field of double heat exchangers, where a first part of the radiator circulates a heat exchange fluid at a first, high temperature, and a second part of the radiator circulates the heat exchange fluid (or another one) at a second, low temperature.

[0004] This type of radiator has many packaging advantages, yet their design is challenging, because they are subject to high stress in the region of separation between the high temperature region and the low temperature region.

[0005] However, as the designs of the heat exchangers have improved, issues relating to local stress have spread to regular heat exchangers, having single or multiple passes, as their dimensions where increasingly reduced to accommodate smaller packaging and lower weight.

[0006] Many designs have been tried to deal with these problems:

- use of two neighboring baffles in both tanks, thereby generating dead tubes, and in which tightness of the tanks is hard to ensure, and tank assembly process is complicated,
- use of tank profile modification, by brazing the collector and the header forming the tank to provide a baffle, which complicates the tank assembly,
- use of a region separating baffle in both tanks, jointly with corks in the adjoining tubes, in order to reduce the flow in these regions, which among other drawbacks greatly complicates the radiator and tank assembly,
- use of a region separating baffle in both tanks, the baffle also covering several tubes to provide dead tubes, and being complemented with tightness gaskets, which an expansive solution with a complicated assembly,
- use of inserts for creating dead tubes, which greatly complicates the assembly,

etc.

[0007] It is obvious from the mere length of the above list that no satisfactory solution has been found so far to provide a good local reinforcement of the tank/tube junction while limiting pressure drop, cost increase and assembly complication.

[0008] The invention improves this situation.

[0009] To meet this goal, the invention proposes a heat exchanger for an automotive vehicle, comprising a tank and a beam of tubes, received at their extremities in openings of said tank where said tubes are linked to said tank through tube to tank junctions, some of said tube to tank junctions suffering thermal stress characterized in that at least some of the tubes involved in said tube to tank junctions suffering thermal stress have a higher mechanical resistance than the other tubes.

[0010] According to the invention, the mechanical resistance of the heat exchanger is thus enhanced in the areas suffering thermal stress by the tubes themselves. And the risk of failure due to thermal stress is lowered without additional parts or complicated designs. Pressure drop increase is also limited.

[0011] Preferably, said tubes having higher mechanical resistance are extruded tubes and said other tubes are folded tubes.

[0012] Other characteristics and advantages of the invention will appear from the following description of drawings, given by way of example and in a non limitative way.

[0013] In the drawings:

- figure 1 shows a schematic view of a heat exchanger according to the invention,
- figure 2 shows a schematic cross-sectional view of a locally reinforced region of the heat exchanger of figure 1,
- figure 3 shows a top view of the region of figure 2,
- figure 4 and 5 show two further embodiments of a heat exchanger according to the invention, and
- figure 6 shows a schematic cross-sectional view of a locally reinforced region of the heat exchanger of figures 4 and 5.

[0014] The drawings and the following description essentially comprise elements having a defining character. Thus, they may serve to enhance the comprehension of the invention, but also to help defining it, in some cases.

[0015] Figure 1 shows a schematic view of a heat exchanger 2 according to the invention. Heat exchanger 2 is a single pass radiator for air cooling, which comprises tanks 4 and 5 and a beam 6 comprised of tubes 8.

[0016] As appears on figure 2, tanks 4 and 5 each comprise a cover 10 received in a collector 12. Tank 4 comprises a heat exchange fluid input 14, and tank 5 comprises a heat exchange fluid output 16.

[0017] The beam 6 is made of tubes 8 which are generally long, and parallel between them. Each tube 8 is received in a respective opening of tanks 4 and 6. Between tubes 8, fins are arranged, which enhance the heat exchange surface, and which are not represented here for simplicity.

[0018] The tubes 8 are generally made of aluminium are made by folding of a sheet unto itself, thus forming two channels, as can be seen on figure 3. Beam 6 comprises specific tubes in regions referenced by the number 18 located at the tank end.

[0019] In the regions 18, the stress level due to mechanical constraints and temperature shocks is such that the regular folded tubes 8 may break. In order to overcome this problem, the Applicant has found that specific tubes 19 which appear more readily on figures 2 and 3 solves all the resistance issues.

[0020] The tubes 19 are made by an extrusion technique. This is particularly advantageous, because it allows designing tubes which have a different cross-section, as well as several ribs for strengthening, for instance two or more ribs, defining channels 40 for fluid circulation.

[0021] In the example shown on figure 2, tube 19 comprises 3 ribs 20, each having a thickness of 0.35mm. In various embodiments, the number of ribs may be comprised between 2 and 12, and preferably is more than 7 and less than 12. In various embodiments, the thickness of ribs 20 may be chosen between 0.15mm and 3mm, and more preferably between 0.2mm and 1.5mm.

[0022] The tube 19 has a radial wall thickness T of 1.5mm and a transverse wall thickness t of 0.35mm. In various embodiments, the radial wall thickness T may be chosen between 0.225mm and 5mm, and more preferably between 0.75mm and 3mm. In various embodiments, the transverse wall thickness t may be chosen between 0.15mm and 3mm, and more preferably between 0.2mm and 1.5mm.

[0023] In general the radial wall thickness T is chosen to be at least bigger than 1.5 times that of the transverse wall thickness t. Preferably, the wall thickness ratio is chosen to be at least bigger than 2, and less than10.

[0024] The tube 19 resistance in terms of thermal shock elongation and compression is defined by its number of ribs, their thickness, the radial wall thickness T and the transverse wall thickness t.

[0025] The adjustment of the tube parameters will vary according to the application which is considered, and the specific heat dissipation sought. However, the wall thickness ratio will remain in the above mentioned ranges.

[0026] The cross section of the radial walls of the extruded tubes may be circular as regards the external side thereof and circular and/or elliptic as regards the internal side thereof. In other words, the channels 40 extending laterally may have a circular and/or elliptic side wall along the tube lateral sides.

[0027] In other embodiments, regions 18 may be further strengthened by providing more than one tube 19, e.g. 2 to 4 tubes. Since the regions 18 are located at the extremity of the tanks, the use of the tubes 19 does not complicate the assembly of the heat exchanger.

[0028] Figures 4 and 5 show two other embodiments according to the invention. In those figures, tanks 4 and 6 are similar to those of figure 1, but have additional elements.

[0029] In figure 4, tank 4 further comprises a baffle 22 and a further heat exchange fluid input and/or output 24, the heat exchanger thus being a two-pass heat exchanger. In figure 5, tank 5 also further comprises a baffle 26 and a further heat exchange fluid input and/or output 28, the heat exchanger thus forming a double heat exchanger.

[0030] The beam of the heat exchangers of figures 4 and 5 show further local stress regions referenced 30. Figure 6 shows a top view of a region 30, from the inside of tank. In the example shown in figure 6, it is the region 30 of figure 4 or 5 which is represented, and baffle 22 is shown accordingly.

[0031] In the region 30, the baffle 22 is arranged between two openings of tank 4. Since the heat exchange fluid circulating in the heat exchanger will show significant difference in temperature, the tubes in the region 30, i.e. the tubes received in the opening neighboring baffle 22, are subject to a high level of stress, similarly to tubes 19 of regions 18.

[0032] In order to address these stress issues, region 30 comprises tubes 32 received in the openings which surround baffle 32. While the use of a baffle does complicate the assembly process, no other satisfactory solution exists to this day. Also, the use of tubes 32 allows better stress resistance, and ensures tightness of the heat exchanger, thus providing the best trade-off in terms of assembly and resistance.

[0033] The tubes 32 are similar to tubes 19, i.e they are built by an extrusion technique. Furthermore, they have identical dimensions in the example shown here, and they may be made with dimensions within the previously described ranges, including the number of ribs.

[0034] Also, while the region 30 shown in figure 6 comprises only one tube 32 on each side of baffle 22, it may comprise more than one tube 32 on each side, e.g. 2 to 4. Further, there may be more tubes 32 on one side of baffle 22 than on the other side, e.g. 1 or 2 tubes 32 on one side, and 3 or 4 tubes 32 on the other sides.

[0035] While the invention above has been described with respect to specific embodiments, it should be understood that they can be combined, and that the present specification discloses all of the possible combinations of those specific embodiments.

Claims

1. Heat exchanger for an automotive vehicle, comprising a tank and a beam of tubes, received at their extremities in openings of said tank where said tubes are linked to said tank through tube to tank junctions, some of said tube to tank junctions suffering thermal stress **characterized in that** at least some of the tubes involved in said tube to tank junctions suffering thermal stress have a higher mechanical resistance

than the other tubes.

2. Heat exchanger according to claim 1 where said tubes having higher mechanical resistance are extruded tubes and said other tubes are folded tubes.

3. Heat exchanger according to claim 2, wherein said extruded tubes have a radial wall thickness to transverse wall thickness ratio superior or equal to 1.5.

4. Heat exchanger according to claim 3, wherein said radial wall thickness is chosen within the range of 0.225mm to 5mm, and more preferably between 0.75mm and 3mm.

5. Heat exchanger according to claim 3, wherein said radial wall thickness is equal to 1.5mm.

6. Heat exchanger according to any of the claims 2 to 5, said transverse wall thickness being within the range of 0.15mm to 3mm, and more preferably between 0.2mm and 1.5mm.

7. Heat exchanger according to any of the claims 2 to 5, wherein said transverse wall thickness is equal to 0.35mm.

8. Heat exchanger according to any of the claims 2 to 7, wherein said extruded tubes comprise a chosen number of ribs, each rib having a thickness chosen within the range of 0.15mm and 3mm, and more preferably between 0.2mm and 1.5mm, the number of ribs beings chosen between 2 and 12, and preferably between 7 and less than 12.

9. Heat exchanger according to claim 8, wherein the number of ribs is 3, and wherein the thickness of each rib is 0.35mm.

10. Heat exchanger according to any of the claims 2 to 9, wherein said extruded tubes are located at both ends of said beam.

11. Heat exchanger according to any of the claims 2 to 10, further comprising at least one baffle located between two openings of a tank, wherein the tubes received in these two openings are extruded tubes.

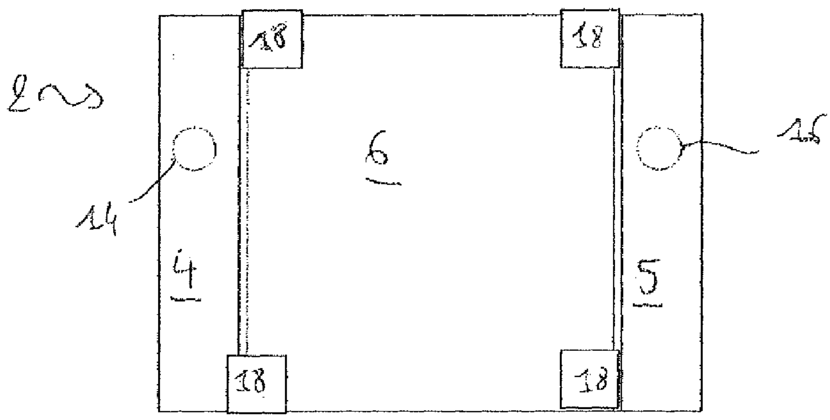

Fig.1

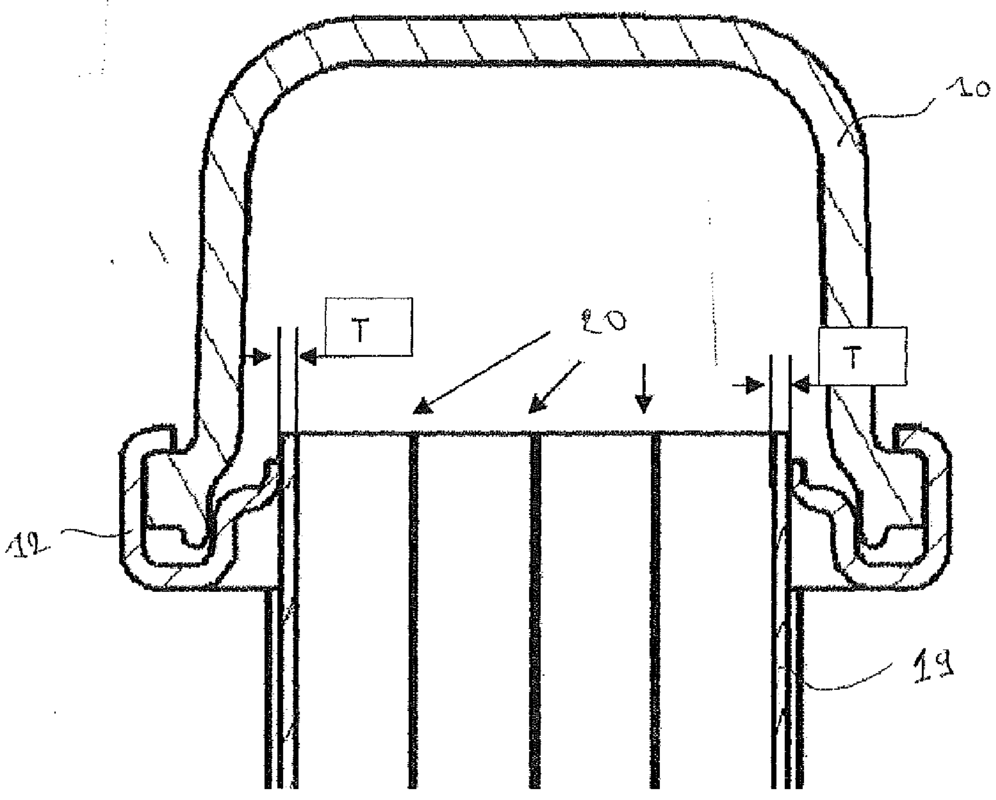

Fig.2

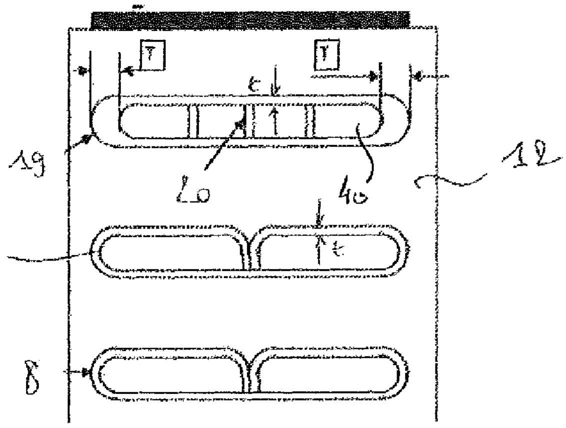

Fig.3

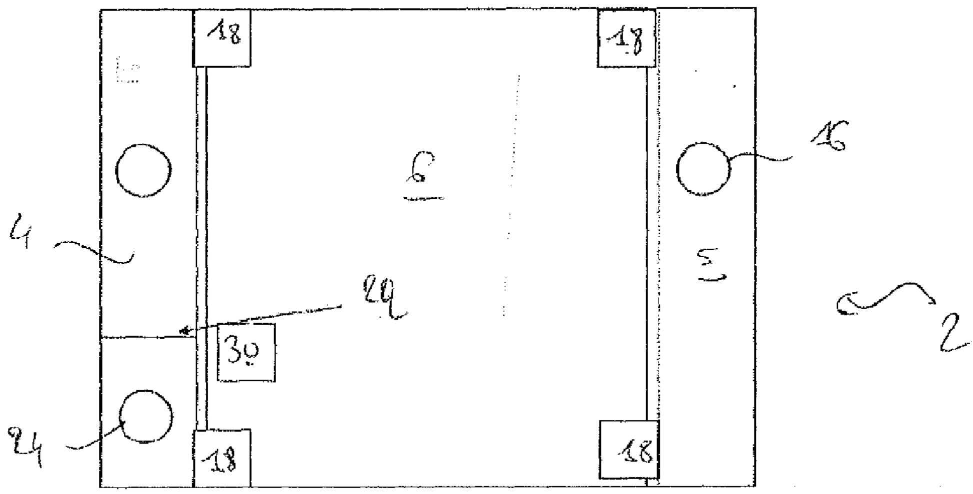

Fig.4

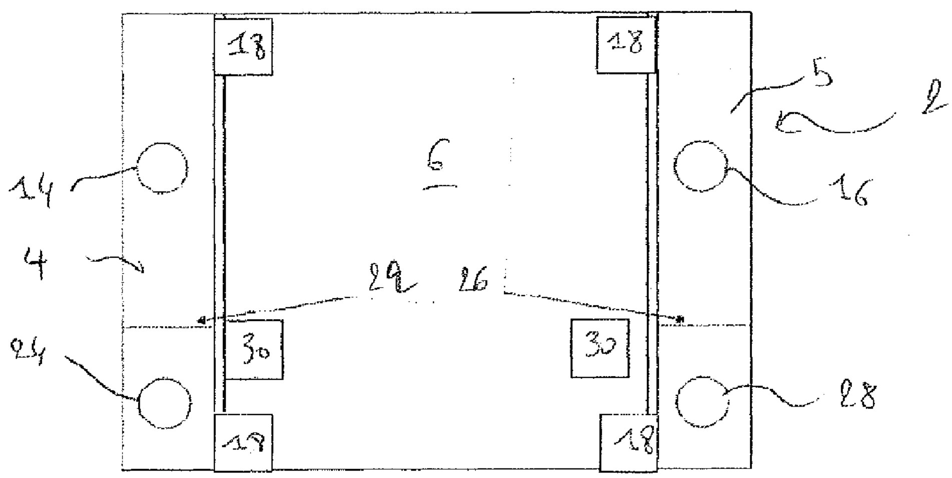

Fig.5

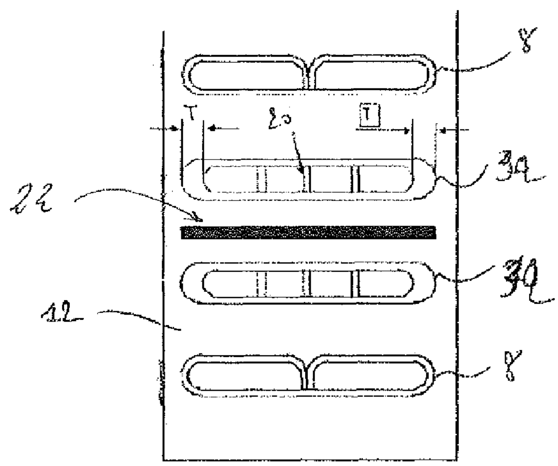

Fig.6

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EUROPEAN SEARCH REPORT

Application Number
EP 10 46 1512

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	JP 2001 153571 A (DENSO CORP; TOKYO ELECTRIC POWER CO; CENTRAL RES INST ELECT) 8 June 2001 (2001-06-08) * abstract; figures 1,2,11 * -----	1,2 4	INV. F28D1/03 F28D1/053 F28F9/02 F28F1/02
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			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	11 November 2010	Martínez Rico, Celia

CATEGORY OF CITED DOCUMENTS

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