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(54) **A TUBE FOR A HEAT EXCHANGER**

(57) The object of the invention is, among others, 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), wherein the fusible part (20) protrudes from a coupling edge (11), characterised in that the fusible part (20) comprises a first fuse element (21) adjacent to the coupling edge (11), 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 decoupling zone (23) comprising a first side parallel to at least one flat wall and a second side perpendicular to the first side, 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, wherein the decoupling zone (23) further comprises at least one notch (99) located on the first side configured to facilitate separation of the second fuse element (22) from the first fuse element (21).

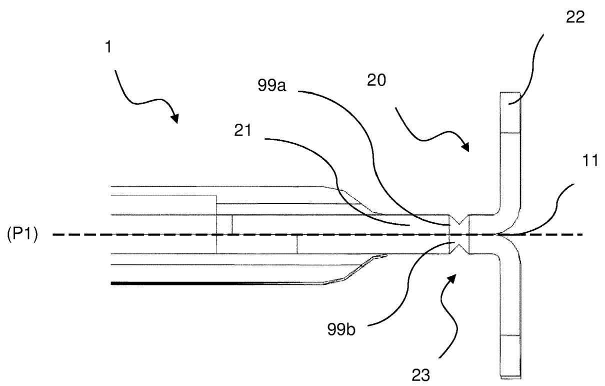

Fig. 5

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 break irregularly, so that the fracture zone is difficult to predict. The uneven parts of the tab may lead to collision between sub-components. Such collision may lead to mechanical stress, and finally, to malfunction of the heat exchanger due to leakage. Further, the breakable tabs need relatively high stress level to break. Consequently, the breakable tabs of the tubes subjected to greater stress break quicker than the ones being subjected to relatively lower stress at the same time. This may lead to tube cracking in an undesired areas so that the leaks occur.

[0020] There is therefore a need for a heat exchanger tube with an original design that ensures more predictable and quicker separation of the breakable tabs.

[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 or unpredictable and uncontrollable breaking of the tabs.

[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 protrudes from a coupling edge, characterised in that the fusible part comprises a first fuse element adjacent to the coupling edge, 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, the decoupling zone comprising a first side parallel to at least one flat wall and a second side perpendicular to the first side, 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, wherein the decoupling zone further comprises at least one notch located on the first side configured to facilitate separation of the second fuse element from the first fuse element.

[0027] Advantageously, the decoupling zone is 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.

[0028] Advantageously, the notch extends parallelly to the general plane of the tube.

[0029] Advantageously, the tube is formed by a first plate and a second plate assembled with each other with their respective opposite faces.

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

[0031] Advantageously, the first plate comprises a first notch and the second plate comprises a second notch .

[0032] Advantageously, the first notch and the second notch are located symmetrically with respect to the general plane.

[0033] Advantageously, the first notch and the second notch are located asymmetrically with respect to the general plane.

[0034] Advantageously, the decoupling zone comprises at least one indent located on the second side thereof configured to further facilitate separation of the second fuse element from the first fuse element.

[0035] Advantageously, said tube comprises a fluid inlet and a fluid outlet, each of the fluid inlet and outlet having a collar configured to provide a fluid- tight connection between tube and the manifold of the heat exchanger.

[0036] Advantageously, the tube is in one piece and made of a metallic material, such as aluminum or an aluminum alloy.

[0037] Advantageously, each of the two opposite corners of the tube comprises a fusible part.

[0038] Advantageously, 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.

[0039] 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.

[0040] 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

[0041] 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 side view of the sub component forming the tube shown in Fig. 3.

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

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

Fig. 7 shows a perspective view of the tube and the fusible part comprising notch and an indent according to other aspect of invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0042] 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.

[0043] Although these elements are important for proper operation of the WCAC, they are omitted in the figures and specification for the sake of clarity.

[0044] 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.

[0045] 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.

[0046] 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.

[0047] 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.

[0048] 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.

[0049] 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.

[0050] 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}.

[0051] 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.

[0052] Fig. 2 shows the heat exchanger 100 with plurality of tubes 1 in accordance to prior art. The turbulators or fins 160 visible in Fig.1 are omitted for the sake of clarity.

[0053] 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.

[0054] 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 1 may be the flat tube assembled of two half-plates so that it comprises two flat walls joined along at least two coupling edges 11, as shown in Fig. 3.

[0055] Alternatively, the tube 1 may be a folded tube.

[0056] 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.

[0057] 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.

[0058] Fig. 3 shows a perspective view of the standalone tube 1.

[0059] 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.

[0060] 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.

[0061] 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.

[0062] 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.

[0063] Fig. 4 shows in detail a half- plate of the same tube 1 as shown in Fig. 3. In particular, Fig. 4 shows the half-plate comprising the coupling edge which may be used to form the tube 1 which comprises the fusible part 20.

[0064] The fusible part 20 may comprise a first fuse element 21 adjacent to the coupling edge 11, a second fuse element 22 configured to be fixed to the wall of the heat exchanger 100, and a decoupling zone 23 situated between the first fuse element 21 and the second fuse element 22. The decoupling zone 23 may comprise a first side parallel to at least one flat wall and a second side perpendicular to the first side. Referring to Figs 1 and 2, the first side of the decoupling zone 23 may be perpendicular to the direction of stacking of the tubes 1. Referring to Figs 3, 5 and 6, the first side of each half-plate may be parallel to the general plane (P1). It is to be noted that the flat wall of the half-plate is substantially parallel to the general plane (P1). Term "side" may to refer to flat surface of the fuse element 20 of individual half- plate which delimits the decoupling zone 23 relatively to the direction of its extension and relatively to the orientation of the half- plate. The second fuse element 22 may be 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. In Fig. 4 the decoupling zone 23 is essentially parallel to the general plane (P1) of the tube 1. However, 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.

[0065] 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.

[0066] 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.

[0067] The first fuse element 21 may protrude from the coupling edge 11 towards the third wall 130. The first fuse element 21 may protrude from the coupling edge 11 in a direction which is parallel with respect to the general plane (P1) of the tube 1, as shown in Fig. 5. Alternatively, the first fuse element 21 may protrude from the coupling edge 11 in a direction which is at an angle with respect to the general plane (P1) of the tube 1. 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.

[0068] The fusible part 20 may further comprise the decoupling zone 23 located between the first fuse element 21 and the second fuse element 22. The decoupling zone 23 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 subcomponents 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.

[0069] In order to provide a predictable zone in which the second fuse element 21 may be separated from the first fuse element 21, the decoupling zone 23 may comprise at least one notch 99.

[0070] Referring to Figs 4-7, The notch 99 may be located on the first side of the decoupling zone 23. The first side of the decoupling zone 23 may extend substantially in a direction parallel to the flat wall of the half-plate or to the general plane (P1) of the tube 1. The second side of the decoupling zone 23 may extend in a direction substantially perpendicular to the first side. It means that if the fusible part 20 comprises any bends or inclinations, the second side of the decoupling zone 23 should be measured relatively to the orientation of the fusible part 20, not the whole tube 1. The notch 99 may thus be configured to facilitate separation of the second fuse element 22 from the first fuse element 21.

[0071] The notch 99 may be formed by incision in the surface of the tube 1 or by any means that will ensure proper functionality thereof.

[0072] The notch 99 may extend through the decoupling element 23 from one edge to another along the shortest path. However, the notch 99 may also extend obliquely, even if the shortest path through the decoupling zone is available.

[0073] The decoupling zone 23 may further comprise at least one indent 98 located on the second side being substantially parallel to the first side of the decoupling zone 23. The indent 98 is configured to further facilitate separation of the second fuse element 22 from the first fuse element 21 by being located in the vicinity of the notch 99. Alternatively, the decoupling zone may comprise the indent 98 only.

[0074] As shown in Fig. 5, the notch 99 and/or the indent 98 may be in a form of a cutout in an essentially triangular shape. The shape of the triangle is the easiest in terms of production feasibility, however, other shapes of the notch 99, for example, semicircular are also envisaged.

[0075] In the basic embodiment of an invention, the notch 99 may extend parallelly to the general plane (P1) of the tube 1.

[0076] As already discussed in previous paragraphs, the tube 1 may be formed by two half-plates. In order to form the tube 1 in form of the plate, a first plate 201 and a second plate 202 may be assembled with each other with their respective opposite faces.

[0077] Such tube 1 may further comprise coupling edges 11 configured to delimit a conduit for the circulation of a heat-transfer fluid within the tube 1.

[0078] The first plate 201 may comprise a first notch 99a and the second plate 202 may comprise a second notch 99b.

[0079] Preferably, the first notch 99a and the second notch 99b may be located symmetrically with respect to the general plane (P1) of the tube 1. Such configuration facilitates separation of the second fuse element 22 form the first fuse element 21 because the distance between the first notch 99a and the second notch 99b is the shortest.

[0080] If required, the strength of the decoupling zone 23 may be controlled by location of the first notch 99a with respect to the second notch 99b.

[0081] As shown in Fig. 5, he first notch 99a and the second notch 99b may located symmetrically with respect to the general plane (P1) of the tube 1. Term "symmetrically" or "asymmetrically refers to axis which may formed by the notches 99a and 99b. If the notches 99a and 99b are located symmetrically, their axis may form one, mutual axis for both of notches 99a and 99b so that the decoupling zone 23 is as thin as possible, thus the fuse elements 21 and 22 may be easily separated. If the notches 99a, 99b are located asymmetrically, as shown in Fig. 6, they may form two respective axis which do not overlap to form one, mutual axis for both notches 99a and 99b. Thus, the distance between the notches 99a and 99b is increased, so that the decoupling zone 23 is stronger than in previous example.

[0082] Another way to control the strength of the decoupling zone 23 is by providing different shape of depth between the corresponding notches 99a and 99b. For example, the first notch 99a may penetrate deeper towards the median portion of the first plate than the second notch 99b. Consequently, the strength of the decoupling zone 23 may be controlled.

[0083] As already discussed, the notches 99a and 99b may be of different shapes and sizes. If the notches 99a and 99b have the triangular form, it may be preferred that the angle between the cutouts forming each triangular form is between 30-120 degrees, in particular 90 degrees.

[0084] Further, the first fuse element 21 and/ or the second fuse element 22 may comprise a first inflections. The inflections 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 inflections may be configured to deviate the fusible part 20 relatively to the general plane (P1) of the tube 1.

[0085] 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.

[0086] 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.

[0087] 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.

[0088] 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.

[0089] Contrary to other known solutions, the decoupling zone 23 with at least one notch 99 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 is quickly separated from the housing 150 in a desired place. This allows to significantly improve the thermal resistance of the whole heat exchanger 100.

[0090] 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), wherein the fusible part (20) protrudes from a coupling edge (11), **characterised in that** the fusible part (20) comprises a first fuse element (21) adjacent to the coupling edge (11), 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 decoupling zone (23) comprising a first side parallel to at least one flat wall and a second side perpendicular to the first side, 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, wherein the decoupling zone (23) further comprises at least one notch (99) located on the first side configured to facilitate separation of the second fuse element (22) from the first fuse element (21).

2. The tube (1) according to claim 1, wherein the decoupling zone (23) is 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.

3. The tube (1) according to claim 2, wherein the notch (99) extends parallelly to the general plane (P1) of the tube (1).

4. The tube (1) according to any of the preceding claims, wherein the tube (1) is formed by a first plate (201) and a second plate (202) assembled with each other with their respective opposite faces.

5. The tube (1) for a heat exchanger (100) according to claim 4 wherein the plates (201, 202) comprise coupling edges (11) configured to delimit a conduit for the circulation of a heat-transfer fluid within the tube (1).

6. The tube (1) for a heat exchanger (100) according to any of claims 4 or 5, wherein the first plate (201) comprises a first notch (99a) and the second plate (202) comprises a second notch (99b).

7. The tube (1) for a heat exchanger (100) according to claim 6, wherein the first notch (99a) and the second notch (99b) are located symmetrically with respect to the general plane (P1).

8. The tube (1) for a heat exchanger (100) according to claim 6, wherein the first notch (99a) and the second notch (99b) are located asymmetrically with respect to the general plane (P1).

9. The tube (1) for a heat exchanger (100) according to any of the preceding claims, wherein the decoupling zone (23) comprises at least one indent (98) located on the second side thereof configured to further facilitate separation of the second fuse element (22) from the first fuse element (21).

10. 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 connection between tube (1) and the manifold of the heat exchanger (100).

11. 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.

12. 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).

13. 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).

14. A tube (1) for a heat exchanger (100) according to any of the preceding claims, wherein the fusible part (20) is thicker than 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).

15. A tube (1) for a heat exchanger (100) according to any of the preceding claims, wherein the fusible part (20) is thinner than 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).

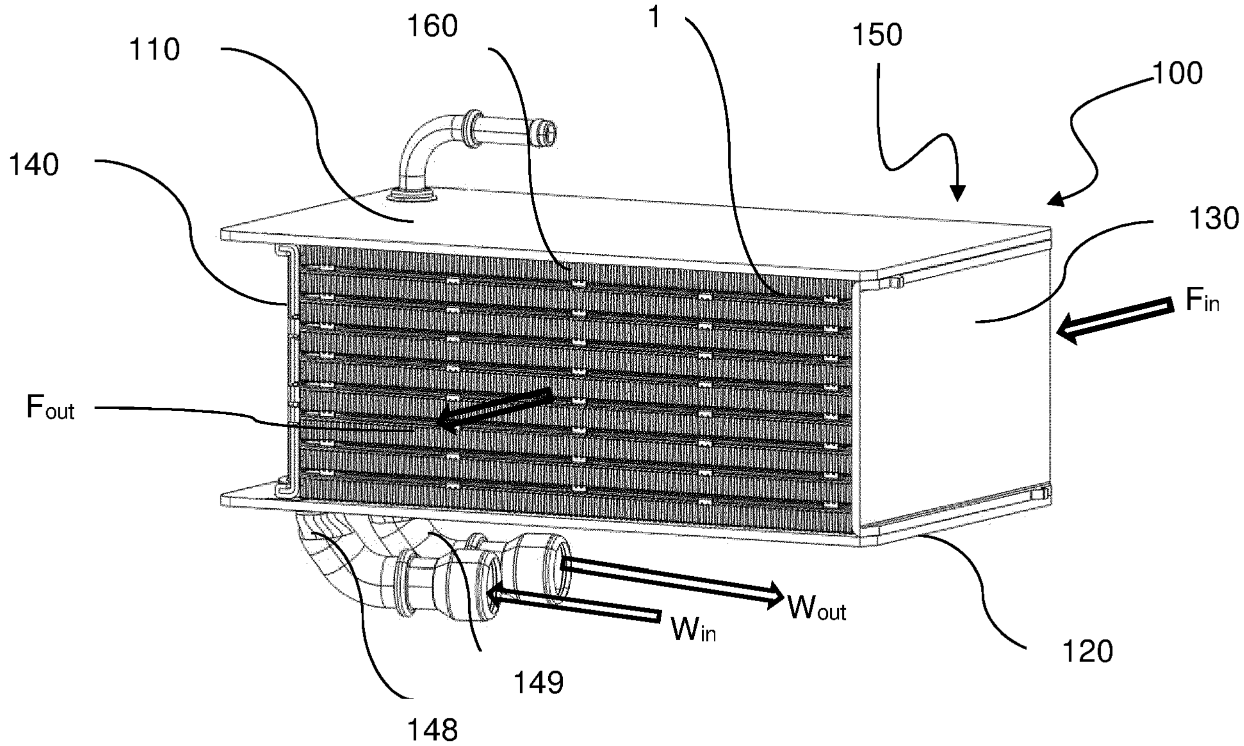

Fig. 1

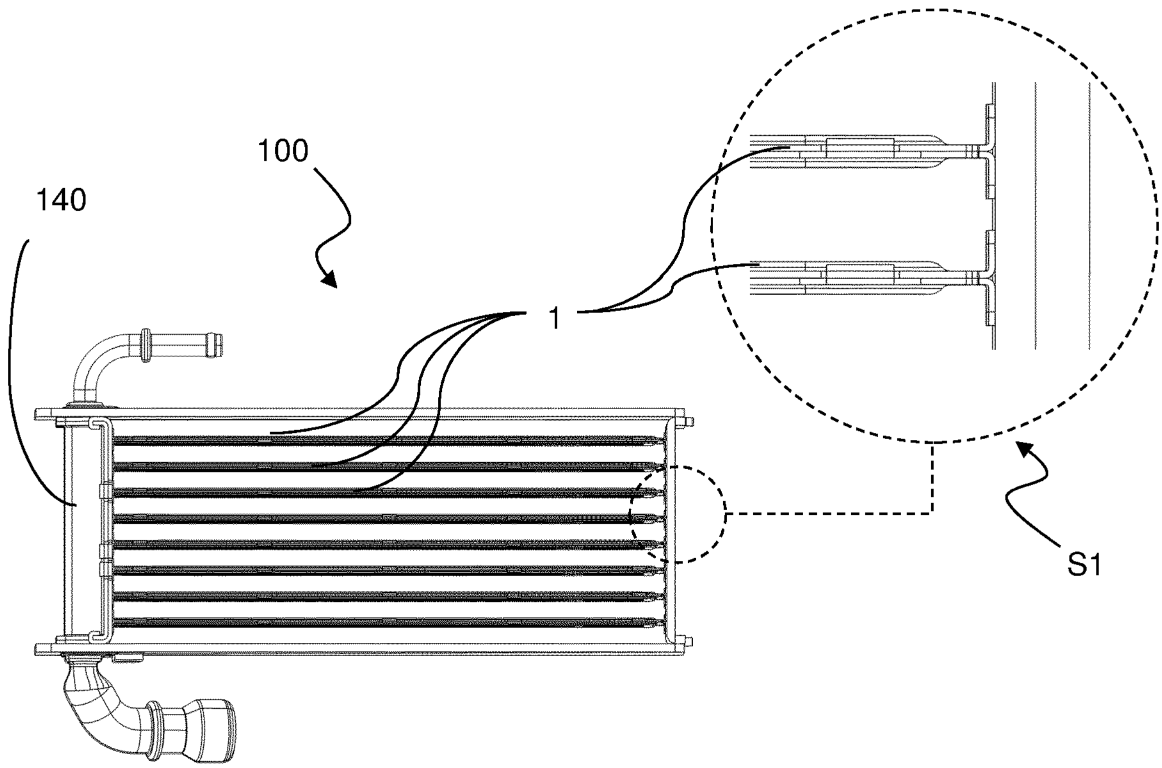

Fig. 2 (Prior art.)

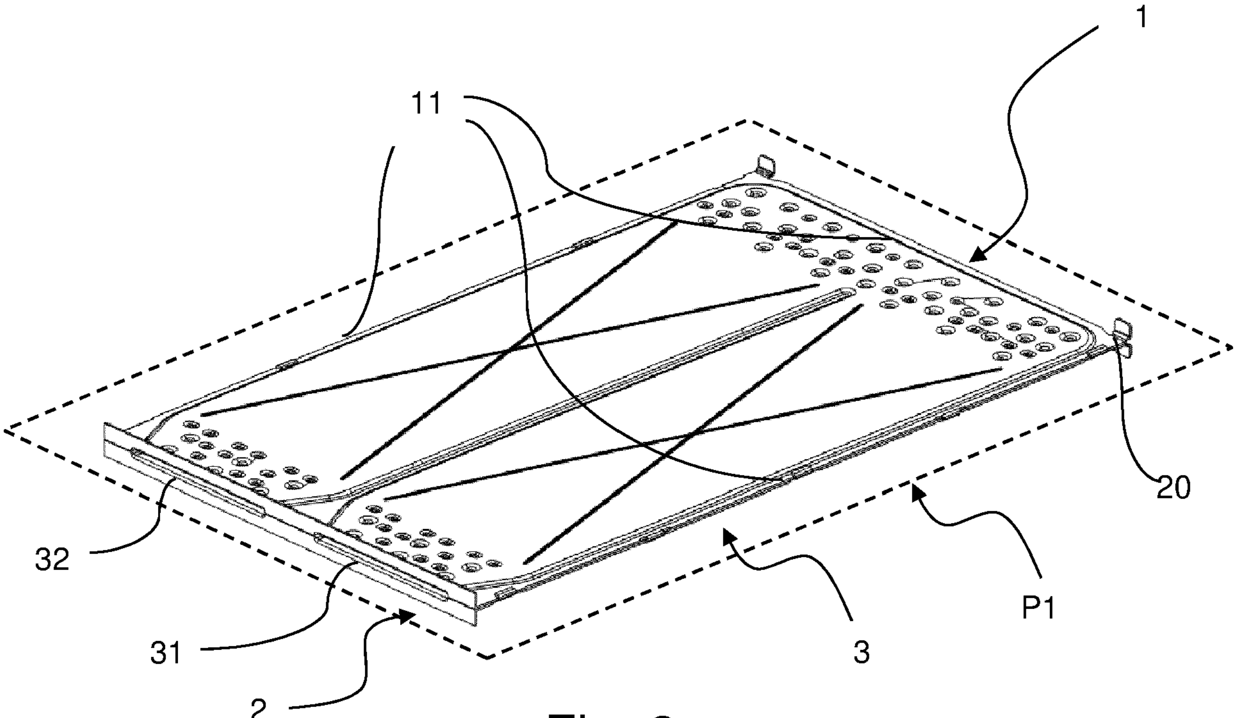

Fig. 3

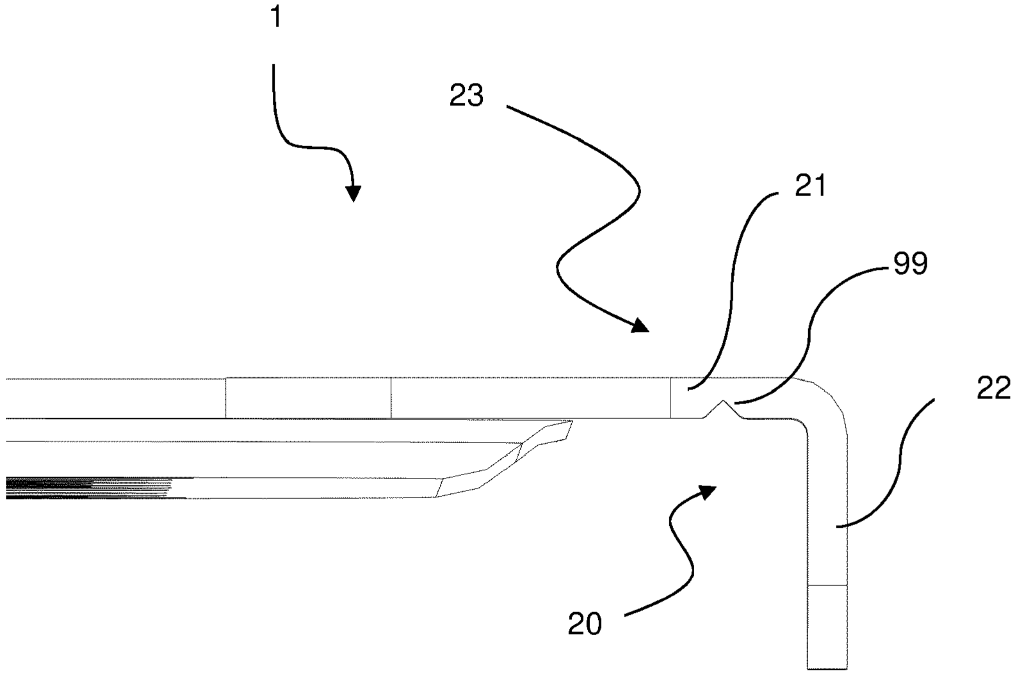

Fig. 4

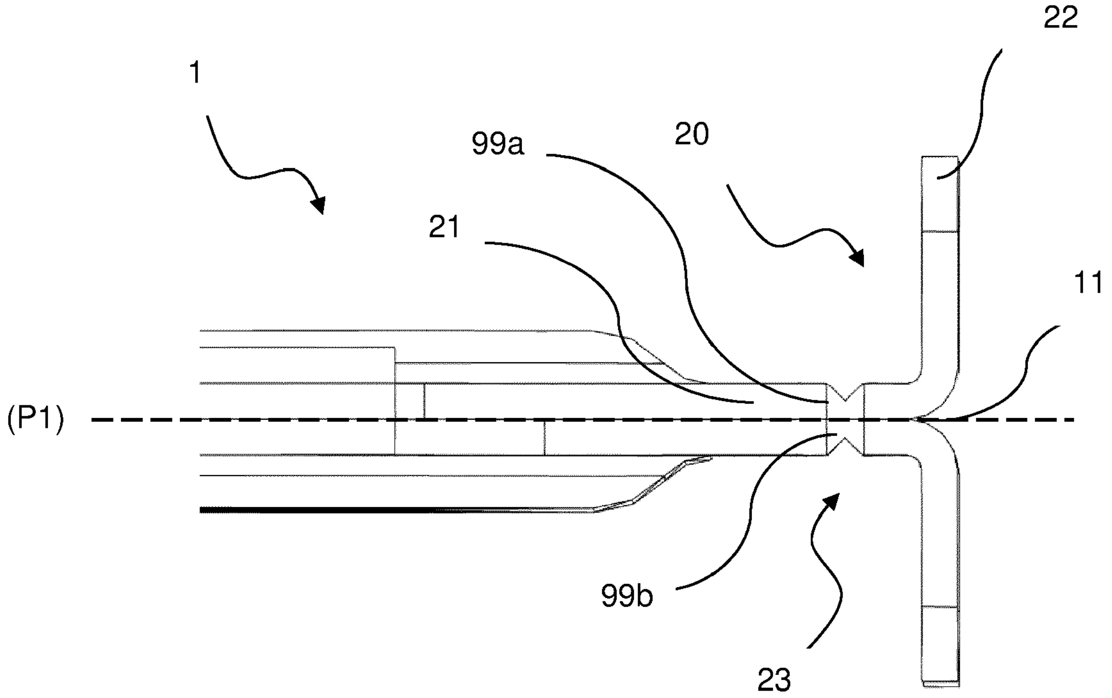

Fig. 5

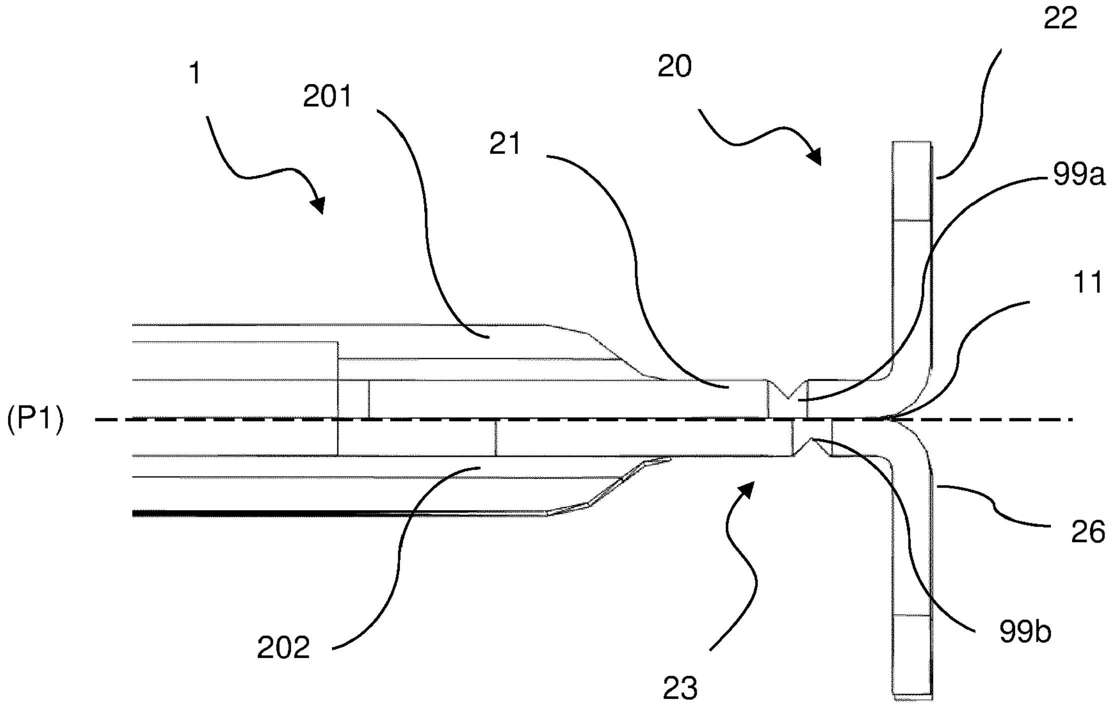

Fig. 6

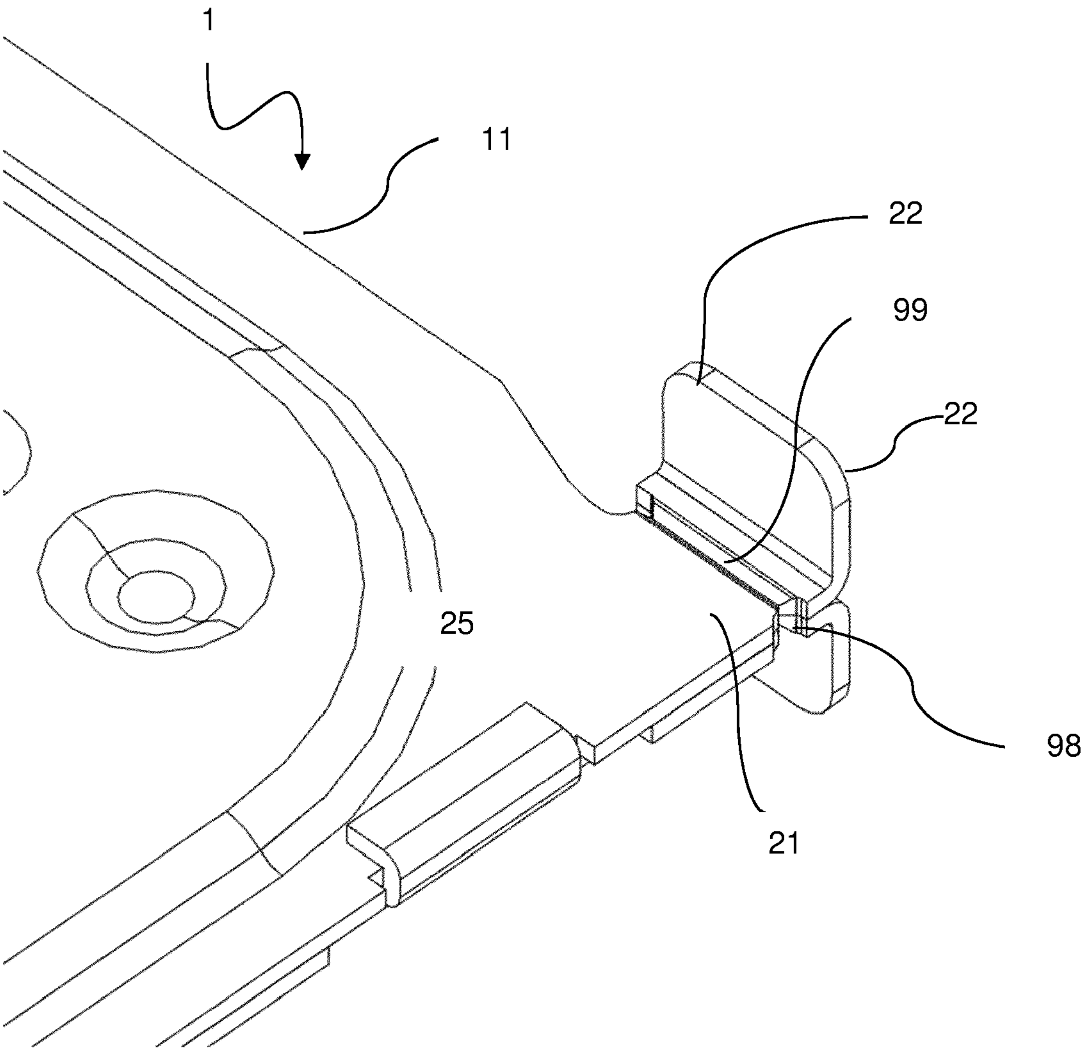

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 20 46 1614

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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 3-7 * -----	1-15	INV. F28D9/00 F28F9/00
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TECHNICAL FIELDS SEARCHED (IPC)
F28D
F28F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	19 May 2021	Mellado Ramirez, J

CATEGORY OF CITED DOCUMENTS

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19-05-2021

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