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(54) **A vehicle heat exchanger**

Wärmetauscher für Kraftfahrzeug

Echangeur de chaleur pour véhicule automobile

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Description

[0001] The present invention relates to a vehicle heat exchanger and in particular to a vehicle heat exchanger for use as an oil cooler in automotive applications.

[0002] Oil coolers of brazed aluminium construction are known. These typically comprise a plurality of stacked brazable aluminium plates having interposed therebetween planar apertured turbulators. The turbulators space the plates defining fluid receiving galleries and provide a flow matrix for inducing agitated flow through the oil cooler. Typically the galleries are arranged in alternating fluid connection in the stack, a first connected gallery system defining a flowpath through the oil cooler for a cooling fluid (typically water); a second connected gallery system defining a flowpath through the oil cooler for the oil to be cooled. In such oil coolers the turbulators for the 'oil side' galleries and the 'water side' galleries are typically substantially identical (and of the same depth). The depth of the 'oil side' and 'water side' galleries is therefore substantially identical.

[0003] It has been found that efficient oil cooler performance is achieved by reducing the 'water side' gallery depth and replacing the 'water side' turbulator by conical projections provided on relevant plates. 'Oil side' turbulators are necessary to provide the required surface area in view of the lower heat capacity of oil compared with water. The conical projections provide support preventing collapse of the 'water side' galleries when the oil cooler is pressurised.

[0004] By reducing the depth of the 'water side' galleries the overall dimensions of the oil cooler can be minimised without significant compromise in performance. This is of substantial benefit in view of the premium placed on engine bay space in current vehicle engine design.

[0005] The present invention seeks to provide an improved heat exchanger (particularly an oil cooler) of enhanced construction, durability and performance.

[0006] Prior art heat exchangers are disclosed in, for example, EP-742418, DE-9309741 and EP-623798. The arrangement described in EP-623798 may be described as comprising a vehicle heat exchanger comprising a plurality of stacked galleries, including a first gallery system for containing a first fluid, and a second gallery system for containing a second fluid, the first and second gallery systems being substantially sealed from one another, the gallery systems being defined by a plurality of stacked elements comprising:

i) a dimpled shell element including a tapered peripheral wall and a plurality of spaced dimples formed in and projecting away from a surface of the dimpled shell element;

ii) a plain shell element nested within the dimpled shell element and having a surface contacted by the plurality of projecting dimples of the dimpled shell

element, the plain shell element including a tapered peripheral wall nested in contact with the corresponding tapering peripheral wall of the dimpled shell element, such that the projecting dimples of the dimpled shell element about the nesting plain shell element and define the nesting overlap of the peripheral tapered walls, a first gallery being defined between the plain shell element and the dimpled shell element;

iii) a turbulator element nested within the plain shell element; and,

iv) a further dimpled shell element being nested in the plain shell element, the further dimpled element including a tapered peripheral wall nesting in contact with the corresponding tapered peripheral wall of the plain shell element, and a plurality of spaced dimples projecting away from the turbulator element, a second gallery being defined between the further dimpled shell element and the nesting plain shell element, and occupied by the turbulator element.

[0007] According to the present invention the dimples formed in the dimpled shell elements project upwardly in the same general direction as the tapered peripheral wall of the respective dimpled shell element.

[0008] Desirably the elements comprising the heat exchanger are of brazable aluminium. Typically the plain shell element and/or the dimpled shell element and/or the turbulator are clad in a fusible brazing alloy when assembled, the fusible brazing alloy flowing during brazing to bond adjacent components at contact points.

[0009] It is preferred that galleries in the first gallery system (the "water side" galleries) are of a depth less than galleries in the second gallery system (the "oil side" galleries). This leads to the space saving benefits identified above.

[0010] The nested stacked sequence of dimpled shell, plain shell, turbulator element preferably repeats, typically to provide between 5 and 9 galleries in each gallery system.

[0011] The peripheral wall of the plain shell element desirably extends beyond the peripheral wall of the dimpled shell element within which the plain shell element is nested.

[0012] The peripheral walls of the nesting dimpled shell element the nested plain shell element and the further nested dimpled shell element beneficially define the outer wall of the heat exchanger.

[0013] Tapering nesting peripheral walls for the dimpled and plain shell elements are particularly beneficial in accordance with the invention because good contact for brazing is ensured by the dimples of the dimpled shell element abutting (and defining the nesting overlap with) the plain shell element.

[0014] The spaced dimples preferably taper from a

root portion to a head portion, the head portion of a respective dimple desirably comprising a flat. The flat abuts against a respective portion of the plain shell element and provides improved contact surfaces for brazing.

[0015] The turbulator element advantageously comprises a substantially planar element such as a turbulator plate, preferably including a plurality of apertures or formations permitting fluid flow through the turbulator element (and along the gallery). The turbulator element beneficially has an undulating profile including a series of undulations (preferably comprising spaced linear ridge lines) defining contact points with the adjacent dimpled shell element and shell element. The spaced elongate ridges of the turbulator are beneficially so spaced and arranged relative to the dimpled plate that contact with the dimpled shell is substantially with undimpled contact points.

[0016] The plain shell element and dimpled shell element preferably have nested peripheral walls brazed together, as preferably have the plain shell element and further dimpled shell element.

[0017] A fluid supply inlet and outlet is provided for the first gallery system, and a fluid supply inlet and outlet is provided for the second gallery system. Fluid communication means between successively stacked galleries in the same gallery system is provided. The fluid communication means comprises co-aligned apertures in the plain shell elements and dimpled shell elements, the co-aligned apertures having respective rims arranged either to seal against one another or be spaced from one another depending upon the fluid to be carried in a respective gallery. It is therefore preferred that both the dimpled and plain shell elements have respective co-aligned apertures having rims projecting toward the other of the respective dimpled or shell element.

[0018] The fluid galleries are stacked alternately, such that adjacent galleries comprise galleries from alternate gallery systems.

[0019] A heat exchanger according to the invention may be manufactured by building a stacked assembly of brazable aluminium elements comprising:

- v) a dimpled shell element including a plurality of spaced dimples formed in and projecting away from a surface of the first shell element;
- vi) a plain shell element nested within the dimpled shell element and having a surface contacted by the plurality of projecting dimples of the dimpled shell element, a first gallery being defined between the plain shell element and the dimpled shell element;
- vii) a turbulator element nested within the plain shell element; and,
- viii) a further dimpled shell element being nested in the plain shell element, the further dimpled element

including a plurality of spaced dimples projecting away from the turbulator element, a second gallery being defined between the further dimpled shell element and the nesting plain shell element, and occupied by the turbulator element;

and brazing the stacked assembly.

[0020] The invention will now be further described in a specific embodiment, by way of example only, and with reference to the accompanying drawings, in which:

Figure 1 is a sectional view through a heat exchanger according to the invention;

Figure 2 is a an exploded view of stacked elements comprising the heat exchanger of figure 1; and

Figure 3 is a detailed sectional view of a dimpled projection provided on a dimpled shell.

[0021] The oil cooler 1 is of brazed aluminium construction and comprises a series of nested stacked aluminium shells 2, 4 brazed to form the structure shown in Figure 1. The stacked shells 2, 4 define therebetween a "water side" gallery system communicating between a water inlet 5 and a water outlet (not shown in Figure 1) communicating through a top plate 6 of the oil cooler. A second gallery system is also defined by the shells 2, 4 comprising an "oil side" gallery system communicating between an oil inlet 7 and an oil outlet (not shown in Figure 1) communicating via base plate 8.

[0022] As will be described in detail hereafter, the gallery system is arranged such that the stacked arrangement has "water side" galleries alternating with "oil side" galleries. Water flowing between the water inlet 5 and water outlet gains access to all water side galleries via apertures 9a, 10a, 9b, 10b provided in shell plates 2, 4 respectively. Upwardly extending rims 11, 12 provided for apertures 9b, 10b are sealingly brazed to the peripheral edge of respective apertures 9a, 10a to prevent ingress into the "oil side" gallery system (and vice versa). A vertical water "core" (having axis X) is shown in Figure 1 formed by stacked co-aligned apertures 10a, 10b. Corresponding cores exist for the co-aligned apertures 9a, 9b and oil side apertures 16a, 16b and 17a, 17b.

[0023] Dimpled shell 2 includes a spanning portion 13 terminating in an outwardly and upwardly inclined peripheral wall 14. Spanning portion 13 is provided with an array of dimpled projections 15, projecting upwardly in the corresponding direction to peripheral wall 14. On its obverse side spanning portion 13 is provided with a series of dimpled depressions (resulting from the deformation of plate 13 during the forming of the dimples 15). Apertures 16a, 17a in dimpled shell 2 and apertures 16b, 17b in plain shell 4 define the oil flow path through the oil cooler, permitting water to flow into the "oil side" galleries defined between the dimpled depressions on the underside of dimpled shell 2 and the planar upper-

most surface 18 of plain shell 4. Upwardly extending rims 19, 20 around respective apertures 16a, 17a seal with corresponding aperture 16b, 17b (by brazing) provided on an adjacent upper stacked plain shell 4 (not shown in Figure 2) preventing leakage of the oil from the "oil side" gallery system.

[0024] When assembled in a stack prior to brazing, the underside surface of a plain shell 4 sits on the dimpled projections 15 (of an underlying dimpled shell 2). The dimples thereby space an upper plain shell 4 from an underlying, nesting dimpled shell 2. The outer peripheral wall 21 of plain shells 4 is inclined correspondingly to the outer peripheral wall 14 of dimpled shells 2 facilitating ease of nesting and ensuring that a plain shell 4 is snugly received in a respective underlying dimpled shell 2 such that the respective tapered walls 21, 14 are in face to face abutment with one another. This provides a good contact surface for brazing. Furthermore, in view of the fact that the respective peripheral walls 21, 14 are tapered, the tolerance required for nesting is relatively liberal.

[0025] The dimpled projections 15 extend from a root portion 22 extending to a pinnacle in the form of a "flat" 23. The flat 23 provides a good contact surface for brazing with the underside of an above nesting plain shell 4.

[0026] The water side galleries are defined between dimpled shells 2 and above nested shells 4 in the space across which dimples 15 project. Dimples 15 ensure good brazing contact between nested shells 4, 2 and also ensure that the water side galleries do not deform when the oil cooler is pressurised. The oil side galleries are defined between dimpled shells 2 and underlying plain shells 4, a turbulator plate 13 being present in the space between the upper surface 18 of plain element 4 and the dimpled depression underside of an overlying dimpled shell 2. The turbulator plate 13 may be of a form generally known in the art, and comprises a pressed aluminium component having a plurality of ridge formations extending generally transversely to the major axis of the turbulator plate, the ridges including a multiplicity of apertures permitting oil flow throughout the gallery. The upper surface of the turbulator plate 3 is brazed to the dimpled depression underside of overlaid dimpled shell 2. The underside of turbulator plate 3 is brazed to the planar surface of an underlaid plain shell 4. The turbulator plates 3 are nested in respective plain shells 2 during assembly. The side wall 21 extends upwardly beyond the top surface of turbulator plate 3 permitting the nesting of an overlaying dimpled shell 2 within the side wall 21.

[0027] The dimensions of dimpled projections 15 and the depth of turbulator to plate 3 are arranged such that the "water side" galleries are of less depth than the "oil side" galleries. This is because it has been found that in view of the relatively higher heat capacity of water compared to oil, an "additional" turbulator (corresponding to the oil side turbulator 3) is not required in the water side gallery, the dimples 15 providing sufficient water agita-

tion and surface area for good oil cooler performance to be achieved. The dimple projections 15 provide good brazing and sufficient structural integrity to avoid collapsing or bursting of the water galleries when the heat exchanger is pressurised with oil and water. The overall dimensions of the oil cooler can therefore be reduced compared to prior art arrangements. The nesting arrangement in which peripheral walls nest with dimpled shells 2 (and vice versa) provides an extremely convenient way of assembling a stacked oil cooler for brazing.

Claims

1. A vehicle heat exchanger (1) comprising a plurality of stacked galleries, including a first gallery system for containing a first fluid, and a second gallery system for containing a second fluid, the first and second gallery systems being substantially sealed from one another, the gallery systems being defined by a plurality of stacked elements comprising:

i) a dimpled shell element (2) including an outwardly and upwardly inclined peripheral wall (14) and a plurality of spaced dimples (15) formed in and projecting away from a surface (13) of the dimpled shell element (2);

ii) a plain shell element (4) nested within the dimpled shell element (2) and having a surface (18) contacted by the plurality of projecting dimples (15) of the dimpled shell element (2), the plain shell element (4) including a tapered peripheral wall (21) nested in contact with the corresponding outwardly and upwardly inclined peripheral wall (14) of the dimpled shell element (2), such that the projecting dimples (15) of the dimpled shell element (2) abut the nesting plain shell element (4) and define the nesting overlap of the peripheral tapered walls (14, 21), a first gallery being defined between the plain shell element (4) and the dimpled shell element (2);

iii) a turbulator element (3) nested within the plain shell element (4); and,

iv) a further dimpled shell element (2) being nested in the plain shell element (4), the further dimpled element (2) including an outwardly and upwardly inclined peripheral wall (14) nesting in contact with the corresponding tapered peripheral wall (21) of the plain shell element (4), and a plurality of spaced dimples (15) projecting away from the turbulator element (3), a second gallery being defined between the further dimpled shell element (2) and the nesting plain shell element (4), and occupied by the turbula-

tor element (3) ;

characterised in that the dimples formed in the dimpled shell elements (2) project upwardly in the same general direction as the tapered peripheral wall (14) of the respective dimpled shell element (2).

2. A vehicle heat exchanger (1) according to claim 1, wherein first galleries are of a depth less than second galleries.
3. A vehicle heat exchanger (1) according to claim 1 or claim 2, wherein the peripheral wall (21) of the plain shell element (4) extends beyond the peripheral wall (14) of the dimpled shell element (2) within which the plain shell element (4) is nested.
4. A vehicle heat exchanger (1) according to any preceding claim, wherein the spaced dimples (15) taper from a root portion (22) to a head portion (23), the head portion (23) of a respective dimple comprising a flat.
5. A vehicle heat exchanger (1) according to any preceding claim, wherein the turbulator element (3) has an undulating profile including a series of undulations defining contact points with the adjacent dimpled shell element (2) and shell element (4), the undulations preferably comprising spaced elongate ridges, preferably wherein the spaced elongate ridges of the turbulator (3) are so spaced and arranged relative to the dimpled plate (2) that contact with the dimpled shell (3) is substantially with undimpled contact points.
6. A vehicle heat exchanger (1) according to any preceding claim of brazed aluminium construction, wherein the plain shell element (4) and dimpled shell element (2) have nested peripheral walls (14, 21) brazed together, the dimples (15) of the dimpled shell elements (2) are brazed to respective adjacent plain shell elements (4).
7. A vehicle heat exchanger (1) according to any preceding claim, wherein a first fluid supply inlet (5) and outlet is provided for the first gallery system, and a second fluid supply inlet (7) and outlet provided for the second gallery system, fluid communication means being provided between successively stacked galleries in respective gallery systems, the fluid communication means comprising co-aligned pairs of apertures (9a, 9b; 10a, 10b; 16a, 16b; 17a, 17b) in a plain shell element (4) and an adjacent dimpled shell element (2), a first co-aligned pair of apertures (9a, 9b; 10a, 10b) having respective rims formed to seal against one another, and a second co-aligned pair of apertures (16a, 16b; 17a, 17b) having rims formed to be spaced from one another.

8. A vehicle heat exchanger (1) according to any preceding claim, wherein:

i) the galleries are stacked alternately, such that adjacent galleries comprise galleries from alternate gallery systems; and/or

ii) the heat exchanger (1) comprises an oil cooler in which coolant (such as water) is supplied to the first gallery system and oil to be cooled supplied to the second gallery system.

Patentansprüche

1. Wärmetauscher für Fahrzeuge (1) mit einer Mehrzahl gestapelter Galerien, umfassend ein erstes Galeriesystem zur Aufnahme einer ersten Flüssigkeit und ein zweites Galeriesystem zur Aufnahme einer zweiten Flüssigkeit, die gegeneinander im Wesentlichen abgedichtet sind und die durch eine Mehrzahl gestapelter Elemente definiert werden, die umfassen:
 - i) ein Vertiefungen aufweisendes Wannenelement (2), das eine auswärts und nach oben geneigte Außenwand (14) und eine Mehrzahl von voneinander beabstandeten Vertiefungen (15) umfasst, die in eine Oberfläche (13) des Vertiefungen aufweisenden Wannenelements (2) eingeformt sind und aus dieser herausragen,
 - ii) ein ebenes Wannenelement (4), das in dem Vertiefungen aufweisenden Wannenelement (2) verschachtelt ist und das eine Oberfläche (18) hat, die mit der Mehrzahl der herausragenden Vertiefungen (15) des Vertiefungen aufweisenden Wannenelements (2) in Kontakt steht und das eine sich verjüngende Außenwand (21) umfasst, die, in Kontakt mit der korrespondierenden, auswärts und nach oben geneigten Außenwand (14) des Vertiefungen aufweisenden Wannenelements (2) stehend, mit dieser verschachtelt ist, so dass die herausragenden Vertiefungen (15) des Vertiefungen aufweisenden Wannenelements (2) an das mit diesem verschachtelte ebene Wannenelement (4) angrenzen und den Verschachtelungsüberlapp der sich verjüngenden Außenwände (14, 21) bilden, wobei eine erste Galerie zwischen dem ebenen Wannenelement (4) und dem Vertiefungen aufweisenden Wannenelement (2) gebildet ist,
 - iii) ein Turbulatorelement (3), das mit dem ebenen Wannenelement (4) verschachtelt ist und

iv) ein weiteres, Vertiefungen aufweisenden Wannenelement (2),
das in das ebene Wannenelement (4) verschachtelt ist und
das eine auswärts und nach oben geneigte Außenwand (14) umfasst,
die, in Kontakt mit der korrespondierenden, sich verjüngenden Außenwand (21) des ebenen Wannenelements (4) stehend, mit dieser verschachtelt ist und
das eine Mehrzahl von voneinander beabstandeten Vertiefungen (15) umfasst, die aus dem Turbulatorelement (3) herausragen,

wobei eine zweite Galerie zwischen dem weiteren Vertiefungen aufweisenden Wannenelement (2) und dem eingeschachtelten ebenen Wannenelement (4) gebildet ist, die das Turbulatorelement (3) beherbergt,

dadurch gekennzeichnet, dass

die in das Vertiefungen aufweisenden Wannenelement (2) eingeformten Vertiefungen nach oben in die gleiche allgemeine Richtung herausragen wie die sich verjüngende Außenwand (14) des entsprechenden, Vertiefungen aufweisenden Wannenelements (2).

2. Wärmetauscher (1) für Fahrzeuge nach Anspruch 1, bei dem erste Galerien eine geringere Tiefe haben als zweite Galerien.

3. Wärmetauscher (1) für Fahrzeuge nach Anspruch 1 oder 2, bei dem die Außenwand (21) des ebenen Wannenelements (4) sich über die Außenwand (14) des Vertiefungen aufweisenden Wannenelements (2) hinaus erstreckt, innerhalb dessen ebenen Wannenelements (4) es eingeschachtelt ist.

4. Wärmetauscher (1) für Fahrzeuge nach einem der vorstehenden Ansprüche, bei dem sich die voneinander beabstandeten Vertiefungen (15) von einem Grundabschnitt (22) zu einem Kopfabschnitt (23) hin verjüngen, der eine Ebene (23) aufweist.

5. Wärmetauscher (1) für Fahrzeuge nach einem der vorstehenden Ansprüche, bei dem das Turbulatorelement (3) ein gewelltes Profil hat, das eine Serie von Wellen aufweist, die Kontaktpunkte mit dem benachbarten Vertiefungen aufweisenden Wannenelementen (2) und dem Wannenelement (4) definieren und wobei die Wellen vorzugsweise voneinander beabstandete, längliche Rippen umfassen, wobei die voneinander beabstandeten, länglichen Rippen des Turbulators (3) so voneinander beabstandet und relativ zum Vertiefungen aufweisenden Wellenelement (2) angeordnet sind, dass ein Kontakt mit dem Vertiefungen aufweisenden Wellenelement (3)

im Wesentlichen in Kontaktpunkten ohne Vertiefung stattfindet.

6. Wärmetauscher (1) für Fahrzeuge nach einem der vorstehenden Ansprüche aus einer gelöteten Aluminium-Konstruktion, bei dem das ebene Wannenelement (4) und das Vertiefungen aufweisende Wannenelement (2) zusammengelötete, ineinander geschachtelte Außenwände (14, 21) hat und die Vertiefungen (15) des Vertiefungen aufweisenden Wannenelement (2) an entsprechend benachbarte ebene Wannenelementen angelötet sind.

7. Wärmetauscher (1) für Fahrzeuge nach einem der vorstehenden Ansprüche, bei dem ein erster Flüssigkeitseinlass und Flüssigkeitsauslass (5) für das erste Galeriesystem und ein zweiter Flüssigkeitseinlass und Flüssigkeitsauslass (7) für das zweite Galeriesystem vorgesehen sind und

Mittel zur Flüssigkeitskommunikation zwischen sukzessive geschachtelten Galerien im entsprechenden Galeriesystem vorgesehen sind, die miteinander fluchtende Paare von Öffnungen (9a, 9b, 10a, 10b, 16a, 16b, 17a, 17b) in einem ebenen Wannenelement (4)

und ein benachbartes, Vertiefungen aufweisenden Wannenelement (2) umfassen,

bei denen ein erstes miteinander fluchtendes Paar von Öffnungen (9a, 9b, 10a, 10b) entsprechende Berandungen aufweist, die zum Bilden einer Dichtung gegeneinander ausgebildet sind,

und bei denen ein zweites miteinander fluchtendes Paar von Öffnungen (16a, 16b, 17a, 17b) sie voneinander beabstandete Berandungen hat.

8. Wärmetauscher (1) für Fahrzeuge nach einem der vorstehenden Ansprüche, bei dem:

i) die Galerien alternierend geschachtelt sind, so dass eine benachbarte Galerie Galerien von jeweils abwechselnden Galeriesysteme umfasst, und/oder

ii) der Wärmetauscher (1) einen Ölkühler umfasst, in dem Kühlmittel (so wie Wasser) dem ersten Galeriesystem und zu kühlendes Öl dem zweiten Galeriesystem zugeführt ist.

Revendications

1. Echangeur de chaleur pour véhicule (1) comprenant une pluralité de galeries empilées, comprenant un premier système de galerie destiné à contenir un premier fluide, et un deuxième système de galerie destiné à contenir un second fluide, les premier et deuxième systèmes de galeries étant sensiblement joints l'un à l'autre, les systèmes de galeries étant définis par une pluralité d'éléments em-

pilés comprenant :

i) un élément formant enveloppe à embouti (2) comprenant une paroi périphérique inclinée vers l'extérieur et vers le haut (14) et une pluralité d'emboutis espacés (15) formés dans et faisant saillie depuis une surface (13) de l'élément formant enveloppe à embouti (2) ;

ii) un élément formant enveloppe lisse (4) emboîtée dans l'élément formant enveloppe à embouti (2) et comprenant une surface (18) mise en contact par la pluralité d'emboutis faisant saillie (15) de l'élément formant enveloppe à embouti (2), l'élément formant enveloppe lisse (4) comprenant une paroi périphérique conique (21) emboîtée en contact avec la paroi périphérique inclinée vers l'extérieur et vers le haut (14) de l'élément formant enveloppe à embouti (2), de sorte que les emboutis faisant saillie (15) de l'élément formant enveloppe à embouti (2) viennent en butée contre l'élément formant enveloppe lisse s'emboîtant (4) et définissent le chevauchement d'emboîtement des parois coniques périphériques (14, 21), une première galerie étant définie entre l'élément formant enveloppe lisse (4) et l'élément formant enveloppe à embouti (2) ;

iii) un élément formant générateur de turbulence (3) emboîté dans l'élément formant enveloppe lisse (4) ; et

iv) un autre élément formant enveloppe à embouti (2) étant emboîté dans l'élément formant enveloppe lisse (4), l'autre élément à embouti (2) comprenant une paroi périphérique inclinée vers l'extérieur et vers le haut (14) s'emboîtant en contact avec la paroi périphérique conique correspondante (21) de l'élément formant enveloppe lisse (4) et une pluralité d'emboutis espacés (15) faisant saillie depuis l'élément formant générateur de turbulence (3), une deuxième galerie étant définie entre l'autre élément formant enveloppe à embouti (2) et l'élément formant enveloppe lisse s'emboîtant (4), et occupée par l'élément formant générateur de turbulence (3) ;

caractérisé en ce que les emboutis formés dans les éléments formant enveloppe à embouti (2) font saillie vers le haut dans le même sens général que la paroi périphérique conique (14) de l'élément formant enveloppe à embouti (2) respectif.

2. Echangeur de chaleur pour véhicule (1) selon la revendication 1, dans lequel les premières galeries présentent une profondeur inférieure à celle des deuxième galeries.

3. Echangeur de chaleur pour véhicule (1) selon la re-

vendication 1 ou la revendication 2, dans lequel la paroi périphérique (21) de l'élément formant enveloppe lisse (4) s'étend au-delà de la paroi périphérique (14) de l'élément formant enveloppe à embouti (2) à l'intérieur duquel l'élément formant enveloppe lisse (4) est emboîté.

4. Echangeur de chaleur pour véhicule (1) selon l'une quelconque des revendications précédentes, dans lequel les emboutis espacés (15) se rétrécissent à partir d'une partie formant racine (22) vers une partie formant tête (23), la partie formant tête (23) d'un embouti respectif comprenant un plat.

5. Echangeur de chaleur pour véhicule (1) selon l'une quelconque des revendications précédentes, dans lequel l'élément formant générateur de turbulences (3) comprend un profil ondulant comprenant une série d'ondulations définissant des points de contact avec l'élément formant enveloppe à embouti adjacent (2) et l'élément formant enveloppe (4), les ondulations comprenant de préférence des arêtes oblongues espacées, dans lesquelles de préférence les arêtes oblongues espacées du générateur de turbulences (3) sont espacées et agencées par rapport à la plaque à emboutis (2) de telle sorte que le contact avec l'enveloppe à embouti (3) est sensiblement avec des points de contact sans embouti.

6. Echangeur de chaleur pour véhicule (1) selon l'une quelconque des revendications précédentes de construction en aluminium brasé, dans lequel l'élément formant enveloppe lisse (4) et l'élément formant enveloppe à embouti (2) comprennent des parois périphériques emboîtées (14, 21) brasées ensemble, les emboutis (15) des éléments formant enveloppe à embouti (2) sont brasées à des éléments formant enveloppe lisse adjacents respectifs (4).

7. Echangeur de chaleur pour véhicule (1) selon l'une quelconque des revendications précédentes, dans lequel un premier orifice d'entrée d'alimentation en fluide (5) et un orifice de sortie sont prévus pour le premier système de galerie et un deuxième orifice d'entrée d'alimentation en fluide (7) et un orifice de sortie prévus pour le deuxième système de galerie, des moyens de communication de fluide étant prévus entre des galeries empilées successivement dans des systèmes de galeries respectifs, les moyens de communication de fluide comprenant des paires co-alignées d'ouvertures (9a, 9b ; 10a, 10b ; 16a, 16b ; 17a, 17b) dans un élément formant enveloppe lisse (4) et un élément formant enveloppe à embouti adjacent (2), une première paire co-alignée d'ouvertures (9a, 9b ; 10a, 10b) comprenant des couronnes respectives formées pour se joindre l'une contre l'autre, et une deuxième paire

co-alignée d'ouvertures (16a, 16b ; 17a, 17b) comprenant des couronnes formées pour être espacées l'une de l'autre.

8. Echangeur de chaleur pour véhicule (1) selon l'une quelconque des revendications précédentes, dans lequel :

i) les galeries sont empilées de manière alternée, de sorte que des galeries adjacentes comprennent des galeries provenant de systèmes de galeries alternés ; et/ou

ii) l'échangeur de chaleur (1) comprend un refroidisseur d'huile dans lequel le liquide de refroidissement (tel que de l'eau) est amené vers le premier système de galerie et l'huile à refroidir est amenée vers le deuxième système de galerie.

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