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ROD et al.(10) **Pub. No.: US 2012/0000634 A1**(43) **Pub. Date: Jan. 5, 2012**(54) **HEAT EXCHANGER****Publication Classification**(76) Inventors: **Janusz ROD**, Krakow (PL);
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(DE)(51) **Int. Cl.**
F28F 9/02 (2006.01)(52) **U.S. Cl.** **165/173**(57) **ABSTRACT**(21) Appl. No.: **13/076,770**(22) Filed: **Mar. 31, 2011**(30) **Foreign Application Priority Data**

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A heat exchanger for an automotive vehicle comprises a tank and a beam of tubes, received at their extremities in openings of the tank where the tubes are linked to the tank through tube to tank junctions. Some of the tube to tank junctions suffer thermal stress. At least some of the tubes involved in the tube to tank junctions suffering thermal stress have a higher mechanical resistance than the other tubes.

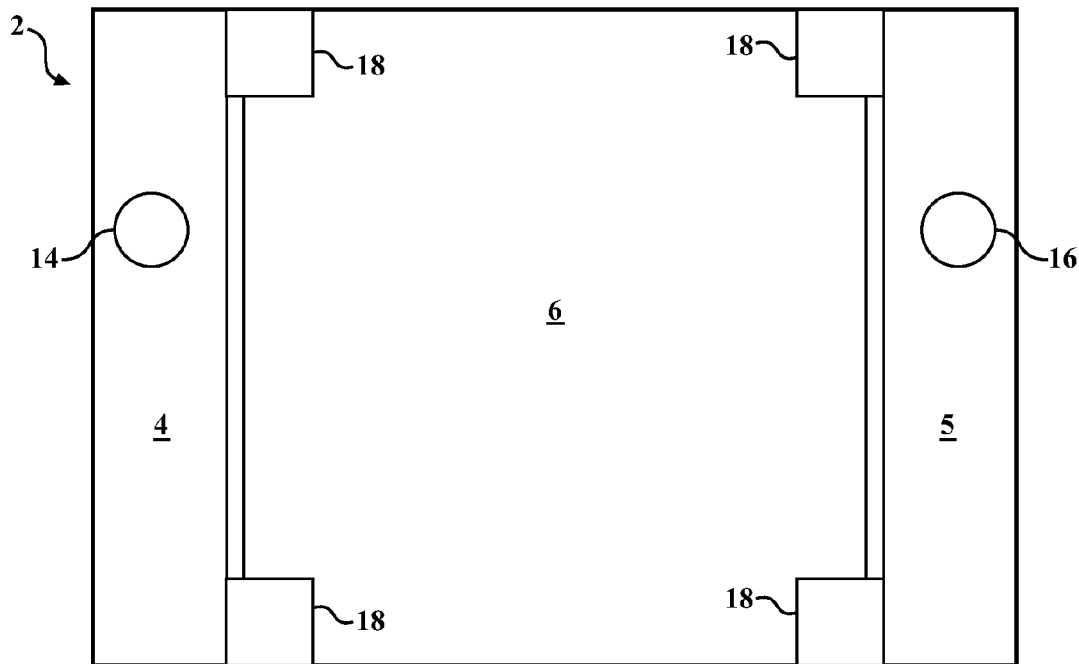


FIG. 1

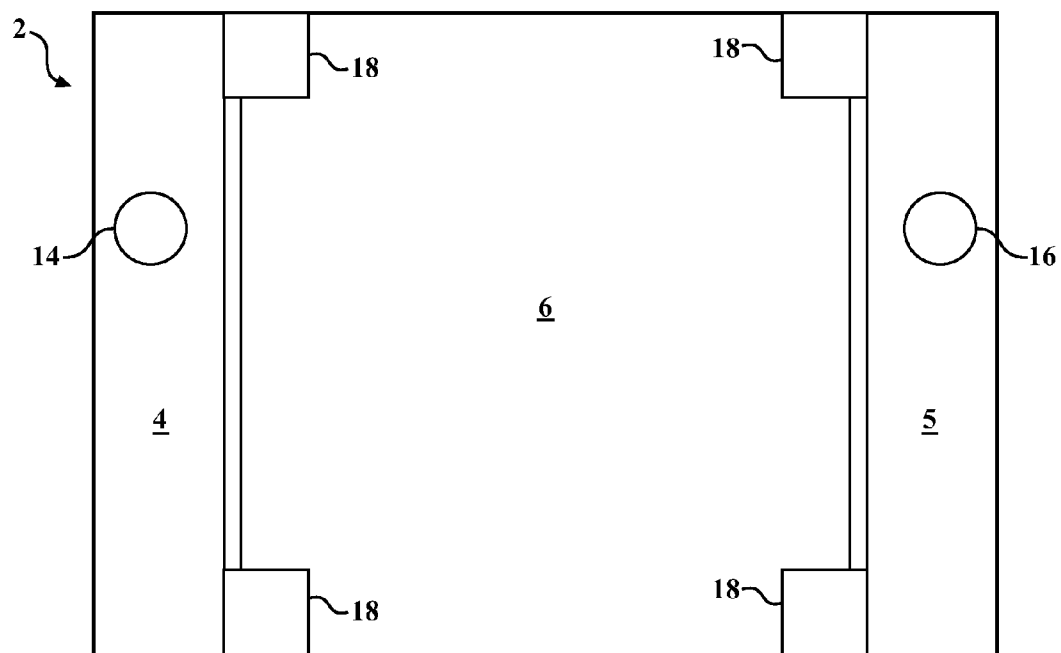


FIG. 2

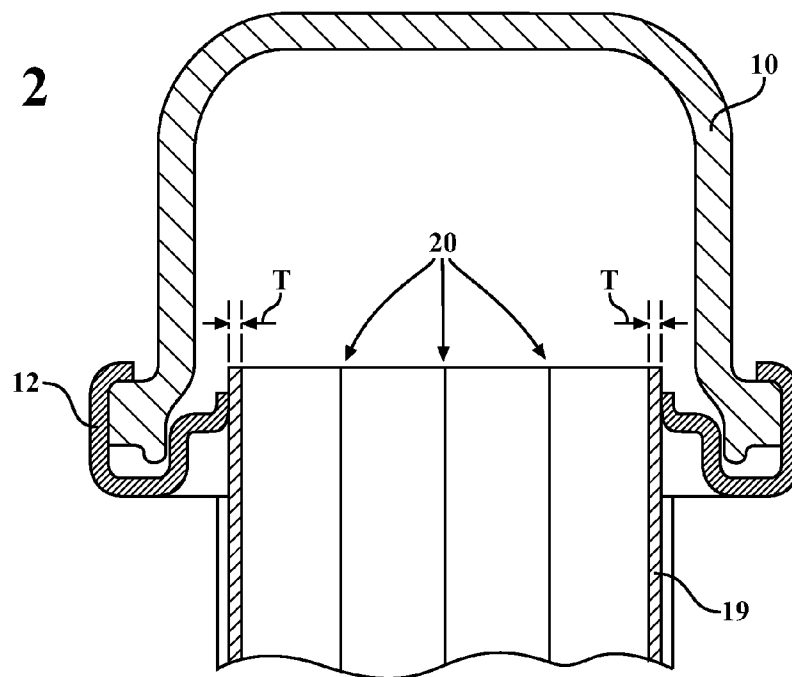


FIG. 3

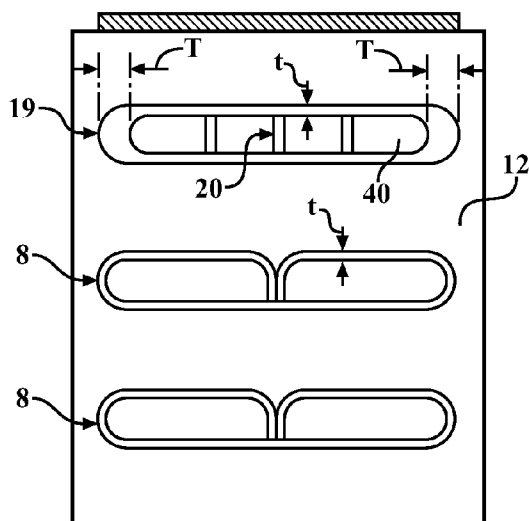


FIG. 4

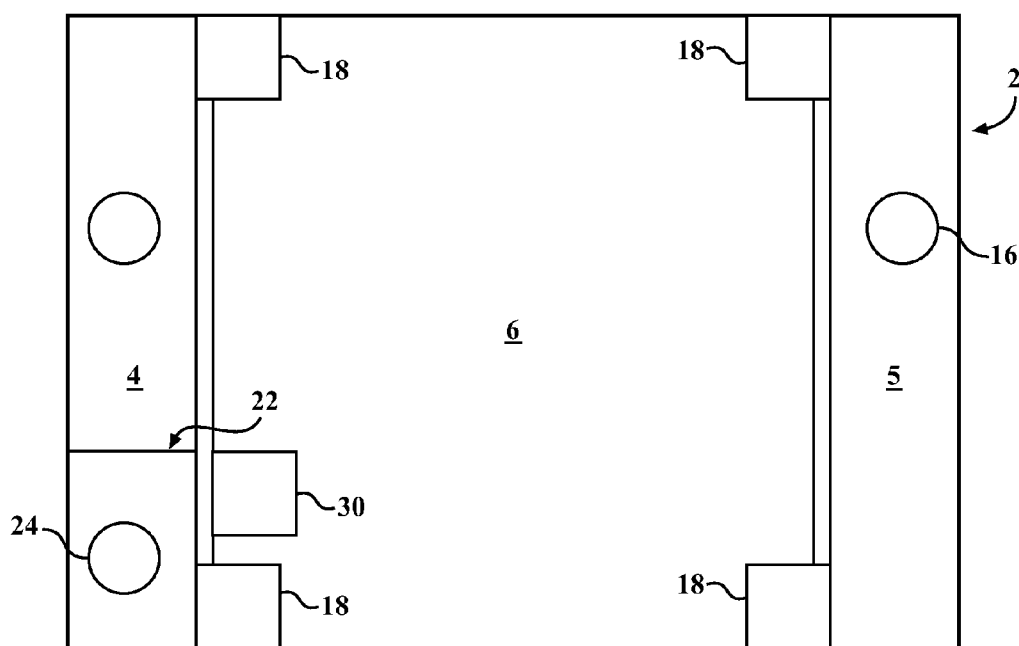


FIG. 6

HEAT EXCHANGER

[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 performance/package/ 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:

[0007] 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,

[0008] use of tank profile modification, by brazing the collector and the header forming the tank to provide a baffle, which complicates the tank assembly,

[0009] 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,

[0010] 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,

[0011] use of inserts for creating dead tubes, which greatly complicates the assembly, etc.

[0012] 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.

[0013] The invention improves this situation.

[0014] 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.

[0015] 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.

[0016] Preferably, said tubes having higher mechanical resistance are extruded tubes and said other tubes are folded tubes.

[0017] 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.

[0018] In the drawings:

[0019] FIG. 1 shows a schematic view of a heat exchanger according to the invention,

[0020] FIG. 2 shows a schematic cross-sectional view of a locally reinforced region of the heat exchanger of FIG. 1,

[0021] FIG. 3 shows a top view of the region of FIG. 2,

[0022] FIGS. 4 and 5 show two further embodiments of a heat exchanger according to the invention, and

[0023] FIG. 6 shows a schematic cross-sectional view of a locally reinforced region of the heat exchanger of FIGS. 4 and 5.

[0024] 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.

[0025] FIG. 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.

[0026] As appears on FIG. 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.

[0027] 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.

[0028] 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 FIG. 3. Beam 6 comprises specific tubes in regions referenced by the number 18 located at the tank end.

[0029] 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 FIGS. 2 and 3 solves all the resistance issues.

[0030] 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.

[0031] In the example shown on FIG. 2, tube 19 comprises 3 ribs 20, each having a thickness of 0.35 mm. 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 0.15 mm and 3 mm, and more preferably between 0.2 mm and 1.5 mm

[0032] The tube 19 has a radial wall thickness T of 1.5 mm and a transverse wall thickness t of 0.35 mm. In various embodiments, the radial wall thickness T may be chosen between 0.225 mm and 5 mm, and more preferably between 0.75 mm and 3 mm. In various embodiments, the transverse

wall thickness t may be chosen between 0.15 mm and 3 mm, and more preferably between 0.2 mm and 1.5 mm

[0033] 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 than 10.

[0034] 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 .

[0035] 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.

[0036] 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.

[0037] 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.

[0038] FIGS. **4** and **5** show two other embodiments according to the invention. In those figures, tanks **4** and **6** are similar to those of FIG. **1**, but have additional elements.

[0039] In FIG. **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 FIG. **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.

[0040] The beam of the heat exchangers of FIGS. **4** and **5** show further local stress regions referenced **30**. FIG. **6** shows a top view of a region **30**, from the inside of tank. In the example shown in FIG. **6**, it is the region **30** of FIG. **4** or **5** which is represented, and baffle **22** is shown accordingly.

[0041] 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**.

[0042] 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.

[0043] 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.

[0044] Also, while the region **30** shown in FIG. **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.

[0045] 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.

1. A heat exchanger for an automotive vehicle, said heat exchanger 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, wherein some of said tube to tank junctions suffer thermal stress, and wherein 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. A heat exchanger according to claim 1, wherein said tubes having higher mechanical resistance are extruded tubes and said other tubes are folded tubes.

3. A 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. A heat exchanger according to claim 3, wherein said radial wall thickness is within the range of 0.225 mm to 5 mm.

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

6. A heat exchanger according to claim 3, wherein said transverse wall thickness is within the range of 0.15 mm to 3 mm.

7. A heat exchanger according to claim 3, wherein said transverse wall thickness is equal to 0.35 mm.

8. A heat exchanger according to claim 2, wherein said extruded tubes comprise a number of ribs between 2 and 12, each rib having a thickness within the range of 0.15 mm and 3 mm.

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

10. A heat exchanger according to claim 2, wherein said extruded tubes are located at both ends of said beam.

11. A heat exchanger according to claim 2, further comprising at least one baffle located between two openings of said tank, wherein said tubes received in these two openings are extruded tubes.

12. A heat exchanger according to claim 3, further comprising at least one baffle located between two openings of said tank, wherein

said extruded tubes comprise a number of ribs between 2 and 12, each rib having a thickness within the range of 0.15 mm and 3 mm,

said extruded tubes are located at both ends of said beam, and

said tubes received in the two openings of said tank are extruded tubes.

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