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(54) A TUBE FOR A HEAT EXCHANGER

(57) A tube (1) for a heat exchanger (100) comprising at least one fusible part (20) for assembling with at least one wall of the heat exchanger (100), wherein the tube (1) is a flat tube assembled of two half-plates so that it comprises two flat walls joined along at least two coupling edges (11), wherein the two coupling edges (11) define a general plane (P1), characterised in that the fusible part (20) comprises a first fuse element (21), a second fuse element (22) configured to be fixed to the wall of the heat exchanger (100), a decoupling zone (23) situated between the first fuse element (21) and the second fuse element (22), wherein said second fuse element (22) is configured to be separated from the first fuse element (21) by differential in expansion/contraction between said tube (1) and said at least one wall to which it is intended to be fixed, the decoupling zone (23) being configured to deviate the second fuse element (22) relatively to a general plane (P1) of the tube (1), wherein the decoupling zone (23) is distanced from the second fuse element (22).

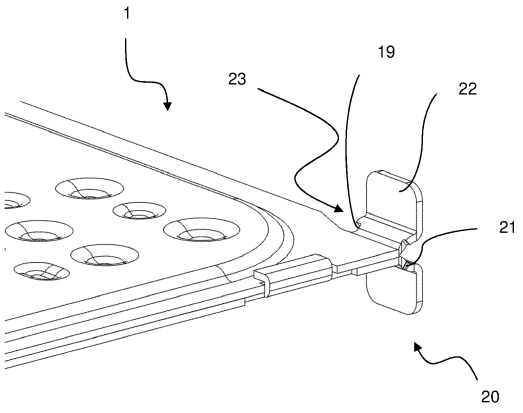


Fig. 4

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Description

FIELD OF THE INVENTION

[0001] The invention relates to a tube for a heat exchanger. In particular, the invention relates to a tube heat exchanger brazed to the walls of the housing.

BACKGROUND OF THE INVENTION

[0002] A power produced from naturally aspirated engines depends mostly on its efficiency and displacement. At the sea level, naturally aspirated engine is able to inhale only such amount of air, which is delivered by atmospheric force i.e. 1 bar. Moreover, atmospheric pressure decreases with elevation. However, conventional engines can be easily upgraded in order to increase its performance, thermal efficiency and fuel economy.

[0003] To overcome the limitations of an atmospheric pressure, air is pressurized (herein referred to as the "charge air") by mechanical or electric compressors, known as superchargers or turbochargers. In the forced induction engines, power output becomes a function of how much air is delivered to the cylinders. Most commonly used methods to put these compressors into action recapture energy from gas exhaust manifold through an expansion turbine, which pressurizes air delivered to the engine, or relay part of engine's power to motorize a supercharger, usually by a set of pulleys.

[0004] Pressurizing the air leads to substantial increase of its temperature. Consequently, the density of the air decreases with temperature, because hot air is less dense than cold air.

[0005] The automotive industry, like many other industrial fields, uses heat exchangers to ensure optimal temperature operating conditions for the engine.

[0006] It is therefore known to equip a vehicle with a charge air cooler which is equipped with a set of tubes forming a heat exchange bundle between a first fluid and a second heat transfer fluid, this exchange bundle being housed in a casing.

[0007] With respect to cooling medium, charge air coolers can be divided into three types: air-cooled charge air coolers (ACAC), water-cooled charge air coolers (WCAC) and an assemblies that use air conditioning refrigerant for charge air cooling. However, WCAC seems to be favored by automotive manufacturers, due to its efficiency and small packaging.

[0008] For several decades now, aluminum has established itself as the constituent metal of heat exchangers and has in fact replaced other metals such as copper, which are used because of their good thermal properties.

[0009] Aluminum offers significant weight savings, and aluminum alloys also have good thermal and corrosion resistance.

[0010] Due to the complexity of heat exchangers and the small dimensions allowed, the components of a heat exchanger are assembled industrially by brazing, not by spot welding.

[0011] The tubes of known heat exchangers are typically brazed to the housing of heat exchanger, i.e. joined by adding liquid metal to the metal parts to be joined. As these tubes are brazed over their entire surface in contact with the walls of housing, the metal thus added forms a continuous line.

[0012] This results in a lack of flexibility of the assembly thus obtained.

[0013] It is well known that heat exchangers are subjected to high and varied stresses during operational mode, such as thermomechanical stresses and chemical reactions with more or less aggressive environments.

[0014] In particular, there are thermal shocks caused by a sudden and significant change in temperature, for example when opening valves equipped with sensors that measure engine temperature and allow cold engine cooling water to pass into the warmer engine air intake system.

[0015] These thermal shocks lead to expansion/contraction phenomena of the tubes of heat exchanger, called thermal cycles.

[0016] However, the lack of flexibility of tubes generates significant stresses, which can lead to the appearance of rupture zones in tubes.

[0017] It can then be observed that these fracture zones can lead to leakage of heat transfer fluid.

[0018] Prior art heat exchanger tubes comprise a breakable tabs between the tube and the housing which are intended to crack during thermal cycle.

[0019] However, the breakable tabs tend to form unpredictable shapes and structures which in most cases would cause collision between the housing and the tube, especially during expansion of the tubes. Such collision may lead to mechanical stress, and finally, to malfunction of the heat exchanger due to leakage.

[0020] There is therefore a need for a heat exchanger tube with an original design that ensures greater tube flexibility and which allows to avoid collision between the remaining elements of the breakable fuse element.

[0021] The present invention therefore aims to compensate for the disadvantages of the previous art and to meet the above-mentioned constraints by proposing a tube for heat exchanger, simple in its design and in its operating mode, reliable and economical, which makes it possible to limit, or even avoid, the appearance in the tube of rupture zones linked to thermal shocks, and collision between the remaining elements of the breakable fuse element.

[0022] Another object of the present invention is such a tube for a heat exchanger providing a support on the opposite walls of the casing with a view to its assembly by brazing with a complementary tube to form a conduit for the circulation of a heat transfer fluid.

[0023] The present invention is also intended for a heat exchanger comprising at least one such tube for an exchanger, so as to present enhanced reliability.

[0024] For this purpose, the invention concerns a tube

for a heat exchanger, said tube comprising a coupling edge to another tube.

[0025] According to the invention, said edge comprises at least one fusible part for assembling this coupling edge with at least one housing wall, said at least one fusible part being configured to be separated from the rest of said coupling edge by differential expansion/contraction between said tube and said at least one housing wall on which it is intended to be assembled.

SUMMARY OF THE INVENTION

[0026] The object of the invention is, among others, a tube for a heat exchanger comprising at least one fusible part for assembling with at least one wall of the heat exchanger, wherein the tube is a flat tube assembled of two half-plates so that it comprises two flat walls joined along at least two coupling edges, wherein the two coupling edges define a general plane, wherein the fusible part comprises a first fuse element, a second fuse element configured to be fixed to the wall of the heat exchanger, a decoupling zone situated between the first fuse element and the second fuse element, wherein said second fuse element is configured to be separated from the first fuse element by differential in expansion/contraction between said tube and said at least one wall to which it is intended to be fixed, the decoupling zone being configured to deviate the second fuse element relatively to a general plane of the tube, wherein the decoupling zone is distanced from the second fuse element.

[0027] Advantageously, the fusible part comprises at least two inflection, wherein the first fuse element comprises a first inflection, and the second fuse element comprises a second inflection.

[0028] Advantageously, the tube comprises at least one recessed section located on the corner area of the tube, in particular the recessed section being located between the coupling edge and the first fuse element.

[0029] Advantageously, the tube comprises a coupling edge configured to delimit the tube formed by two tubes assembled with each other with their respective opposite faces.

[0030] Advantageously, the coupling edges are intended to delimit a conduit for the circulation of a heat-transfer fluid within the tube.

[0031] Advantageously, the tube comprises a fluid inlet and a fluid outlet, each of the fluid inlet and outlet having a collar configured to provide a fluidal communication between tube and the manifold of the heat exchanger.

[0032] Advantageously, the tube is in one piece and made of a metallic material, such as aluminum or an aluminum alloy.

[0033] Advantageously, the fusible part slopes outwardly with respect to the general plane of the tube, so that the decoupling zone is shifted from the coupling edge of tube in a cross-section perpendicular to the general plane.

[0034] Advantageously, the fusible part slopes inwardly with respect to the general plane of the tube, so that the decoupling zone is shifted towards the coupling edge of tube in a cross-section perpendicular with respect to the general plane.

[0035] Advantageously, the second inflection is sloping in different direction than the first inflection.

[0036] Advantageously, at least a portion of the second fuse element is parallel with respect to the general plane of the tube.

[0037] Advantageously, at least a portion of the first fuse element is at an angle with respect to the general plane of the tube.

[0038] Advantageously, the second fuse element is greater than the first fuse element.

[0039] Advantageously, each of the two opposite corners of the tube comprises a fusible part.

[0040] Advantageously, wherein the fusible part is half the thickness of the tube, wherein the thickness is measured in a direction perpendicular to the general plane of the tube.

[0041] Advantageously, the fusible part is thicker than half the thickness of the tube, wherein the thickness is measured in a direction perpendicular to the general plane of the tube.

[0042] Advantageously, the fusible part is thinner than half the thickness of the tube, wherein the thickness is measured in a direction perpendicular to the general plane of the tube.

BRIEF DESCRITPTION OF DRAWINGS

[0043] Examples of the invention will be apparent from and described in detail with reference to the accompanying drawings, in which:

Fig. 1 shows a perspective view of the heat exchanger.

Fig. 2 shows a side view of the heat exchanger with a detailed view of the tube-housing assembly, according to state of the art.

Fig. 3 shows a perspective view of a standalone tube for the heat exchanger.

Fig. 4 shows a perspective view of a corner section of the tube shown in Fig. 3.

Fig. 5 shows a side view of the tube and the fusible part according to one aspect of invention.

Fig. 6 shows a side view of the tube and the fusible part according to other aspect of invention.

Fig. 7 shows a side view of the tube and the fusible part according to other aspect of invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0044] Embodiments of the invention comprise a tube for a water charge air cooler (WCAC) which may be used in automotive industry. The WCAC has evolved to stand out by showing up high efficiency with relatively compact packaging. Apart from the heat exchange unit, which is primarily responsible for heat exchange between the media, WCAC comprises other elements which allow to obtain desired efficiency, such as: sensors, charge air intake/ outtake of a specific shape and smoothness, electric throttle body which regulates the mass flow of air delivered to WCAC, and other.

[0045] Although these elements are important for proper operation of the WCAC, they are omitted in the figures and specification for the sake of clarity.

[0046] Fig.1 shows a perspective view of the heat exchanger 100 which may comprise a first wall 110, a second wall 120 and a third wall 130, wherein the first wall110 and the second wall 120 are aligned parallelly and spaced from each other, and the third wall 130 may be aligned perpendicularly with respect to the first 110 and the second 120 wall, so that the opposite edges of the third wall 130 are in contact with the first wall 110, as well as the second wall 120.

[0047] The heat exchanger 100 further comprises a manifold 140. The manifold 140 may be located parallelly with respect to the third wall 130 and perpendicularly with respect to the first 110 and the second wall 120, so that, similarly to the third wall 130, the opposite edges of the manifold 140 are in contact with the first wall 110, as well as the second wall 120.

[0048] The walls 110, 120, 130 and the manifold 140 may be joined together, e.g. by brazing, so that these sub-components form an essentially rectangular fluid tight housing 150 which delimits a first conduit for a first fluid, e.g. charge air. The housing 150 may further receive intake and outtake (not shown) for the first fluid on its open ends. The exemplary first fluid flow direction from intake to outtake is depicted in Fig.1 by F_{in} and F_{out}, respectively.

[0049] A second conduit for a second fluid may be formed, inter alia, by the manifold 140, which may comprise an inlet spigot 148 and an outlet spigot 149 for delivering or collecting second fluid, e.g. coolant. The exemplary second fluid flow direction from the inlet to the outlet is depicted in Fig. 1 by W_{in} and W_{out}, respectively.

[0050] The second conduit further comprises at least one tube 1 located within the housing 150. Term "within" means, that the tube 1 does not protrude beyond the space delimited by the housing 150. The tube 1 is aligned substantially in parallel with respect to the first wall 110 and he second wall 120 and in perpendicular to the manifold 150 and the third wall 130.

[0051] The tube 1 extends form the manifold 140 to the third wall 130, whereas it is fluidly connected only with the first of these sub-components. The tube 1 is formed, so as to enable at least one U-turn at the path of the second fluid flowing there through. Naturally, the manifold 140 is configured to deliver and/or collect the second fluid to the tube 1 through two parallel channels formed therein. Preferably, the channels in the manifold 150 are formed as an unitary element with e.g. partition, however other means of providing channels for the second fluid are also envisaged.

[0052] Usually, the heat exchanger 100 may comprise a plurality of tubes 1 to improve the efficiency thereof. The tubes 1 are stacked one on the other in a parallel manner, perpendicularly to the manifold 140, so that the second fluid is distributed as homogenously as possible. The second fluid may flow through the inlet W_{in} and it is directed to respective channel of the manifold 140 which feeds the tubes 1. Next, the second fluid flows through the U-shaped tube 1 back to the manifold 150 and then it is collected by the second fluid outlet W_{out}.

[0053] In order to improve the heat exchange efficiency, the stack of tubes 1 may be interlaced with so-called turbulators or fins 160 . The number of turbulators or fins 160 interlaced between the tubes 1 corresponds the free spaces in the vicinity of the tubes 1. In other words, turbulators or fins 160 fill the spaces not occupied by other sub-components within the housing 140 in order to maximize the heat exchange efficiency and to reduce bypassing of the tubes 1 by the first fluid.

[0054] Fig. 2 shows the heat exchanger 100 with plurality of tubes 1 in accordance to prior art. The turbulators or fins 160 are omitted for the sake of clarity.

[0055] The heat exchanger 100 may be oriented horizontally. Horizontal orientation of the heat exchanger 100 refers to horizontal direction of stacking of its tubes 1. Alternatively, the heat exchanger 100 could be oriented at any angle with respect to horizontal orientation as long as the first and second fluid are efficiently delivered to provide effective heat exchange between them.

[0056] Fig. 2 further shows that each tube 1 may be formed out of two half-plates produced in the same process, wherein one half-plate is substantially a mirror image of the other to delimit the path for the circulation of a heat transfer fluid between these half-plates. In other words, the tube may be the flat tube assembled of two half-plates so that it comprises two flat walls joined along at least two coupling edges.

[0057] Alternatively, the tube 1 may be a folded tube.

[0058] Fig. 2 further shows detailed section S1 of an assembly of the tube 1 with the housing 140. According to prior art, the tubes 1 are stacked and spaced form each other in order to provide good efficiency of entire heat exchanger 100. During the operational mode the heat exchanger 100 expands and contracts depending on the temperature of the first and the second fluid, as well as the temperature difference between them in different sections of the heat exchanger 100. Further, the different sub-components of the heat exchanger 100 may expand od contract to different extent, because the heat is not usually distributed evenly across all sub- components.

[0059] The tubes 1 may be initially, i.e. in a pre-operational mode, secured both to the manifold 140 and the third wall 130, yet it may be possible for the tubes 1 to be secured only the manifold 140.

[0060] Figs 3 and 4 show an isometric view of the standalone tube 1 and one of the corner areas of the same tube 1, accordingly. Figs 3 and 4 show the first ascpectof the invention.

[0061] Referring to Fig. 3 each tube 1 may have essentially rectangular shape, so that a general plane (P1) may be defined. The general plane (P1) of the tube 1 could be defined along the contact area of two half-plates. In other words, the general plane (P1) of the tube 1 runs parallelly and in-between the half-plates of particular tube 1. In other words, the general plane (P1) may cross the median section the tube 1, so that the conduit for the first fluid in both sections thereof is split into two even halves.

[0062] Fig 3. shows that the tube 1 may further comprise a coupling edge 11 for coupling two half-plates. The coupling edge 11 may comprise at least one fusible part 20 for assembling coupling edge 11 with at least one wall of the heat exchanger, in particular the third wall 130 of the housing 150.

[0063] Further, the tube 1 may comprise a fluid inlet 31 and a fluid outlet 32, as shown in Fig.3. Each of the fluid inlet 31 and fluid outlet 32 may comprise a collar configured to provide a fluid- tight connection between tube 1 and the manifold of the heat exchanger 100.

[0064] Thus, in preferred embodiment of an invention, the tube 1 is fixed to the housing 150 with one end, and the other ought to be a free end during the operational mode of the heat exchanger 100, in order to allow expansion or contraction of the tube 1 within the housing 150.

[0065] Fig. 4 shows in detail a fragment of the same tube 1 as shown in Fig. 3. In particular, Fig. 4 shows one of the corer areas of the tube 1 which comprises the fusible part 20.

[0066] The fusible part 20 may further comprise a first fuse element 21, a second fuse element 22 configured to be fixed to the wall of the heat exchanger 100, a decoupling zone 23 situated between the first fuse element 21 and the second fuse element 22. The second fuse element 22 is configured to be separated from the first fuse element 21 by differential in expansion/contraction between the tube 1 and at least one wall to which it is intended to be fixed, such as the third wall 130. The decoupling zone 23 may be configured to deviate the second fuse element 22 relatively to a general plane (P1) of the tube 1, yet the decoupling zone 23 is distanced from the second fuse element 22.

[0067] Each coupling edge 11 may comprise at least one fusible part 20, whereas said fusible parts 20 may be arranged on the edges of the tubes 1 in such a way that, after assembly of the latter, two fusible parts 20 belonging to distinct half-plates of the tube 1 are placed opposite with respect to each other. The fusible part 20 may be carried by a corner area of the tube 1 or by a portion of the coupling edge 11, close to this corner.

[0068] Fig. 4 shows at least one recessed section 19 which may be located on the corner area of the tube 1. The recessed section 19 is made integrally with the fusible part 20 and it allows to form fusible part 20 easily, due to reduced material which helps to bend or deviate the material.

[0069] Fig. 5 shows a side view of the tube 1 assembled out of two half-plates. The general plane (P1) is depicted as the straight line, because the tube 1 in Fig. 5 is shown parallelly thereto. In other words, the general plane (P1) is shown in parallel to viewer's perspective.

[0070] The first fuse element 21 may protrude from the coupling edge 11 towards the third wall 130. In particular, the first fuse element 21 protrudes form the coupling edge 11 in a direction which is at an angle with respect to the general plane (P1) of the tube 1. In particular, the fusible part 20 with the first fuse element 21 may be aligned with respect to the general plane (P1) of the plate 1 at an angle between 0 and 90 degrees. Preferably, the angle between the first fuse element 21 and the general plane (P1) of the plate 1 is between 30 and 60 degrees. In particular, the angle between the first fuse element 21 and the general plane (P1) of the plate 1 may be exactly 45 degrees.

[0071] The second fuse element 22 may be located on the outermost portion of the tube 1 and it enables to form the firm connection by e.g. brazing with the third wall 130. The second fuse element 22 may be secured parallelly to the third wall 130, and substantially in perpendicular with respect to the general plane (P1) of the tube 1. The second fuse element 22 is bigger than the first fuse element, so that its surface contacting the third wall 130 of the housing 150 may be sufficient to avoid decoupling the second fuse element 22 from the housing 150 during the operational mode of the heat exchanger 100.

[0072] The fusible part 20 further comprises the decoupling zone 23 located between the first fuse element 21 and the second fuse element 22. The decoupling zone may be connecting the first fuse element 21 with the second fuse element 22 during pre-operational mode of the heat exchanger 100, for example, during assembling the heat exchanger 100, during transportation thereof, etc. During the operational mode of the heat exchanger 100, the decoupling zone 23 is intended to separate the first fuse element 21 and the second fuse element 22. The process of separation these two elements is due to heat expansion and/or contraction of the sub-components of heat exchanger 100 during its operational mode. Consequently, the heat exchanger 100 comprises a free end of the tube 1 localized transversely to the manifold 140. This may avoid fracturing of the tube 1 during the operational mode of the heat exchanger 100 due the thermal expansion or contraction of the material.

[0073] The decoupling zone 23 may be in a form of an area of weakened material, for example at least one decoupling incision located between the first fuse element 21 and the second fuse element 22. However, other ways

of providing the decoupling zone 23 which would allow to achieve the same effect are also envisaged.

[0074] Further, as shown in Figs 5, 6 and 7, the first fuse element 21 may comprise a first inflection 25. The second fuse element 22 may comprise a second inflection 26. Additionally, according to Figs 6 and 7, the fusible element 20 may comprise at least one third inflection 27 located between the first inflection 25 and the second inflection 26. The inflection 25, 26, 27 may be defined as the portion of the fusible part 20 which slopes away or towards the general plane (P1) of the tube 1, so that the decoupling zone 23 does not overlap the coupling edge 11 of tube 1 in a cross-section perpendicular with respect to the general plane (P1). In other words, the inflection 25, 26, 27 is configured to deviate the fusible part 20 relatively to the general plane (P1) of the tube 1. In the most basic embodiment of the invention, the fusible part 20 comprises two inflections.

[0075] Referring to Fig. 5, the fusible part 20 comprises the first inflection 25 and the second inflection 26, whrein the portions of the first fuse element 21 and the second fuse element 22 form a straight portion. The decoupling element 23 may thus be located on this straight portion. The advantage of the later embodiment is its simplicity and feasibility of production process.

[0076] Referring to Figs. 6 and 7, apart from the first inflection 25 and the second inflection 26, the fusible part 20 may further comprise, the third inflection 27. The third inflection 27 may be connecting a flat portion of the second fuse element 22, wherein this flat portion is substantially parallel with respect to the general plane (P1) of the tube 1, and the first fuse element 21 sloping at an 30-60 degree angle relatively to the general plane (P1) of the tube 1, as shown in Fig. 6. Alternatively, the third inflection 27 may be connecting a sloping portion of the second fuse element 22, wherein this sloping portion is at an 0-30 degree angle relatively to the general plane (P1) of the tube 1, and the first fuse element 21 sloping at an 30-60 degree angle relatively to the general plane (P1) of the tube 1, as shown in Fig. 7. The shape of the fusible part 20 depicted in Fig. 7 may thus be referred as to chicaning.

[0077] As already discussed, the second fuse element 22 may be configured to be separated from the first fuse element 21 by differential in expansion or contraction between the tube 1 and at least one wall on which it is intended to be assembled, such as the third wall 130. During the first thermal cycles, the stress put between the tubes 1 and the housing 150 allows the decoupling zone 23 to separate the first fuse element 21 from the second fuse element 22. Consequently, the first fuse element 21 is integral with the tube 1 and the second fuse element 22 is integral with the housing 150, in particular the third wall 130.

[0078] Preferably, the fusible part 20 may be half the thickness of the tube 1, wherein the thickness is measured in a direction perpendicular to the general plane (P1) of the tube 1. In other words, preferably each fusible part 20 protruding from one corner area is of the same thickness as the half-plate from which it protrudes from.

[0079] Alternatively, the fusible part 20 protruding from one corner area of the tube 1 is thicker than the half-plate from which it protrudes from.

[0080] Alternatively, the fusible part 20 protruding from one corner area of the tube 1 is thinner than the half-plate from which it protrudes from.

[0081] Contrary to other known solutions, the decoupling zone 23 allows the second fuse element 22 be separated from the first fuse element 21 in such a way, that during the operational mode of the heat exchanger 100, the tube 1 does not collide with the housing 150 or the contact between these elements is very gentle. This allows to significantly improve the thermal resistance of the whole heat exchanger 100. To achieve similar effect, those skilled in the art could, for example, increase the size of the housing 150 in the direction parallel to the general plane (P1) of the tube 1, so that the tubes can expand and contract freely, yet it would create several problems, such as increased packaging, reduced thermal efficiency of the heat exchanger, and other.

[0082] Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of drawings, the disclosure, and the appended claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to the advantage.

Claims

1. A tube (1) for a heat exchanger (100) comprising at least one fusible part (20) for assembling with at least one wall of the heat exchanger (100), wherein the tube (1) is a flat tube assembled of two half-plates so that it comprises two flat walls joined along at least two coupling edges (11), wherein the two coupling edges (11) define a general plane (P1), **characterised in that** the fusible part (20) comprises a first fuse element (21), a second fuse element (22) configured to be fixed to the wall of the heat exchanger (100), a decoupling zone (23) situated between the first fuse element (21) and the second fuse element (22), wherein said second fuse element (22) is configured to be separated from the first fuse element (21) by differential in expansion/contraction between said tube (1) and said at least one wall to which it is intended to be fixed, the decoupling zone (23) being configured to deviate the second fuse element (22) relatively to a general plane (P1) of the tube (1), wherein the decoupling zone (23) is distanced from the second fuse element (22).

2. The tube (1) according to claim 1, wherein the fusible part (20) comprises at least two inflections , wherein the first fuse element (21) comprises a first inflection

(25), and the second fuse element (22) comprises a second inflection (26).

3. The tube (1) according to any of the preceding claims comprising at least one recessed section (19) located on the corner area of the tube (1), in particular the recessed section being located between the coupling edge (11) and the first fuse element (21).

4. The tube (1) according to any of the preceding claims, wherein coupling edge (11) is configured to delimit the tube (1) formed by two plates assembled with each other with their respective opposite faces.

5. The tube (1) for a heat exchanger (100) according to any of the preceding claims, wherein the coupling edges (11) are intended to delimit a conduit for the circulation of a heat-transfer fluid within the tube (1).

6. The tube (1) according to any of the preceding claims, wherein said tube (1) comprises a fluid inlet (31) and a fluid outlet (32), each of the fluid inlet and outlet having a collar configured to provide a fluid-tight between tube (1) and the manifold of the heat exchanger (100).

7. The tube (1) according to any of the preceding claims **characterized in that** said tube (1) is in one piece and made of a metallic material, such as aluminum or an aluminum alloy.

8. The tube (1) according to any of the preceding claims, wherein fusible part (20) slopes outwardly with respect to the general plane (P1) of the tube (1), so that the decoupling zone (23) is shifted from the coupling edge (11) of tube (1) in a cross-section perpendicular to the general plane (P1).

9. The tube (1) according to any of claims 1-7, wherein fusible part (20) slopes inwardly with respect to the general plane (P1) of the tube (1), so that the decoupling zone (23) is shifted towards the coupling edge (11) of tube (1) in a cross-section perpendicular with respect to the general plane (P1).

10. The tube (1) according to claims 8 or 9, wherein the second inflection (26) is sloping in different direction than the first inflection (25).

11. The tube (1) according to any of the preceding claims, wherein at least a portion of the second fuse element (22) is parallel with respect to the general plane (P1) of the tube (1).

12. The tube (1) according to any of the preceding claims, wherein at least a portion of the first fuse element (21) is at an angle with respect to the general plane (P1) of the tube (1).

13. The tube (1) according to any of the preceding claims, wherein the second fuse element (22) is greater than the first fuse element (21).

14. The tube (1) according to any of the preceding claims, wherein each of the two opposite corners of the tube (1) comprises a fusible part (20).

15. A tube (1) for a heat exchanger (100) according to any of the preceding claims, wherein the fusible part (20) is half the thickness of the tube (1), wherein the thickness is measured in a direction perpendicular to the general plane (P1) of the tube (1).

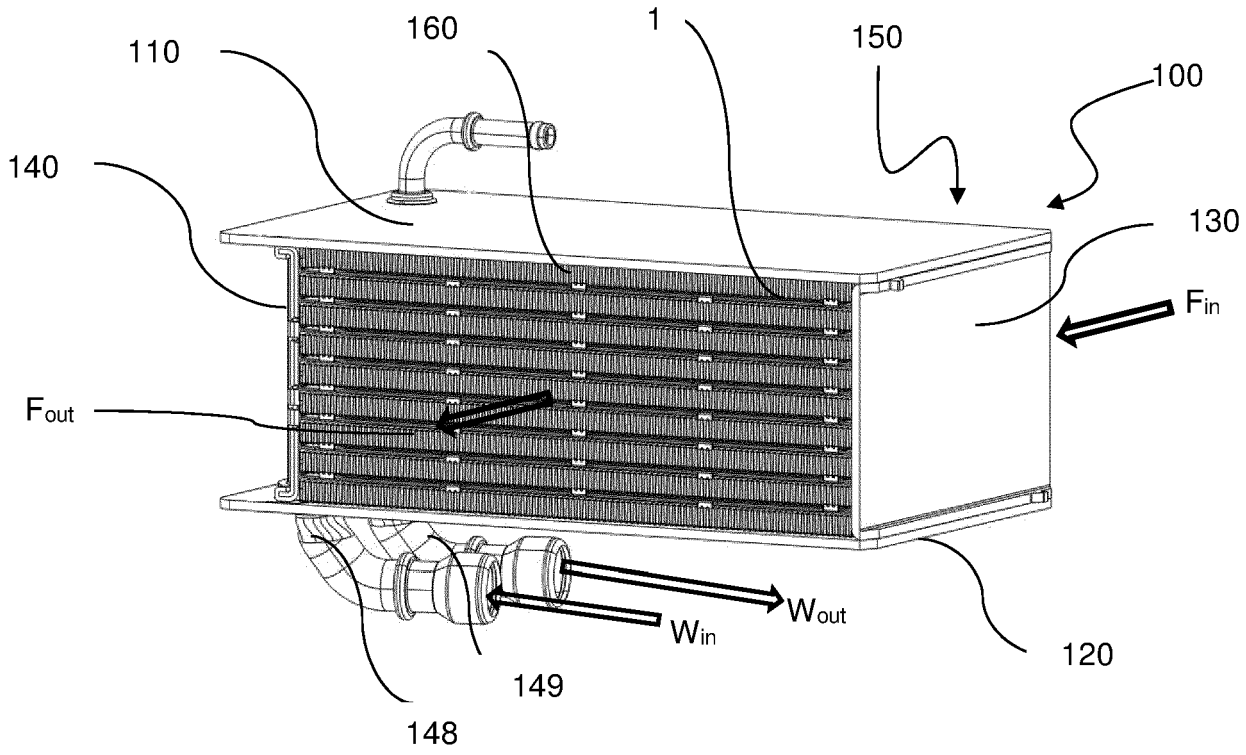


Fig. 1

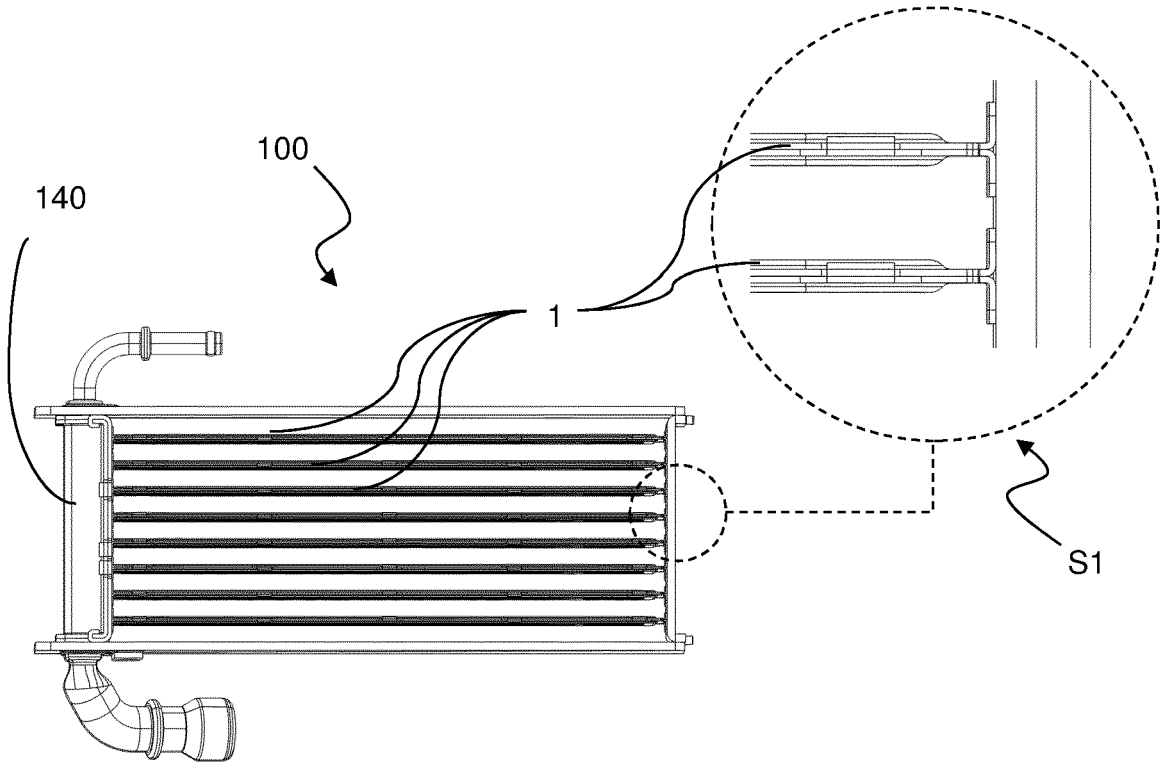


Fig. 2 (Prior art.)

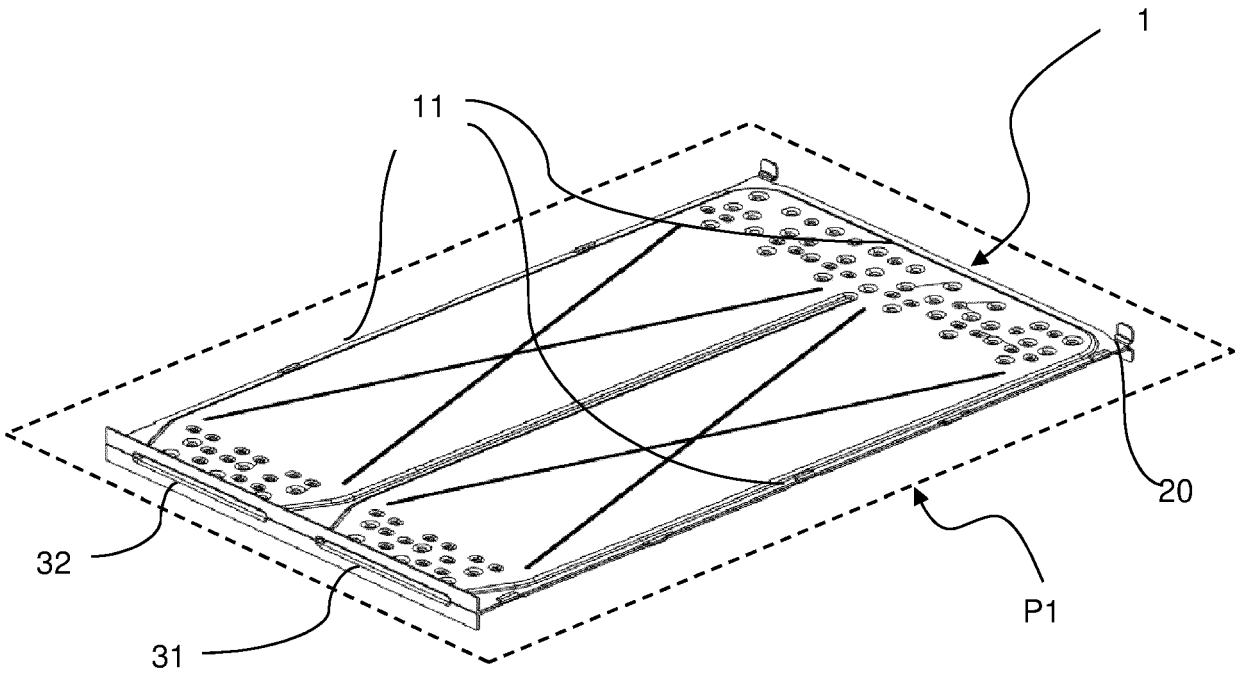


Fig. 3

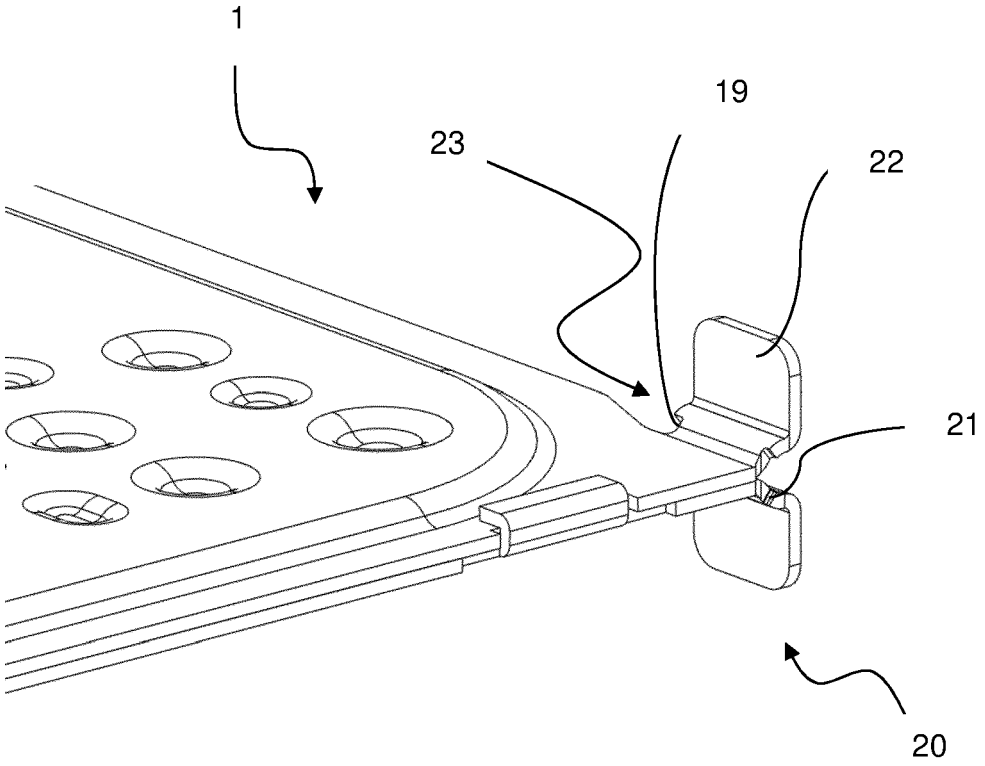


Fig. 4

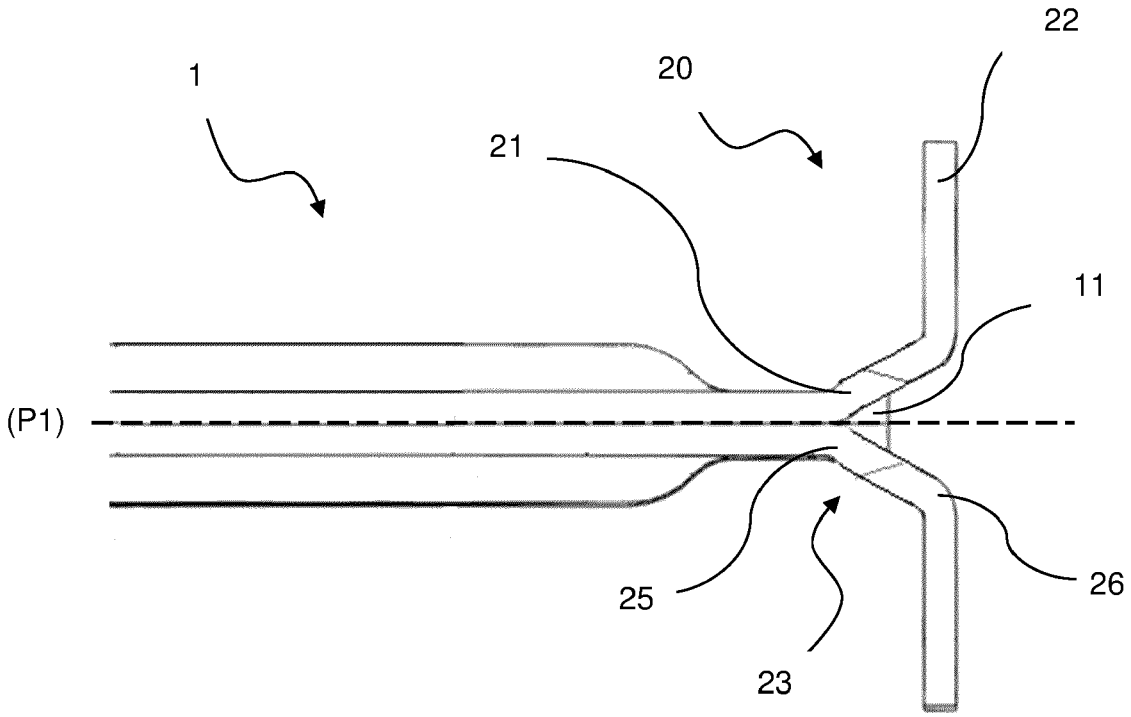


Fig. 5

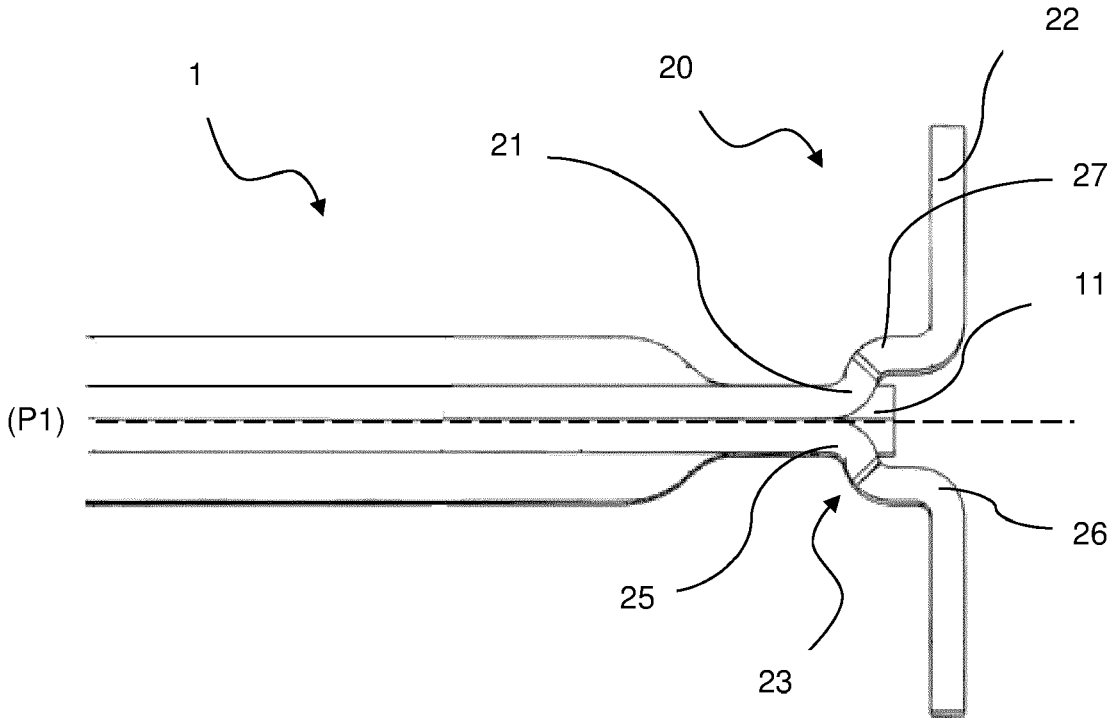


Fig. 6

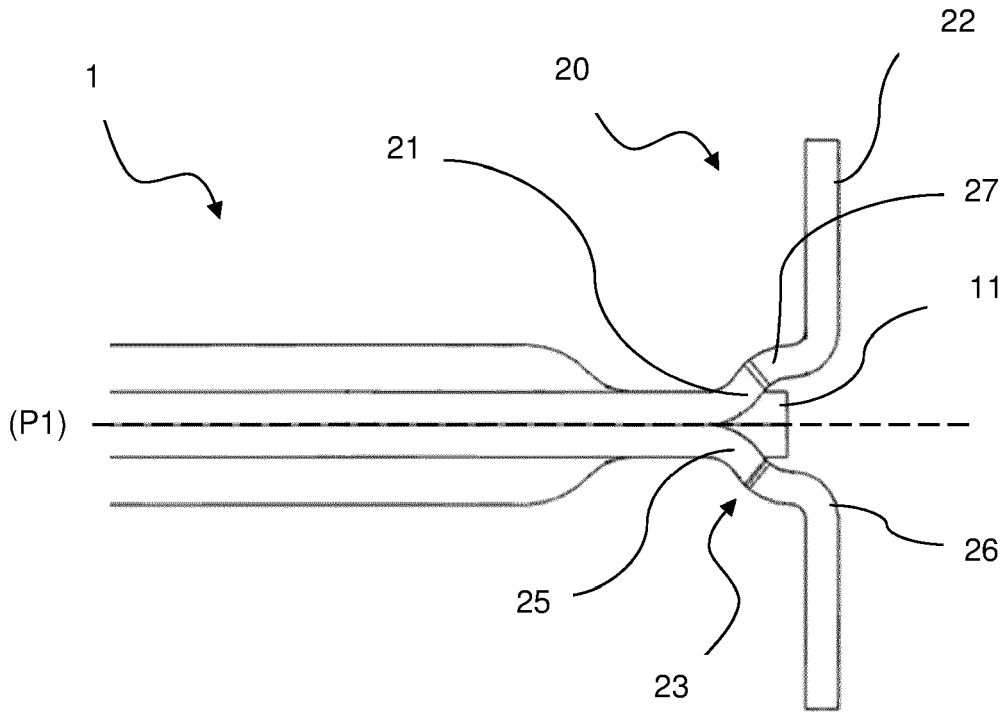


Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 20 46 1612

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	WO 2019/145022 A1 (VALEO SYSTEMES THERMIQUES [FR]) 1 August 2019 (2019-08-01) * figures *	1-15	INV. F28F9/00 F28D9/00
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TECHNICAL FIELDS SEARCHED (IPC)

F28F
F28D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 May 2021	Mellado Ramirez, J

CATEGORY OF CITED DOCUMENTS

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18-05-2021

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