(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 825 634 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
26.05.2021 Bulletin 2021/21

(51) Int Cl.:
***F28D 1/053** (2006.01)*

(21) Application number: **19461604.1**

(22) Date of filing: **19.11.2019**

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

(71) Applicant: **Valeo Autosystemy SP. Z.O.O.**
32-050 Skawina (PL)

(72) Inventors:
- **BARUS, Lukasz**
  32-050 Skawina (PL)
- **DULIBAN, Lukasz**
  32-050 Skawina (PL)
- **JURKIEWICZ, Damian**
  32-050 Skawina (PL)
- **NUKALA, Vineela**
  600130 Chennai, Tamil Nadu (IN)
- **PENTAPALLI, Venkatesh**
  600130 Chennai, Tamil Nadu (IN)
- **MUDAGAL, Raghavendra**
  600130 Chennai, Tamil Nadu (IN)

(74) Representative: **Bialkowski, Adam**
Valeo Systèmes Thermiques
Industrial Property Department
ZA L'Agiot
8 rue Louis Lormand
CS 80517 LA VERRIERE
78322 Le Mesnil Saint Denis Cedex (FR)

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

(57) The invention comprises a heat exchanger (1) in particular for a motor vehicle comprising: a first header (2), a first tank (40) assembled with the first header (2), a second header (3), a second tank (50) assembled with the second header (3),
a plurality of tubes (4) deployed in parallel to each other between the first header (2) and the second header (3), the tubes (4) comprising open ends received in the headers (2,3), and- at least one tube reinforcement (10), characterised in that,
the tube reinforcement (10) comprises a support element (11), a plurality of projecting legs (12) protruding substantially perpendicularly from the support element (11), wherein the projecting legs (12) are introduced into at least three tubes so that they are in contact with the inner walls of the tubes (4).

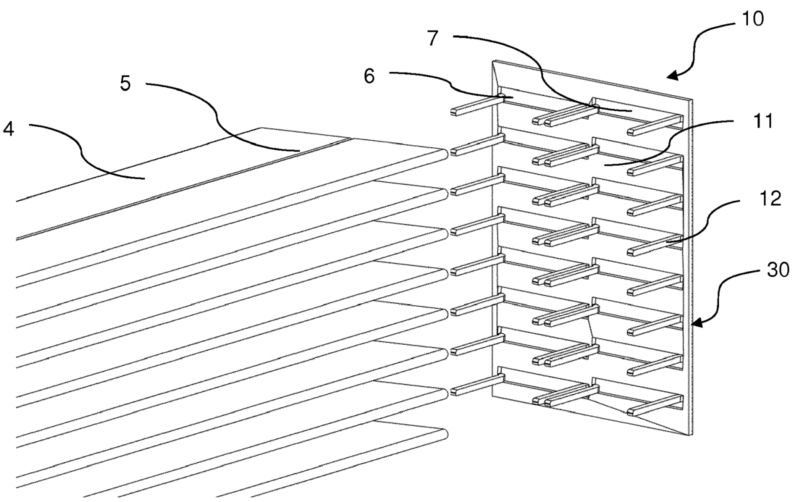

Fig. 3

EP 3 825 634 A1

Description

FIELD OF THE INVENTION

[0001] The invention relates to a heat exchanger, in particular to the heat exchanger for a motor vehicle.

BACKGROUND OF THE INVENTION

[0002] Heat exchangers in motor vehicles are usually responsible for thermal management of the powertrain, the air conditioning system, the power steering system, and other. This includes, for example, internal combustion vehicles and electric vehicles, wherein the proper management of the heat can reflect on emissions, fuel or energy consumption, maximal driving range, etc. The similar effects may be obtained, for example, by reducing the weight and the size of the vehicle components, such as the heat exchanger. The size of the heat exchanger may be reduced by implementing specific architectures that provide the same or better efficiency while using the smaller amount of space. As the result, the weight of the sub-components may decrease, as well as the size thereof. Furthermore, the weight can be further decreased by reducing the amount of material used for sub- components production, for example, by slimming the walls of the particular components.

[0003] However, the ongoing interest in continuous weight and size reduction of vehicle's sub-components may lead to its undesired vulnerability to damage and/or decreased efficiency of the whole heat exchange system. The heat exchangers these days are usually made of a metal components, such as aluminum assembled with a synthetic components, such as plastic. The sub-components responsible for heat exchange, such as the heat exchanger core comprising tubes assembled with the headers are usually made of metal component, whereas the sub-components responsible for delivering or collecting the media, such as tanks, are usually made synthetic material.

[0004] In operational mode, the heat exchanger core expands and/or contracts depending on the temperature of media and pressure accumulated in the system. The thermal expansion of the material can make the tubes want to move with respect to the header, thus increasing a threat of leakage. Further, the heat exchanger may suffer so-called thermal shock every time the hot medium is directed into the core and said core expansion occurs it the short time. Between the subsequent operational modes the core contracts and returns to its nominal size, which can be regarded as dimensions of the heat exchanger in the standard temperature and under normal pressure.

[0005] Thus, the cycles of operational and non-operational mode may a significantly impact the longevity of the heat exchanger due to both thermal, mechanical load and corrosion.

[0006] The common area mostly vulnerable to thermal damage and leakage is located usually in the vicinity of tube-slot connection, especially on the inlet side of the heat exchanger.

[0007] To remedy the negative effects of upper mentioned factors one may provide a supporting means for the most vulnerable parts of the core. Usually, the support means are configured to strengthen the inner walls of the tube by the legs extending from the terminal end of the tube and finishing beyond the point where the tube goes through the slot. Already existing designs include, for example, a fork-shaped portion entered using force into the terminal end of the tube. The process of introducing such portions requires a lot of precision and force from e.g. the operator. Another negative aspect is the amount of time required to reinforce the tubes of a single heat exchanger, as only one portion at a time may be introduced into the tube. Other applications provide reinforcement of two consecutive tubes by using a single supporting means, however, it still may not be sufficient.

[0008] It would be desired to provide a supporting means for a heat exchanger that would reinforce at least three tubes. Moreover, these supporting means should be cheap, efficient and easy to manufacture in large quantities.

SUMMARY OF THE INVENTION

[0009] The object of the invention is, among others, a heat exchanger in particular for a motor vehicle comprising a first header, a first tank assembled with the first header, a second header, a second tank assembled with the second header, a plurality of tubes deployed in parallel to each other between the first header and the second header, the tubes comprising an open ends received in the headers, and at least one tube reinforcement, characterised in that the tube reinforcement comprises a support element, plurality of projecting legs protruding substantially perpendicularly from the support element, wherein the projecting legs are introduced into at least three tubes so that they are in contact with the inner walls of the tubes.

[0010] The invention provides a tube reinforcement for three or more tubes. The tube reinforcement may be produced in a cheap and efficient way. Providing a reinforcement for at least three tubes improves the heat exchanger's efficiency and prevents malfunction, due to e.g. thermal shock.

[0011] Preferably, the tube comprises an inner wall deployed between the two opposite walls of the tube, wherein at least one of the projecting legs is introduced into the tube in the vicinity of the inner wall so that it is in a contact with the inner wall.

[0012] Preferably, the tube reinforcement comprises at least one opening section, the opening section comprising at least one opening configured to fluidly communicate the tank with the tube adjacent to said opening, wherein the opening comprises two shorter sides from which the projecting legs protrude, and two longer sides deployed between the projecting legs.

[0013] Preferably, the opening section is of a size substantially equal to the inner perimeter of the open end of the tube.

[0014] Preferably, the opening section comprises at least two openings which are aligned in series and parallelly to the open end of the adjacent tube.

[0015] Preferably, the openings adjacent to the same tube are inclined with respect to the tube and shifted with respect to each other in the direction of the consecutive tubes.

[0016] Preferably, the length of the projecting legs protruding from the opening section is substantially equal to the half of length of a longer side of the opening.

[0017] Preferably, the length of the projecting legs protruding from the opening section is substantially equal to the length of the longer side of the opening.

[0018] Preferably, the width of the projecting legs is substantially equal to half of the shorter side of the opening section.

[0019] Preferably, the support element comprises an upper surface, a lower surface, two side surfaces, and two terminal surfaces, wherein the upper surface faces the tank, the lower surface faces the headers, the side surfaces are parallel to the protruding legs introduced into the same tube, and the terminal surfaces are parallel to the protruding legs introduced into the neighboring tubes.

[0020] Preferably, at least two projecting legs introduced into the same tube are deployed on the opposite terminal side surfaces of the support element.

[0021] Preferably, the support portion comprises an arched portion connecting the projecting legs with the side surfaces of the support portions.

[0022] Preferably, the arched portions of the neighboring support portions are deployed symmetrically between the two adjacent tubes so that the fluidal communication between the tubes and the tanks is enabled.

[0023] Preferably, the tube reinforcement comprises at least one bar extending perpendicularly to the projecting legs, the bar being configured to immobilize with respect to each other at least two support portions.

[0024] Preferably, the bar is integral with at least one of the surfaces of the support portions.

[0025] Preferably, the bar is integral with the upper surfaces of the support portions.

[0026] Preferably, the bar is integral with the lower surfaces of the support portions.

[0027] Preferably, the bar is integral with the side surfaces of the neighboring support portions.

[0028] Preferably, bar is integral with the terminal surfaces of the neighboring support portions.

[0029] Preferably, the projecting legs are introduced into at least three consecutive tubes.

[0030] Preferably, the heat exchanger, comprises at least one unreinforced tube deployed between the subsequently projecting legs of the tube reinforcement.

[0031] Preferably, the projecting legs comprise beveled ends.

[0032] Preferably, the tube reinforcement is made of the single sheet of metal.

BRIEF DESCRITPTION OF DRAWINGS

[0033] Examples of the invention will be apparent from and described in detail with reference to the accompanying drawings, in which:

Fig. 1 shows an exploded view of a heat exchanger with tube reinforcement in one of the examples.

Fig. 2 shows a partially transparent side view of tube reinforcement deployment in one of the examples.

Fig. 3 shows a perspective exploded view of tube reinforcement- tube assembly in one of the examples.

Fig. 4 shows a first perspective view of the tube reinforcement with the bar connection in one of the examples.

Fig. 5 shows a second perspective view of the tube reinforcement with the bar connection in one of the examples.

Fig. 6 shows a third perspective view of the tube reinforcement with the bar connection in one of the examples.

DETAILED DESCRIPTION OF EMBODIMENTS

[0034] The invention relates to heat exchangers, in particular radiators used in automobiles.

[0035] Fig.1 presents a heat exchanger 1, in particular a radiator that may be used in an automobile. The heat exchanger 1 is configured to convey a cooling medium, such as a coolant through its sub-components so that the temperature of the cooling medium flowing out of the heat exchanger 1 would be lower than the temperature of the cooling medium flowing into the heat exchanger 1 thanks to heat exchange with a second medium, e.g. air.

[0036] The cooling medium is usually delivered into the heat exchanger 1 by an inlet and collected from by an outlet. Depending on the architecture, i.e. the number of passes, desired heat exchanger deployment in the engine bay, etc., the inlet and the outlet are usually deployed either on the opposite sides of the heat exchanger 1, or on the same side of the heat exchanger 1. The inlet and the outlet have usually circular cross-section protruding from inlet and/or outlet of the tanks 40, 50, respectively.

[0037] The first tank 40 is usually an elongated container made of synthetic material that is configured to distribute the cooling medium, whereas the second tank 50 is configured to collect the cooling medium from the heat exchanger 1. Alternatively, a reversed flow through the heat exchanger 1 is allowed. Both tanks 40, 50 usually comprise an openings having substantially rectangular cross-section for receiving a header 2, 3 with a tubes 4. The shape of the tanks 40, 50 presented in the Fig.1 is proven to ensure a homogenous distribution of coolant, yet other shapes of the tanks 40, 50 that will provide similar or better performance are also allowed.

[0038] The tanks 40, 50 may also comprise a plurality of transverse ribs deployed alternately in a direction perpendicular to the longitudinal direction of the tanks 40, 50. Ribs provide rigidity of the tanks 40, 50 at high pressures and ensure reduced deformations thereof. The tanks 40, 50 widen at the side of the rectangular opening to enable tight connection with a respective headers 2, 3.

[0039] The headers 2, 3 are usually an elongated plates made of metal material. Preferably, the metallic components of the heat exchanger 1 are made of lightweight metal alloy e.g. aluminum. The headers 2, 3 usually have a shape similar to the shape of the openings comprised in the tanks 40, 50. In most applications, the synthetic tanks 40,50 are assembled with metal headers 2, 3 by the means of crimping one to the other, as welding is impossible.

[0040] The headers 2, 3 usually comprise slots for receiving a plurality of tubes 4 which protrude from the flat surface of the header 2, 3 towards the tanks 40, 50. The number of slots is usually equal to the number of the tubes 4.

[0041] The tubes 4 are usually made of a single sheet of metal which is folded inwardly, so that the terminal ends of metal sheet create an inner wall 5 that can be attached (e.g. by brazing) to the flat portion of the tube 4. The inner wall 5 is deployed between the two opposite walls of the tube 4. Alternatively, the tubes 4 are made in the process of extrusion. It is also possible for the tubes 4 to not comprise any inner walls 5 e.g. the tubes may be folded on its side.

[0042] The tubes 4 comprise two open ends, and they are usually deployed in parallel to each other between the first header 2 and the second header 3, wherein the open ends of the tubes 4 are received in the slots of the headers 2, 3. To provide a tight connection, the headers 2, 3 and the tubes 4 may be brazed together.

[0043] The heat exchanger 1 comprises also at least one tube reinforcement 10, which can be made of a single sheet of metal. The tube reinforcements 10 may be entered between the tubes 4 and the tank 40, 50, as presented in the Figures 1 and 2. Fig. 1 presents only an exemplary location of the tube reinforcement 10 in the heat exchanger 1.

[0044] Fig.2 presents an assembly of the header 2, 3 comprising a plurality of the tubes 4 and the tube reinforcement 10. The space between the tubes 4 may be filled by heat dispersion elements (not shown), for example fins, in order to increase the heat exchanger 1 efficiency.

[0045] The tube reinforcement 10 comprises in all of its forms a support element 11, which is essentially a flat portion perpendicular to the main direction of the tubes 4. The support element 11 neither enters the slot of the header 2, 3, nor the open ends of the tubes 4 and it is usually deployed between the header 2, 3 and the tank 40, 50. The support element 11 visible in Fig. 2 and Fig. 3 is made of a single sheet of metal and it comprises two lateral walls perpendicular to the main direction of the tubes 4 and parallel to the main direction of the header 2, 3, and two transverse walls which are essentially perpendicular to the lateral walls. Phrase "essentially perpendicular" means that some leftover material forming a sloping wall comprised in the lateral wall is allowed. In majority of applications, the lateral walls are longer than the transverse walls, yet the support element 11 comprising the transverse walls longer or equal to the lateral walls is also envisaged.

[0046] The tube reinforcement 10 comprises also a projecting legs 12 protruding substantially perpendicularly from the support element 11. The projecting legs 12 are formed from the support element 11, so that both portions are materially connected. This may be achieved, for example, by using the stamping process, wherein it may be executable to cut the material to form the projecting legs 12 in the first action, and to bend them to desired orientation with respect to the support element 11 in the second action. Alternatively, it may be feasible to laser cut the material to shape the projecting legs 12 in the first action, and to bend them to desired orientation in with respect to the support element 11 in the second action. Alternatively, it may be feasible to water jet the material to shape the projecting legs 12 in the first action, and to bend them to desired orientation in with respect to the support element 11 in the second action. The projecting legs 12 are usually introduced into at least three consecutive tubes 4. The projecting legs 12 enter the tube 4 so that they penetrate the cross- section of the header 2, 3 as presented in the Fig. 2. The projecting legs 12 are deployed in the tubes 4, so that they remain in a contact with the inner walls of the tube 4, and at least one side of the inner wall 5 if the tube 4 comprises it. The projecting legs 12 may comprise a beveled ends to facilitate introducing the tube reinforcement into the tubes 4.

[0047] Fig. 3 presents an exploded view of the exemplary tube reinforcement 10 pre-inserted into the open ends of the tubes 4. The tube reinforcement 10 comprises at least one opening section 30. The opening section 30 has an essentially rectangular shape, wherein the longer sides are substantially parallel to the transverse walls of the support portion 11. The opening section 30 is of a size substantially equal to the inner perimeter of the open end of the tube 4. In other words, the outline of the opening section 30 corresponds to the inner perimeter of the open end of the tube 4. This includes also the tube 4 comprising the inner wall 5, wherein the inner perimeter of the open end of the tube 4 would be delimited by the sum of inner perimeters of two adjacent channels, which are divided by the inner wall 5.

[0048] The opening section 30 enables fluidal communication between the tube 4 and the tanks 40, 50 by at least one opening 6, 7 comprised therein. In the majority of the applications, the openings 6, 7 may be aligned in series and parallelly to the open end of the adjacent tube 4. Alternatively, the openings 6, 7 adjacent to the same tube 4 may be inclined with respect to the tube 4 and shifted with respect to each other substantially in the direction of the consecutive tubes 4, as presented in the Fig. 3. This allows to improve rigidity of the plate compared to non-shifted arrangement by limiting the length of relatively thin wall portions between the openings 6, 7. Using shifted openings 6, 7 in some applications may be beneficial in terms of e.g. pressure drop. The number of the openings 6, 7 in the single opening section 30 may be increased by at least one in reference to the number of the inner walls 5 comprised within the single tube 4. The openings 6, 7 are configured to fluidly communicate the tanks 40, 50 with the tube 4, in particular the tube 4 which is in the nearest vicinity of the opening 6, 7. As shown in the Fig. 3, the projecting legs 12 may protrude from the opening 6, 7, because the opening section 30 with the openings 6, 7 and the projecting legs 12 may comprise the common portions.

[0049] Further, the projecting legs 12 may protrude from the openings 6, 7 in at least two different ways. One pair of projecting legs 12 carried out from the opening 6, 7 may be separated along the axis of symmetry of the opening 6, 7 being perpendicular to its longer side. In other words, the protruding legs 12 may be cut and bent in the middle of the opening. As the consequence, the length of the projecting legs 12 protruding from the opening section 30 is substantially equal to the half of length of a longer side of the opening 6, 7. The one pair of projecting legs 12 carried out from the opening 6, 7 may also be separated along the axis of symmetry of the opening 6, 7 being parallel to its longer side, so that the projecting legs 12 are deployed alternately with respect to each other, as shown in the Fig. 3. As the consequence, the length of the projecting legs 12 protruding from the opening section 30 is substantially equal to the length of the longer side of the opening 6,7. It is highly notable that the length between the terminal end of the projecting leg 12 and the surface of the support element 11 opposite thereto is greater than the length between the inner surface of the header 2,3 and the surface of the support element 11 opposite thereto. The surface of the support element 11 should be regarded as the surface not occupied by the projecting legs 12. i.e. opposite to the main direction of projection of the projecting legs 12.

[0050] The method of deployment of the alternate projecting legs 12 may be preferred for the shifted openings 6, 7 deployment, so that the projecting legs 12 comprised in one opening section 30 would be aligned linearly with respect to the open ends of the tube 4.

[0051] Both methods of deploying the projecting legs 12 may be advantageous in certain circumstances. In the first example, the protruding legs 12 are shorter than in the second example, but they are thicker and less vulnerable for deformations, as the width of the projecting legs 12 is substantially equal to shorter side of the opening section 30.

[0052] In the second example, the projecting legs 12 are longer than in the first example, but they are able to penetrate deeper into the tube 4 to increase the contact area between the projecting legs 12 and the inner side of the tube 4, as the width of the projecting legs 12 is substantially equal to half of the shorter side of the opening section 30.

[0053] Alternatively, one pair of projecting legs 12 carried out from the opening 6, 7 may be separated along the diagonal axis of the opening 6, 7 forming spiky-shaped projecting legs 12, however, this form of legs would be undesired due to complicated production process.

[0054] The subject of an invention may be produced also in a different way as shown in Figs 4-6.

[0055] The tube reinforcement 10 can be made of at least two segments which remain materially connected with each other. The single segment is substantially a single support element 11 comprising the projecting legs 12. In some applications, it is possible to make a tube reinforcement 10 presented in Figs 4-6 out of the single sheet of metal.

[0056] The support element 11 presented in the Figs 4-6 usually comprises four sides, wherein each side has its surface, i.e. an upper surface S1, a lower surface S2, two side surfaces S3, S3', and two terminal surfaces S4, S4'. The upper side S1 faces the tank 40, 50 and the lower surface S2 faces the headers 2, 3. The planes delimited by the side surfaces S3, S3' are parallel to the planes delimited by the protruding legs 12 introduced into the same tube 4, and the planes delimited by the terminal surfaces S4, S4' are parallel to the plane delimited by the protruding legs 12 introduced into the same side of the neighboring consecutive tubes 4.

[0057] The term "surface" could be analogically applied in embodiments presented in the Figs 1-3, however, the wording used for describing essential features thereof is sufficient.

[0058] Figs. 4-6 show the tube reinforcements 10 comprising, amongst others, the support elements 11, the projecting legs 12 protruding from the support element 11, and at least one bar 15a, 15b configured to immobilize at least two support elements 11 with respect to each other.

[0059] Each of the support elements 11 may comprise at least one through hole which facilitates the insertion process of the tube reinforcement 10 into the tubes 4. In the embodiments presented in the Figs 4-6, the tube reinforcements 10 comprise two through holes deployed symmetrically and penetrating the support elements 11 towards the header 2, 3.

[0060] The shape of the support elements 11 may be considered as essentially rectangular, although the upper surface S1 and the lower surface S2 widens in the vicinity of the projecting legs 12. This allows to increase the ratio between the spread of the projecting legs 12 of the support element 11 introduced into consecutive tubes 4 and the spread of the side surfaces S3 and S3' of the support element 11. Consequently, the support portions 11 comprise an arched portion 14 connecting the projecting legs 12 with the side surfaces S3, S3' of the support portions 11. It further allows an undisturbed fluid transfer between the tube 4 and the tanks 40, 50 by preventing the support element 11 from blocking the ends of the tube 4. In other words, the arched portion 14 of the neighboring support portions 11 are deployed symmetrically between the two adjacent tubes 4 so that the fluidal communication between the tubes 4 and the tanks 40, 50 is enabled.

[0061] The projecting legs 12 protruding from the support elements 11 comprise a length, a width, and a thickness, wherein the width of the projecting leg 12 is usually greater than its thickness and the length is greater than width and thickness. The thicker projecting legs 12 significantly limit unwanted bending thereof and also increase contact surface between the tube reinforcement 10 and the inner wall of the tube 4.

[0062] It has been already mentioned that the projecting legs 12 are introduced into at least three consecutive tubes 4, so the invention presented in the Figs 4-6 requires a connecting of at least two segments.

[0063] The tube reinforcement 10 usually comprises at least two projecting legs 12 introduced into the same tube 4 that are deployed on the opposite terminal side surfaces S3, S3' of the support element 11.

[0064] Fig. 4 presents an example of the tube reinforcement 10 comprising several segments immobilized with respect to each other by the means of the bar 15a extending perpendicularly to the projecting legs 12. The bar 15a may be deployed symmetrically between the terminal surfaces S4 and S4' and connected to the upper surfaces S1 of the consecutive support elements 11 by the means of e.g. brazing. Alternatively, the bar 15a may be integral with the upper surfaces S1 of the consecutive support portions 11.

[0065] Alternatively, the bar 15 may be integral with the lower surfaces S2 of consecutive support portions 11 to provide a distancing means between the tube 4 and the tube reinforcement 10.

[0066] The term "integral" means that there is a consolidated connection between at least two elements, so that distinguishing these elements or the means of connecting them is impossible.

[0067] Fig. 5 presents an example of the tube reinforcement 10 comprising several segments immobilized with respect to each other by the means of the integrated bar 15a extending perpendicularly to the projecting legs 12. The integrated bar 15a may be deployed symmetrically between the terminal surfaces S4 and S4' and it may connect the side surface S3' of one support element 11 with the side surface S3 of the consecutive support element 11.

[0068] Fig. 6 presents an example of the tube reinforcement 10 comprising several segments immobilized with respect to each other by the means of the two integrated bars 15a, 15b extending perpendicularly to the projecting legs 12. The integrated bars 15a, 15b may be deployed symmetrically with respect to each other. In the embodiment presented in the Fig. 6, the first bar 15a connects the consecutive terminal surfaces S4 of one side of the support portion 11 and the second bar 15b connects the consecutive terminal surfaces S4' of the other side of the support portion 11.

[0069] The heat exchanger 1 may also comprise at least one unreinforced tube (not shown) deployed between the subsequently projecting legs 12 of the tube reinforcements 10. The term "unreinforced" refers to at least one tube 4, which is in the perimeter of the tube reinforcement 10, but the projecting legs 12 are of reduced length or not provided at all, so that they do not reach the inner walls of the tube 4 and do not come into contact with them.

[0070] 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 heat exchanger (1) in particular for a motor vehicle comprising:

- a first header (2),
- a first tank (40) assembled with the first header (2),
- a second header (3),
- a second tank (50) assembled with the second header (3),
- a plurality of tubes (4) deployed in parallel to each other between the first header (2) and the second header (3), the tubes (4) comprising open ends received in the headers (2,3), and
- at least one tube reinforcement (10),

characterised in that,
the tube reinforcement (10) comprises a support element (11) and a plurality of projecting legs (12) protruding substantially perpendicularly from the support element (11), wherein the projecting legs (12) are introduced into at least three tubes (4) so that they are in contact with the inner walls of the tubes (4).

2. The heat exchanger (1) according to any of the preceding claims, wherein the projecting legs (12) are introduced into at least three consecutive tubes (4).

3. The heat exchanger (1) according to any of the preceding claims, wherein the tube reinforcement (10) comprises at least one opening section (30), the opening section (30) comprising at least one opening (6,7) configured to fluidly communicate tank (40, 50) with the tube (4) adjacent to said opening (6, 7), wherein the opening (6,7) comprises two shorter sides from which the projecting legs (12) protrude, and two longer sides deployed between the projecting legs (12).

4. The heat exchanger (1) according to claim 3, wherein the opening section (30) is of a size substantially equal to the inner perimeter of the open end of the tube (4).

5. The heat exchanger (1) according to any of the preceding claims, wherein the opening section (30) comprises at least two openings (6,7) which are aligned in series and parallelly to the open end of the adjacent tube (4).

6. The heat exchanger (1) according to any of the preceding claims, wherein the openings (6,7) adjacent to the same tube (4) are inclined with respect to the tube (4) and shifted with respect to each other in the direction of the consecutive tubes (4).

7. The heat exchanger (1) according to claim 3, wherein the length of the projecting legs (12) protruding from the opening section (30) is substantially equal to the half of length of a longer side of the opening (6,7).

8. The heat exchanger (1) according to claim 3, wherein the length between the terminal end of the projecting leg (12) and the surface of the support element (11) opposite thereto is greater than the length between the inner surface of the header (2,3) and the surface of the support element (11) opposite thereto.

9. The heat exchanger (1) according to claim 1, wherein the tube (4) comprises an inner wall (5) deployed between the two opposite walls of the tube (4), wherein at least one of the projecting legs (12) is introduced into the tube (4) in the vicinity of the inner wall (5) so that it is in a contact with the inner wall (5).

10. The heat exchanger (1) according to claim 1, wherein the support element (11) comprises an upper surface (S1), a lower surface (S2), two side surfaces (S3, S3'), and two terminal surfaces (S4, S4'), wherein the upper side (S1) faces the tank (40, 50), the lower surface (S2) faces the headers (2, 3), the side surfaces (S3, S3') are parallel to the protruding legs (12) introduced into the same tube (4), and the terminal surfaces (S4, S4') are parallel to the protruding legs (12) introduced into the neighboring tubes (4).

11. The heat exchanger (1) according any of the preceding claims, wherein the tube reinforcement (10) comprises at least one bar (15a, 15b) extending perpendicularly to the projecting legs (12), the bar (15a) being configured to immobilize with respect to each other at least two support portions (11).

12. The heat exchanger (1) according to claim 14, wherein the bar (15a, 15b) is integral with at least one of the surfaces of the support portions (11).

13. The heat exchanger (1) according to claim 15, wherein the bar (15) is integral with the side surfaces (S3, S3') of the neighboring support portions (11).

14. The heat exchanger (1) according to claim 15, wherein the bar (15) is integral with the terminal surfaces (S4, S4') of the neighboring support portions (11).

15. The heat exchanger (1) according to any of the preceding claims, comprising at least one unreinforced tube deployed between the subsequently projecting legs (12) of the tube reinforcement (10).

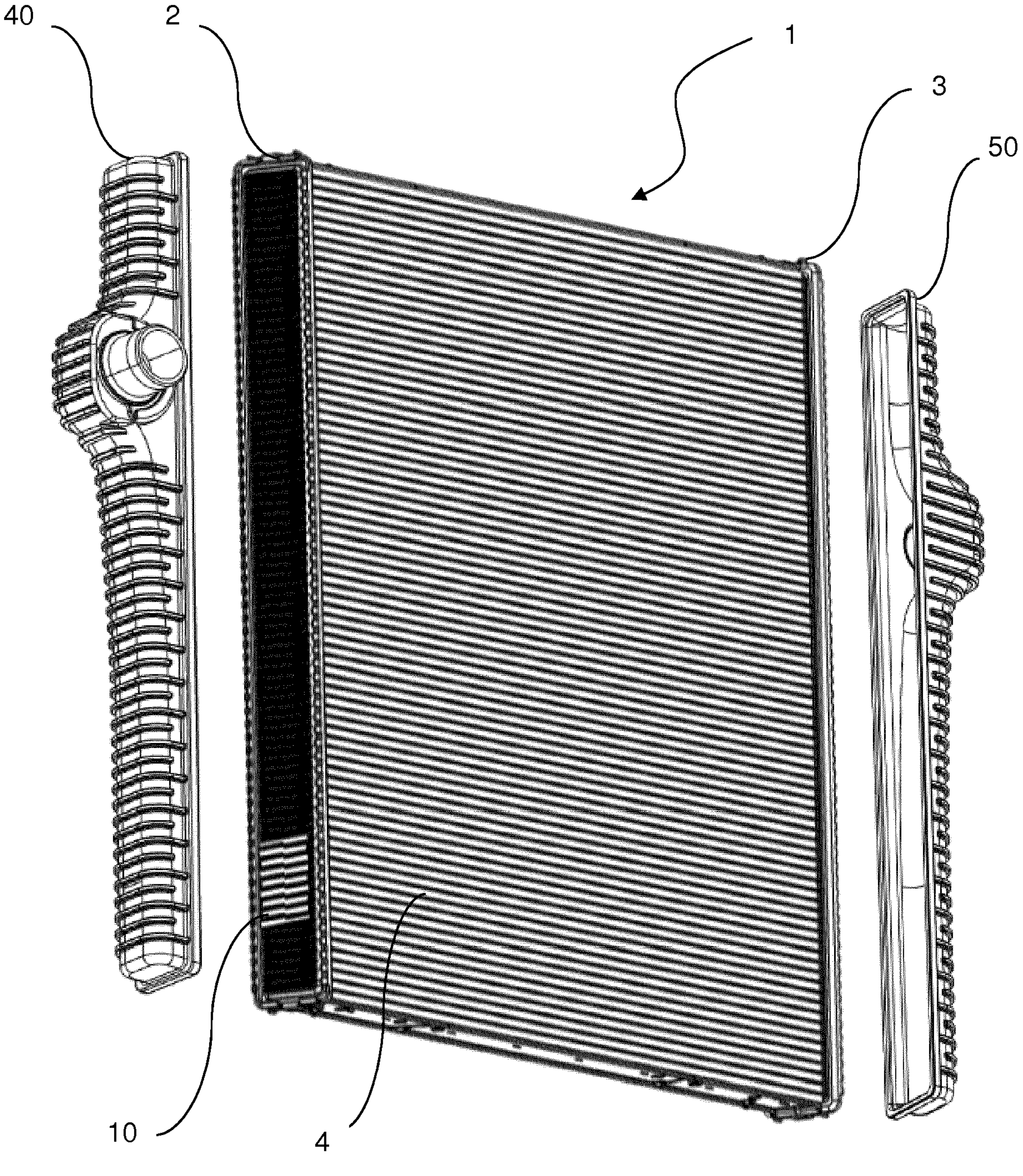

Fig. 1

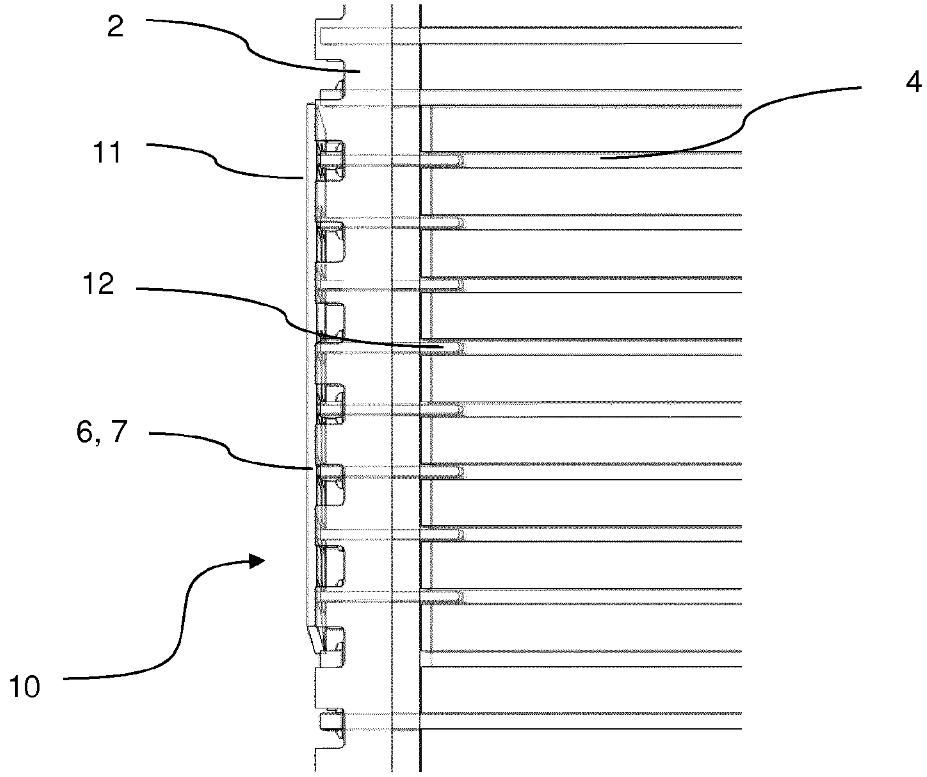

Fig. 2

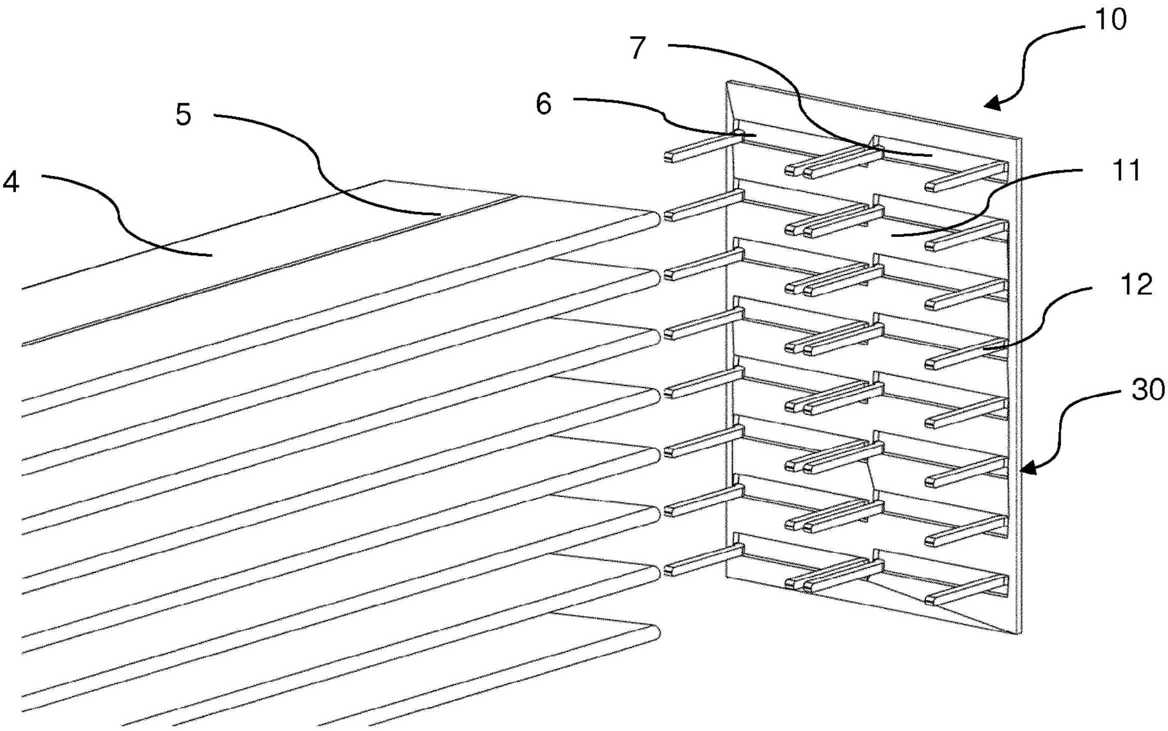

Fig. 3

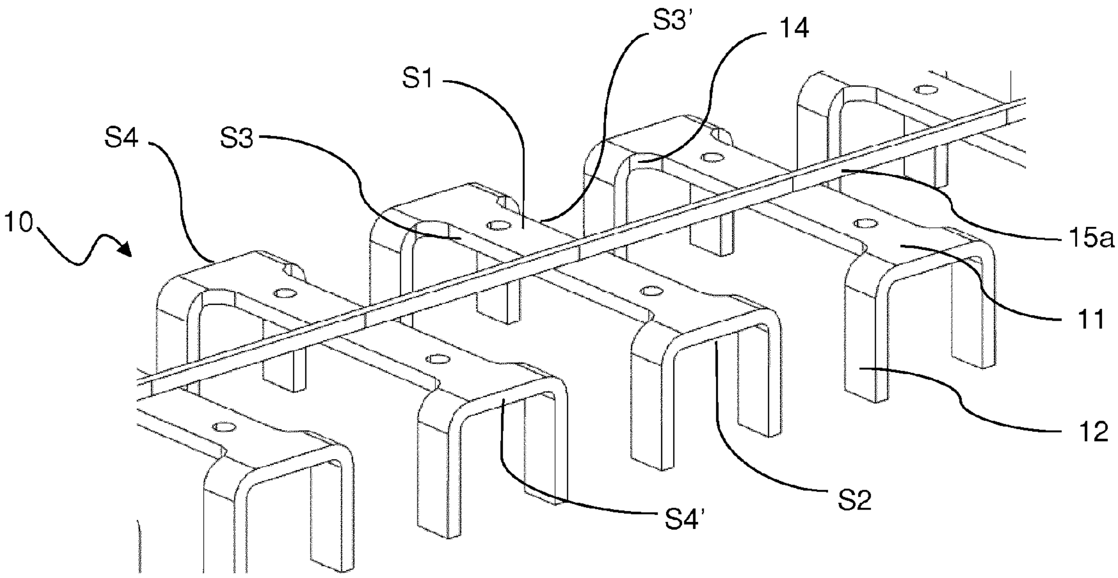

Fig. 4

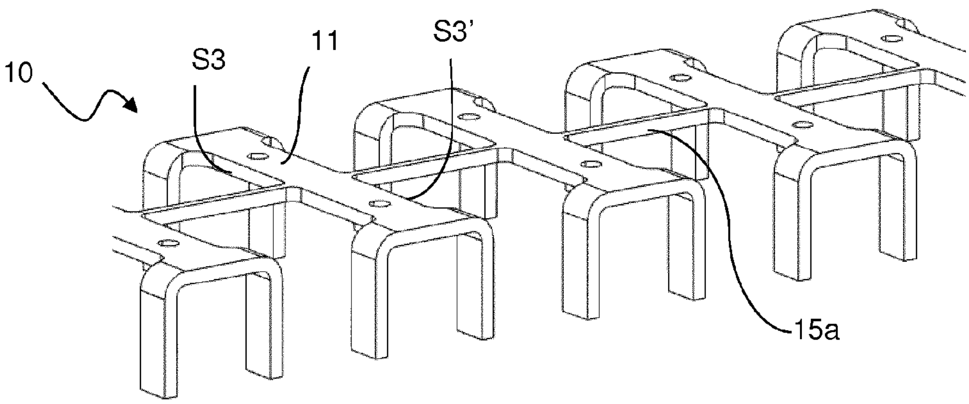

Fig. 5

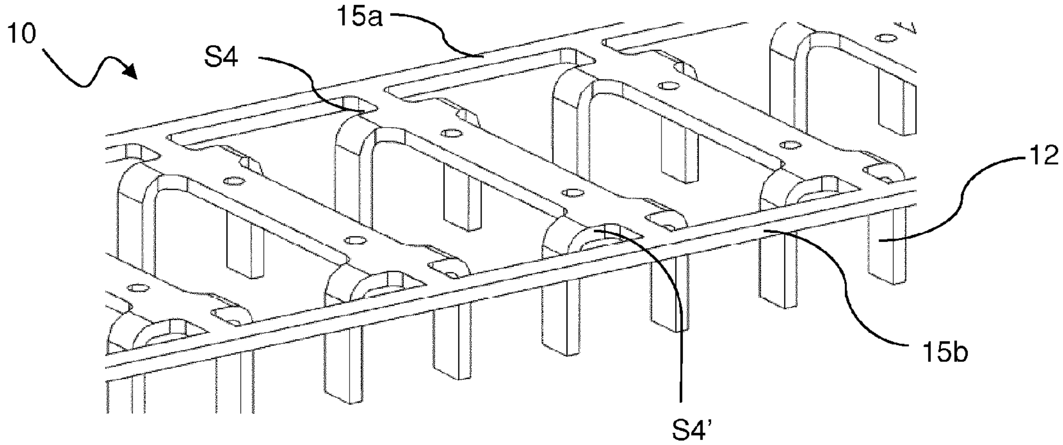

Fig. 6

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 19 46 1604

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	US 2007/144718 A1 (HEINE REINHARD [DE] ET AL) 28 June 2007 (2007-06-28) * figures 1-6 *	1-5,7-10	INV. F28D1/053
X	DE 20 2014 103206 U1 (AUTOKÜHLER GMBH & CO KG [DE]) 14 October 2015 (2015-10-14) * figure 6 *	1-5,7-10	
X	US 8 656 988 B1 (PAUL NEAL [US] ET AL) 25 February 2014 (2014-02-25) * column 3, line 7 - column 6, line 41; figures 1-5 *	1,2,9-14	
X	US 2005/263263 A1 (MERKLEIN BRIAN [US] ET AL) 1 December 2005 (2005-12-01) * paragraph [0054] - paragraph [0058]; figures 1-5 *	1,2, 9-11,15	
A	JP 2011 038655 A (T RAD CO LTD) 24 February 2011 (2011-02-24) * figures 1-8 *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

F28D
F28F

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	18 May 2020	Jessen, Flemming

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 46 1604

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

18-05-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007144718 A1	28-06-2007	BR PI0416772 A	27-02-2007
		CN 1882818 A	20-12-2006
		DE 10354382 A1	16-06-2005
		EP 1687583 A1	09-08-2006
		JP 4460583 B2	12-05-2010
		JP 2007511733 A	10-05-2007
		US 2007144718 A1	28-06-2007
		WO 2005050120 A1	02-06-2005
DE 202014103206 U1	14-10-2015	NONE	
US 8656988 B1	25-02-2014	NONE	
US 2005263263 A1	01-12-2005	CA 2508510 A1	01-12-2005
		DE 102005024902 A1	29-12-2005
		MX PA05005637 A	05-12-2005
		US 2005263263 A1	01-12-2005
JP 2011038655 A	24-02-2011	JP 5443093 B2	19-03-2014
		JP 2011038655 A	24-02-2011

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82