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

(57) The object of the invention is, among others, a flat tube (1) for a heat exchanger (100) for a flow of a fluid therein, the tube (1) being formed by bending a sheet metal strip (2) along its length, the metal strip (2) comprising longitudinal edges (2A, 2B), the flat tube (1) further comprising: a first wall (3), a second wall (4) parallel to the first wall (3), said walls (3, 4) being substantially flat, two complementary side wall portions (6) joining said first and second walls (3, 4) together, wherein the first fall (3) comprises a seam (5) extending along the longitudinal axis of the flat tube (1) so that juxtaposed longitudinal edges (2A, 2B) of the metal strip (2) join together in parallel manner towards the second wall (4) to form a closed profile of the tube (1), wherein the seam (5) comprises a first section (5A) fixed to the second wall (4) and extending along the first portion of the seam (5) along the longitudinal axis of the flat tube (1), characterized in that the seam (5) further comprises a second section (5B) extending along the second portion of the seam (5) arranged in series with respect to the first portion of the seam (5) and along the longitudinal axis of the flat tube (1), wherein the second section (5B) is separated from the second wall (4).

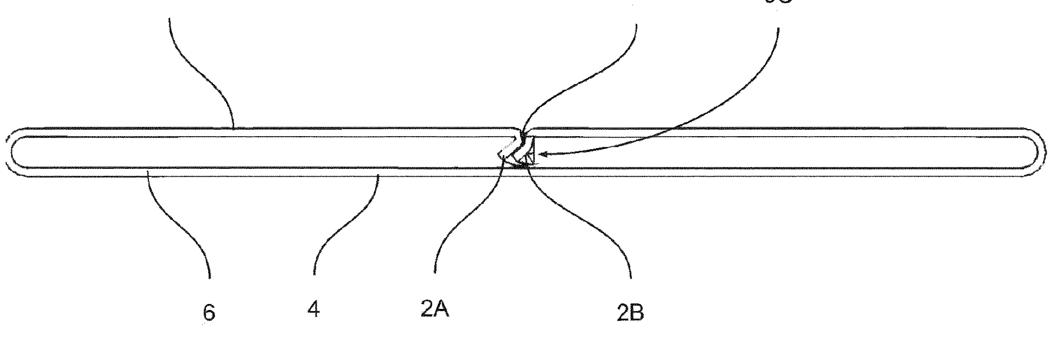

Fig. 4

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Description

FIELD OF THE INVENTION

[0001] The invention relates to a flat tube. In particular, the invention relates to a flat tube for a heat exchanger.

BACKGROUND OF THE INVENTION

[0002] In general, heat exchangers conventionally comprise a core bundle of tubes and two collector tubes such as manifolds through which the ends of the tubes of the core bundle of tubes pass and which are capped by fluid distribution box covers. There may be inserts placed between the tubes of said core in order to improve the exchange of heat.

[0003] There are two main technologies employed in the manufacture of these tubes. Either extrusion, which gives rise to a high cost (specific dies for each type of tube), or bending, offering different advantages. In the latter distance, the tubes used are produced by bending a metal strip over on itself.

[0004] Heat exchanger tubes may be subjected to numerous stresses such as high-speed impact with an object (for example a stone chipping) coming from the external environment. Heat exchanger tubes are therefore subjected to external stresses.

[0005] They are also stressed from the inside by the flow of the fluid. Specifically, during operation, the tubes are subjected to thermal, pressure, expansion stresses.

[0006] Sufficient material strength at tube level has to be guaranteed.

[0007] One known solution is to allow the tube to withstand such an impact in order to avoid any leak of fluid, or to withstand the internal stresses, by locally increasing the thickness of the wall of the tube in the case of an extruded tube.

[0008] However, in the case of a bent tube, the tube cannot be reinforced by simply increasing the thickness of material as it can in the case of an extruded tube.

[0009] As far as bent tubes go, there is, for example, a known solution whereby the open ends of the tube receive inserts increasing the thickness of material at terminal ends of the tube. A disadvantage lies in the fact that the inserts may impact flow through the tube, they are in fact additional components which require precise brazing, they increase overall cost of the heat exchanger and they do not guarantee robustness against internal stress.

[0010] Thus, it would be desired to provide a solution which would overcome latter disadvantages. It is also desirable to provide a tube which would withstand internal stress, preferably without increasing the overall cost of the heat exchanger.

SUMMARY OF THE INVENTION

[0011] The object of the invention is, among others, a flat tube for a heat exchanger for a flow of a fluid therein, the tube being formed by bending a sheet metal strip along its length, the metal strip comprising longitudinal edges, the flat tube further comprising: a first wall, a second wall parallel to the first wall, said walls being substantially flat, two complementary side wall portions joining said first and second walls together, wherein the first fall comprises a seam extending along the longitudinal axis of the flat tube so that juxtaposed longitudinal edges of the metal strip join together in parallel manner towards the second wall to form a closed profile of the tube, wherein the seam comprises a first section fixed to the second wall and extending along the first portion of the seam along the longitudinal axis of the flat tube, characterized in that the seam further comprises a second section extending along the second portion of the seam arranged in series with respect to the first portion of the seam and along the longitudinal axis of the flat tube, wherein the second section is separated from the second wall.

[0012] Advantageously, the longitudinal edges are inclined with respect to the first section towards either of the side walls portions.

[0013] Advantageously, the longitudinal edges are on the same level with respect to the surface of the second wall.

[0014] Advantageously, the seam comprises a third section extending along the third portion of the seam arranged in series between the first and the second portion of the seam and along the longitudinal axis of the flat tube.

[0015] Advantageously, the third section gradually inclines from the first section towards the second section.

[0016] Advantageously, the flat tube comprises a first open end and second open end, wherein the second section is located in the vicinity of at least one of the open ends.

[0017] Advantageously, at least one second section is located between at least two first sections along the longitudinal axis of the flat tube.

[0018] Advantageously, the seam comprises an incision separating at least the portion of the second section at least from the second wall.

[0019] Advantageously, the incision is formed substantially in parallel with respect to the surface of the second wall.

[0020] Advantageously, the longitudinal edges of the metal strip comprise at least one cutout.

[0021] Another object of the invention is a heat exchanger comprising at least one flat tube. The heat exchanger further comprises: a first manifold, a second manifold, wherein the flat tube is configured to provide a fluidal communication between the manifolds.

[0022] Advantageously, the heat exchanger further comprises at least one secondary tube wherein the secondary tube comprises only the first section extending between the open ends thereof.

[0023] Advantageously, the manifolds comprise slots for receiving at least the flat tubes, wherein the second section extends through and beyond the outline of the slots on both of its sides.

[0024] Advantageously, the heat exchanger comprises at least one fin interlaced between any of the flat tubes or secondary tubes, wherein the second section extends from the slot at least to the outline delimited by the terminal end of the fin.

[0025] The flat tube allows to reduce the mechanical stress at desired location of the tube. The second section significantly increases the flexibility of the flat tube which allows it to withstand high pressure and temperature. The heat exchangers comprising such flat tube are advantageous with respect to prior art solution, because its flat tubes are easy to manufacture, they do not require using additional components, and thus they are also inexpensive to produce.

BRIEF DESCRITPTION OF DRAWINGS

[0026] 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 prior art flat tube.
Fig. 2 shows a cross section of the flat tube of Fig.1.
Fig. 3 shows a perspective view of a flat tube comprising second section.
Fig. 4 shows a cross section of the flat tube of Fig.3.
Fig. 5 shows a perspective view of a flat tube comprising an incision.
Fig. 6 shows a cross section of the flat tube of Fig. 5.
Fig. 7 shows a perspective view of a flat tube comprising a cutout.
Fig. 8 shows a metal strip comprising a first example of cutouts.
Fig. 9 shows a metal strip comprising a second example of cutouts.
Fig. 10 shows a cross section of a flat tube formed from a metal strip of Fig. 9.
Fig. 11 shows a perspective view of a heat exchanger comprising at least one flat tube.
Fig. 12 shows the cross section of a flat tube- manifold assembly.

DETAILED DESCRIPTION OF EMBODIMENTS

[0027] The invention relates to a flat tube 1. The flat tube 1 may be adapted for operation in a heat exchanger 100 for a flow of a fluid therein. For example, the heat exchanger 100 may be a radiator and the fluid circulating therein may be a coolant. Other heat exchangers in which the flat tube 1 may be applied are also envisaged.

[0028] Figures 1 and 2 show the prior art flat tube 1. The flat tube 1 may be formed by bending a sheet metal strip 2 along its length. Term "metal strip" refers to a metallic sheet comprising two longer sides which may be further referred to as "longitudinal edges" and two substantially shorter sides, substantially parallel to said longer sides. The metal strip may be made of, for example, aluminum, yet other materials are also envisaged. The metal strip 2 may be bent along its longitudinal edges 2A, 2B to form a closed profile. Thus, the flat tube 1 may extend along its longitudinal axis. In other words, the flat tube 1 may comprise its axis of elongation.

[0029] The flat tube 1 may further comprise a first wall 3 and a second wall 4 parallel to the first wall 3, wherein said walls 3, 4 are formed after bending the metal strip 2. Said walls 3, 4 may be substantially flat. In order to form a closed profile, the flat tube 1 may further comprise two complementary side wall portions 6 joining said first and second walls 3, 4 together.

[0030] In order to provide a fluid tightness of the flat tube 1, the first fall 3 may comprise a seam 5. The seam 5 may extend along the longitudinal axis of the flat tube 1 so that juxtaposed longitudinal edges 2A, 2B of the metal strip 2 join together in parallel manner towards the second wall 4 to form the closed profile of the tube 1. In other words, in the process of bending the metal strip 2 to form the flat tube 1, the longitudinal edges 2A, 2B are bent inwardly at substantially right angle, so that they protrude towards the second wall 4 and they are in contact with each other substantially from the first wall 3 to the second wall 4. The terminal ends of the longitudinal edges 2A, 2B are fixed for example, by brazing to the second wall 4. The metal strip 2 may also be brazed along the portion extending between the first wall 3 and the second wall 4, wherein the longitudinal edges 2A and 2B are substantially parallel and in contact with each other. Consequently, the seam 5 may comprise a first section 5A fixed to the second wall 4 and extending along the first portion of the seam 5 along the longitudinal axis of the flat tube 1.

[0031] The seam 5 may comprise the first section 5A fixed to the second wall 4 and extending along the first portion of the seam 5 along the longitudinal axis of the flat tube 1 allows the coolant to circulate within the heat exchanger 100 while providing efficient heat exchange between the coolant and different medium (e.g. air). However, known tubes tend to crack which may cause coolant leaks, especially in the vicinity of the terminal ends thereof. The cracks may be caused by lack of flexibility of the flat tube 1. Lack of flexibility combined with high pressure and temperature of the coolant may significantly reduce the robustness of the flat tube 1.

[0032] Figures 3-10 show an exemplary solutions which would allow to avoid or mitigate negative aspects of prior art flat tubes 1.

[0033] In order to increase overall robustness of the flat tube 1 and fluid- tightness thereof, that the seam 5 may comprise a second section 5B.

[0034] The second section 5B may increase the flexibility of the flat tube 1 where needed. The second section 5B may extend along the second portion of the seam 5 arranged in series with respect to the first portion of the seam 5 and along the longitudinal axis of the flat tube 1. Term "arranged in series" means that the second section 5B is located directly and subsequently to the first section, or that second section 5B is located in the vicinity of the first section 5A whereas there may be another section between them which allows a transition from the first section 5A to the second section 5B.

[0035] Unlike the first section 5A, the second section 5B may be separated from the second wall 4. More precisely, the second section 5B protrudes from the first wall 3 substantially towards the second wall, yet it does contact the second wall 4. This allows the flat tube 1 to be more flexible during its operational mode. It allows to compensate differences between the pressure and the temperature, so that the flat tube 1 keeps its structural integrity and fluid tightness at all times. An exemplary ways of providing the flat tube 1 comprising the second section 5B are discussed in further paragraphs.

[0036] The first way of providing the flat tube 1 comprising the second section 5B is, for example, punching the terminal end of the flat tube 1 with the special tool. The goal is to separate the first section 5A from the second wall 4, so that these elements form a gap. During this process the first wall 3, the second wall 4 and the side wall portions 6 may remain intact.

[0037] The second section 5B may thus comprise the longitudinal edges 2A, 2B being inclined with respect to the first section 5A towards either of the side walls portions 6. The inclination may vary depending on the shape of the tool which formed the second section 5B and it makes no significant difference between the flow of the coolant through the first section 5A of the flat tube 1 and the second section 5B of the flat tube 1.

[0038] The longitudinal edges 2A, 2B forming the second section 5B may be on the same level with respect to the surface of the second wall 4. In other words, the second section 5B may comprise two portions, both being at the same distance from the second wall 4.

[0039] The flat tube 1 may also comprise at least one dimple (not shown). The dimples are not shown for the sake of clarity of the drawings. The dimple may be in a form of an indent which is configured to change the flow pattern within the flat tube 1. The dimples may be formed on the first wall 3, the second wall 4 or on both walls 3, 4. Usually, the dimples are located along the first section 5A. However, the dimples formed along the second section 5B are also envisaged.

[0040] In order to limit the risk of fracturing the flat tube 1 while forming the second section 5B, it may be advantageous to provide also relatively smooth transition between the first section 5A and the second section 5B.

[0041] Therefore, the seam 5 may comprise a third section 5C extending along the third portion of the seam 5 arranged in series between the first and the second portion of the seam 5 and along the longitudinal axis of the flat tube 1. In other words, the second section may be located between the first section 5A and the second section 5B. Since the third section 5C may be regarded as the transition zone between the first section 5A and the second section 5B, it may exhibit traits and features of the first section 5A and/ or the second section 5B. For example, the gap between the terminal ends of the longitudinal edges 2A, 2B and the second wall 4 may be same as in the first section 5A, wherein the portion of the third section 5C comprising such gap is in the vicinity of the respective, first section 5A. Further, the gap between the terminal ends of the longitudinal edges 2A, 2B and the second wall 4 may be same as in the second section 5B, wherein the portion of the third section 5C comprising such gap is in the vicinity of the respective, second section 5B. Finally, the gap between the third section 5C and the second wall 4 may gradually increase from the first section 5A towards the second section 5B.

[0042] Similarly, the inclination of the third section 5C may also vary. The third section 5C may gradually incline from the first section 5A towards the second section 5B. The inclination of the terminal ends of the longitudinal edges 2A, 2B may be same as in the first section 5A, wherein the portion of the third section comprising such inclination is in the vicinity of the respective, first section 5A. The inclination of the terminal ends of the longitudinal edges 2A, 2B may be same as in the second section 5B, wherein the portion of the third section 5C comprising such inclination is in the vicinity of the respective, second section 5B. Finally, the inclination of the third section 5C may gradually increase from the first section 5A towards the second section 5B.

[0043] In the aforementioned way of providing the second section 5B may be located at the terminal end of the flat tube 1. In other words, the flat tube may comprise a first open end 6A and a second open end 6B located on the opposite side to the first open end 6A, with respect to the longitudinal axis of the flat tube 1. Consequently the second section 5B may located in the vicinity of at least one of the first open end 6A, the second open end 6A or both open ends 6A, 6B.

[0044] Alternatively, the second section 5B may be located, for example, in the middle of the flat tube 1 In other words, at least one second section 5B is located between at least two first sections 5A along the longitudinal axis of the flat tube 1. However, this configuration applies only in exceptional cases, wherein the flexibility of the flat tube 1 needs to be increased in desired portion. Usually, the flexibility of the flat tube 1 needs to be increased in the vicinity of the open ends 6A, 6B thereof.

[0045] As shown in Figs 5 and 6, the alternative way of providing the flat tube 1 comprising the second section 5B is, for example, cutting the longitudinal edges 2A, 2B, so that the seam 5 comprises an incision 7 separating at least the portion of the second section 5B at least from the second wall 4. The incision may 7 may be formed by a sharp tool which would be able to cut through the longitudinal edges 2A, 2B substantially in parallel to the surface of the second wall 4. The incision 7 may also be formed by a cut at an angle with respect to the surface of the second wall 4. The incision 7 may divide the seam 5 into an abscessed portion 7A which is unitary with the longitudinal edges 2A, 2B protruding from the first wall 3, and a remaining portion 7B which remains fixed (e.g.

by brazing) with the second wall 4.

[0046] Ideally, the incision 7 is formed substantially in parallel with respect to the surface of the second wall 4 and along the longitudinal axis of the flat tube 1, yet the incisions of different shape and angle are also envisaged.

[0047] Both aforementioned ways of providing the flat tube 1 comprising the second section 5B refer to a flat tube 1 already formed by a bended metal sheet 2.

[0048] Another way, described in further paragraphs refers to providing the flat tube 1 comprising the second section 5B before bending the metal sheet 2.

[0049] Referring to Figs 7-10, in order to provide the flat tube 1 comprising the second section 5B before bending the metal strip 2, the longitudinal edges 2A, 2B of the metal strip 2 may comprise at least one cutout 8. Unlike already discussed incision 7, the cutout 8 refers to removal part of the material from the metal strip 2.

[0050] Depending on the desired location of the second section 5B, the cutout 8 may be located either in the vicinity of the open ends 6A, 6B, or between them, i.e. at any portion of the metal strip 2 located between the open ends 6A, 6B.

[0051] The cutout 8 may be formed in different shapes and sizes. For example, the cutout 8 may comprise at least one right angle so that when the flat tube 1 is formed the second section 5B instantly transfers to the first section 5A. Alternatively, the cutout 8 may be formed at an angle, i.e. at an angle between 0 and 90 degrees between the short side of the metal strip 2 and the long side of the metal strip. In other words, the cutout 8 may gradually bring the longitudinal edge 2A, 2B towards the longitudinal axis of the metal strip 2, wherein the longitudinal axis of the metal strip 2 is located substantially in the middle thereof. In this case the non-bended metal strip 2 may comprise at least one substantially trapezoidal portion. This form of a cutout 8 is shown in Figs 7 and 8. Alternatively, the cutout 8 may be curved, i.e. it does not form a straight line, but a curved one. The exemplary configuration of such cutout is depicted in Figs 9 and 10.

[0052] Nevertheless, it should be noted that the cutout 8 is so formed, that the metal strip may still be bended to form the closed profile of the flat tube 1.

[0053] The flat tube 1 may be suitable for a heat exchanger 100. In other words, the heat exchanger 100 may comprise at least one flat tube 1 comprising at least one second section 5B. The exemplary heat exchanger 100 is shown in Figs 11 and 12.

[0054] Referring to Fig. 11, the heat exchanger 100 may comprise, inter alia, a first manifold 101 and a second manifold 102, wherein the flat tube 1 is configured to provide a fluidal communication between the manifolds 101, 102.

[0055] The heat exchanger 100 may further comprise at least one secondary tube 103, wherein the secondary tube 103 comprises only the first section 5A extending between the open ends thereof. In other words, the secondary tube 103 is a known, standard tube.

[0056] The heat exchanger 100 may comprise only flat tubes 1 stacked between the manifolds 101, 102.

[0057] Alternatively, the heat exchanger may comprise at least one flat tube 1 and at least one secondary tube 103. Both flat tubes 1 and the secondary tubes 103 may form at least one first set and at least one second set, respectively. The first and the second sets may be arranged in one stack of tubes. In one of the examples, the first set is located at least the terminal end of the stack. Alternatively, at least one first set may be located in-between two adjacent second stacks.

[0058] Referring to Fig. 12, the manifolds 101, 102 may comprise slots 104 for receiving the tubes 1, 103. In case the slot 104 received the flat tube 1, the second section 5B extends through and beyond the outline of the slots 104 on both of its sides. In other words, the second section 5B may extend from the open end 6A, 6B of the flat tube along the longitudinal axis of the flat tube 1 to the first section 5A which does not overlap the slot 104 in any case.

[0059] The heat exchanger 100 may also comprise fins 105 interlaced between any of the flat tubes 1 or secondary tubes 103, depending on the presence of the latter. The outline of the fins 105 is depicted in Fig. 12 by a dashed line, for the sake of clarity of the drawing. Anyway, it is preferred that the second section 5B extends from the open end 6A, 6B of the flat tube 1 at least to the outline delimited by the terminal end of the fin 105 at the adjacent terminal end thereof.

[0060] If the fins 105 are not present or if they cannot be regarded as the reference point, it is preferred that the second section 5B extents from 5mm to 25mm form the open end 6A, 6B, along the longitudinal axis of the flat tube 1.

[0061] 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 flat tube (1) for a heat exchanger (100) for a flow of a fluid therein, the tube (1) being formed by bending a sheet metal strip (2) along its length, the metal strip (2) comprising longitudinal edges (2A, 2B), the flat tube (1) further comprising: a first wall (3), a second wall (4) parallel to the first wall (3), said walls (3, 4) being substantially flat, two complementary side wall portions (6) joining said first and second walls (3, 4) together, wherein the first fall (3) comprises a seam (5) extending along the longitudinal axis of the flat tube (1) so that juxtaposed longitudinal edges (2A, 2B) of the metal strip (2) join together in parallel manner towards the second wall (4) to form a closed

profile of the tube (1), wherein the seam (5) comprises a first section (5A) fixed to the second wall (4) and extending along the first portion of the seam (5) along the longitudinal axis of the flat tube (1), **characterized in that** the seam (5) further comprises a second section (5B) extending along the second portion of the seam (5) arranged in series with respect to the first portion of the seam (5) and along the longitudinal axis of the flat tube (1), wherein the second section (5B) is separated from the second wall (4).

2. The flat tube (1) according to claim 1, the longitudinal edges (2A, 2B) are inclined with respect to the first section (5A) towards either of the side walls portions (6).

3. The flat tube (1) according to any of the claims 1 or 2, wherein the longitudinal edges (2A, 2B) are on the same level with respect to the surface of the second wall (4).

4. The flat tube (1) according to any of the preceding claims, wherein the seam (5) comprises a third section (5C) extending along the third portion of the seam (5) arranged in series between the first and the second portion of the seam (5) and along the longitudinal axis of the flat tube (1).

5. The flat tube (1) according to claim 4, wherein the third section (5C) gradually inclines from the first section (5A) towards the second section (5B).

6. The flat tube (1) according to any of the preceding claims, wherein the flat tube (1) comprises a first open end (6A) and second open end (6B), wherein the second section (5B) is located in the vicinity of at least one of the open ends (6A, 6B).

7. The flat tube (1) according to any of the preceding claims, wherein at least one second section (5B) is located between at least two first sections (5A) along the longitudinal axis of the flat tube (1).

8. The flat tube (1) according to any of claims 1, 2, 3 or 6, wherein the seam (5) comprises an incision (7) separating at least the portion of the second section (5B) at least from the second wall (4).

9. The flat tube (1) according to claim 8, wherein the incision (7) is formed substantially in parallel with respect to the surface of the second wall (4).

10. The flat tube (1) according to any of claims 1-4 or 6 wherein the longitudinal edges (2A, 2B) of the metal strip (2) comprise at least one cutout (8), wherein the cutout (8) is formed by removing part of the material form the metal strip (2).

11. A heat exchanger (100) comprising at least one flat tube (1) according to any of the preceding claims, the heat exchanger (100) further comprising:

- a first manifold (101),
- a second manifold (102), wherein the flat tube (1) is configured to provide a fluidal communication between the manifolds (101, 102).

12. The heat exchanger (100) according to claim 11, wherein the heat exchanger (100) further comprises at least one secondary tube (103) wherein the secondary tube (103) comprises only the first section (5A) extending between the open ends thereof.

13. The heat exchanger (100) according to any of claims 11-12, wherein the manifolds (101, 102) comprise slots (104) for receiving at least the flat tubes (1), wherein the second section (5B) extends through and beyond the outline of the slots (104) on both of its sides.

14. The heat exchanger (100) according to claims 11-13, wherein the heat exchanger (100) comprises at least one fin (105) interlaced between any of the flat tubes (1) or secondary tubes (103), wherein the second section (5B) extends from the slot (104) at least to the outline delimited by the terminal end of the fin (105).

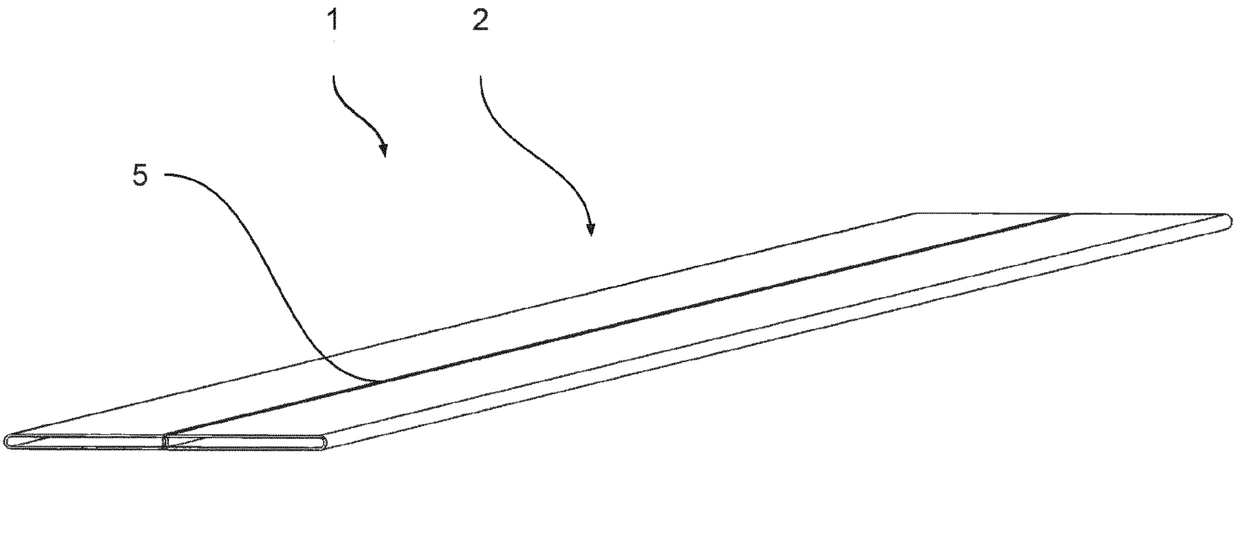

Fig. 1
(Prior art)

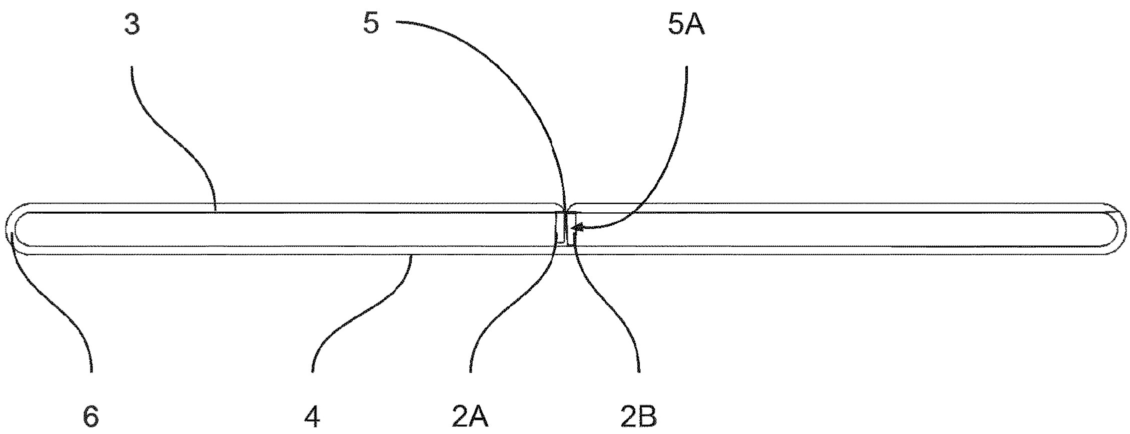

Fig. 2
(Prior art)

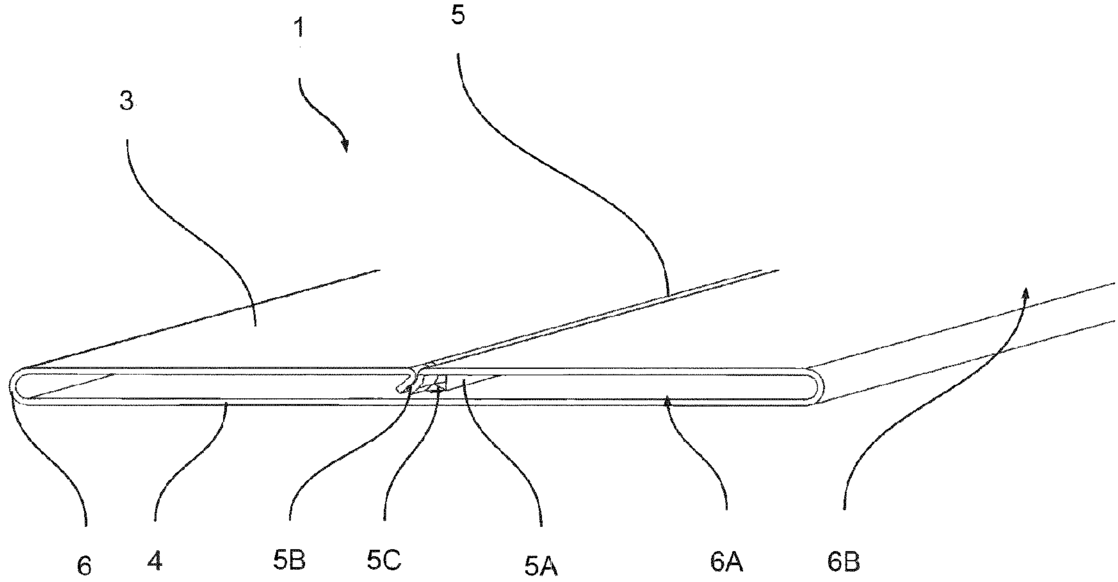

Fig. 3

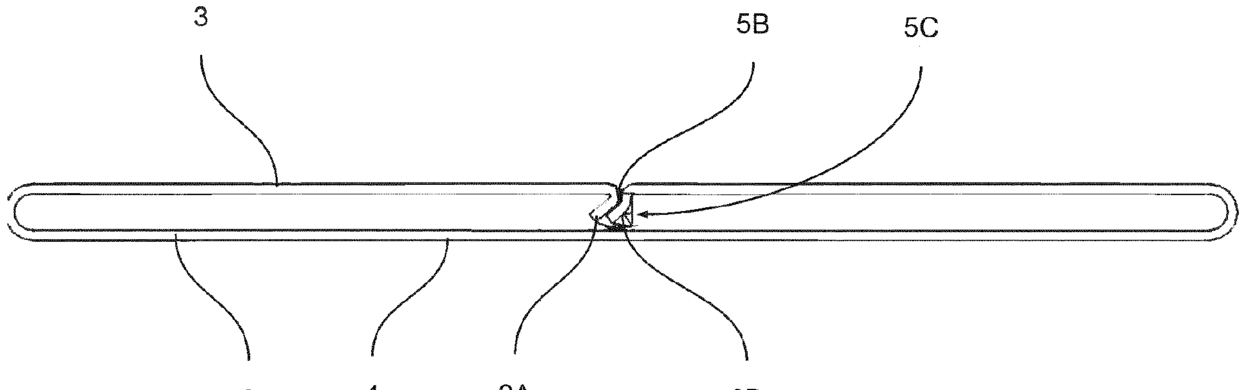

Fig. 4

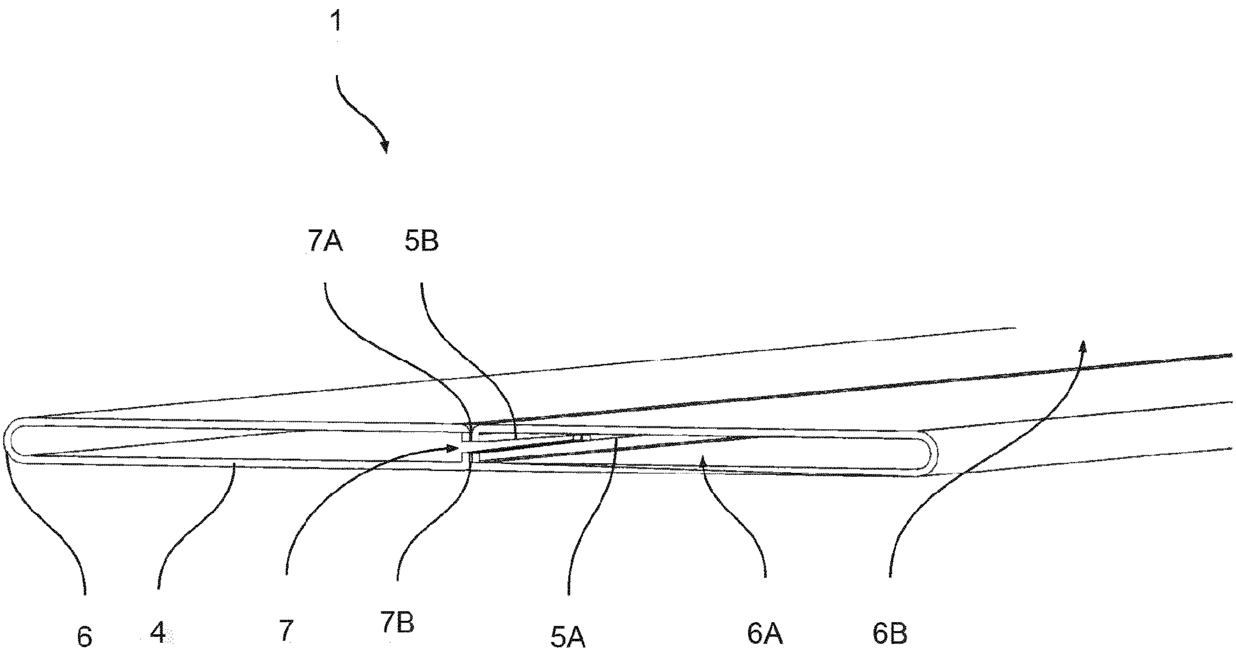

Fig. 5

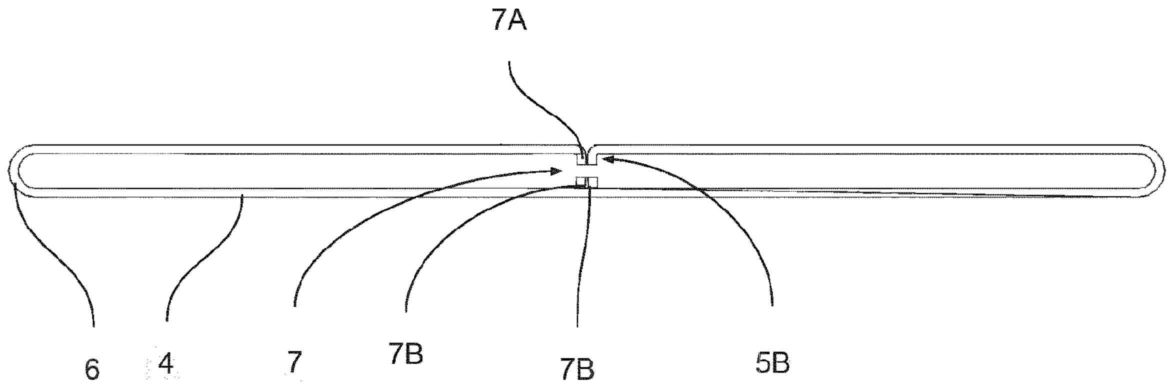

Fig. 6

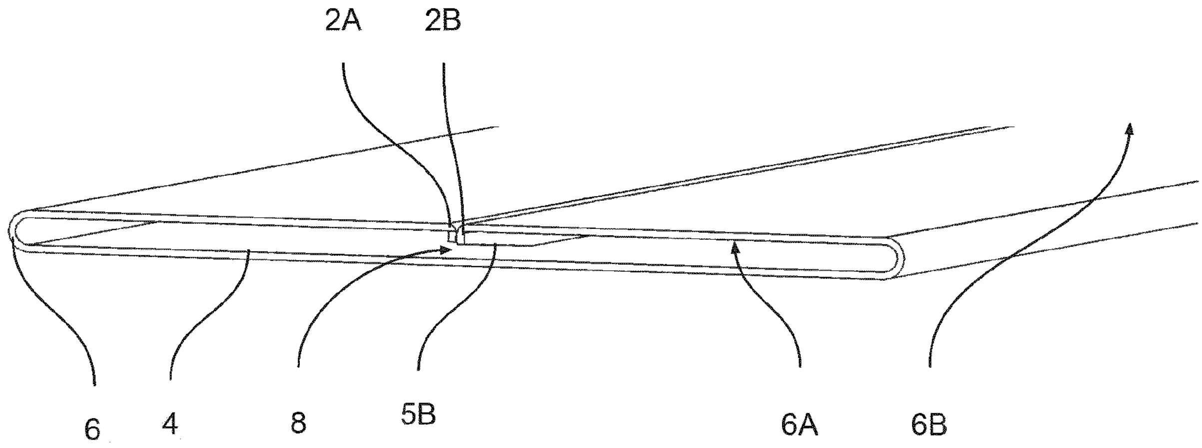

Fig. 7

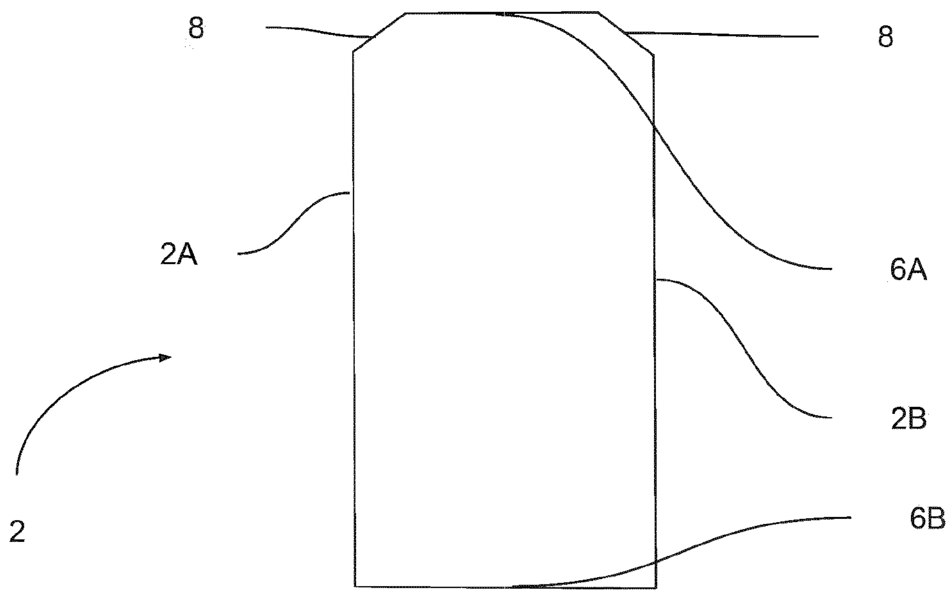

Fig. 8

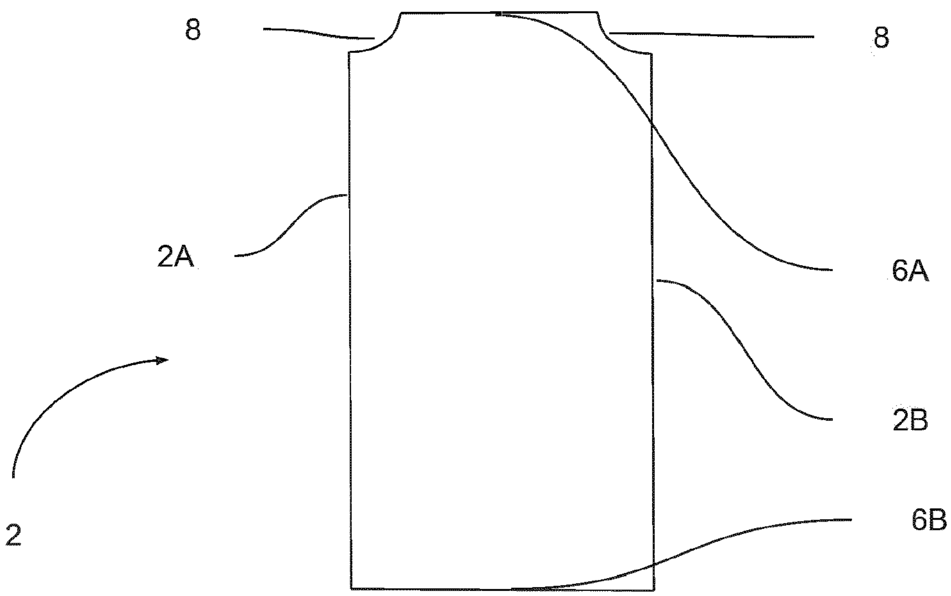

Fig. 9

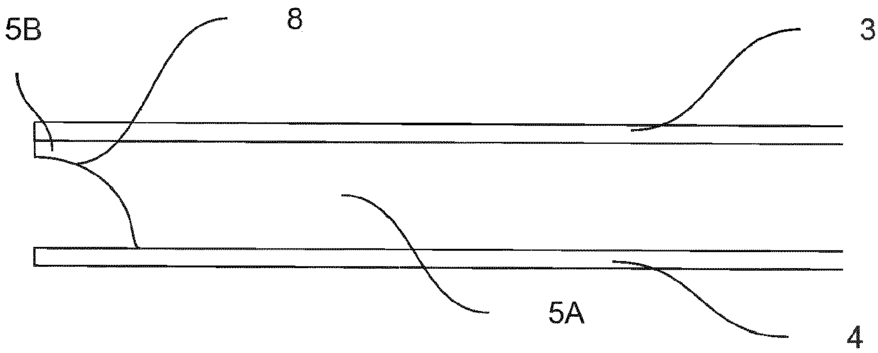

Fig. 10

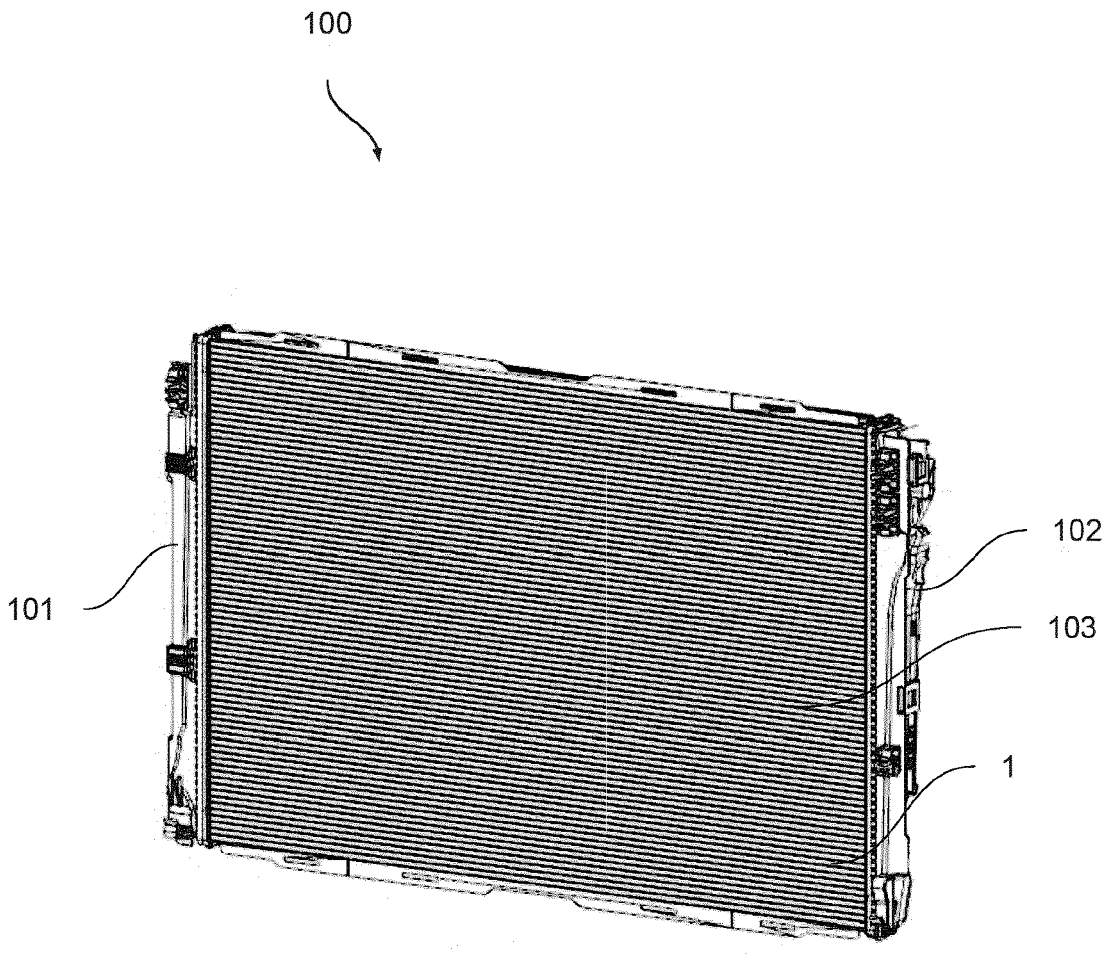

Fig. 11

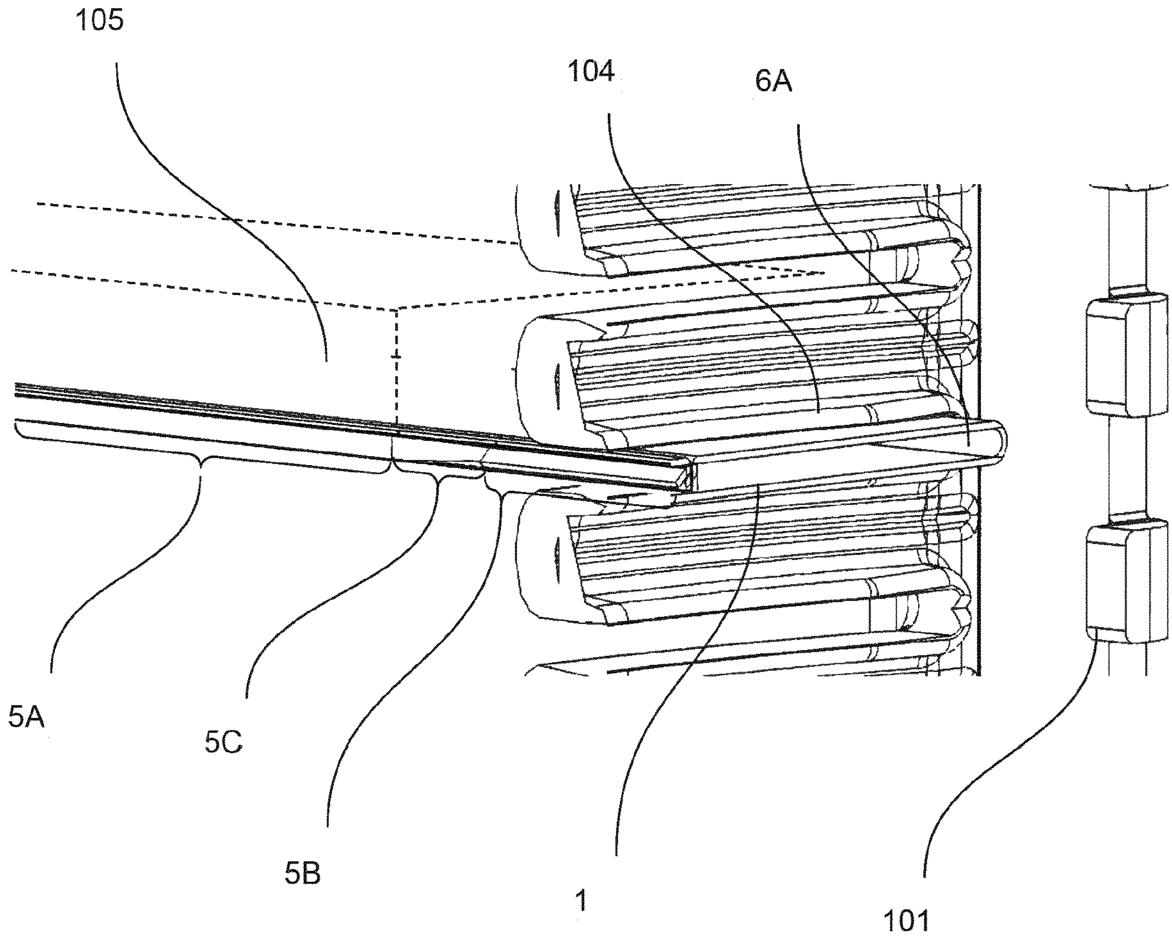

Fig. 12

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EUROPEAN SEARCH REPORT

Application Number
EP 21 19 9440

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 Y	US 2020/011606 A1 (RAJABPOUR MAHDI [US] ET AL) 9 January 2020 (2020-01-09) * figure 9B *	1,3-14 2	INV. F28F1/02 F28D1/03 F28D1/053
X Y A	US 2009/050306 A1 (HELMS WERNER [DE] ET AL) 26 February 2009 (2009-02-26) * figures 3, 9, 10 *	1,3-6, 8-14 2 7	
Y	DE 10 2008 007597 A1 (BEHR GMBH & CO KG [DE]) 6 August 2009 (2009-08-06) * figure 1 *	2	

TECHNICAL FIELDS SEARCHED (IPC)
F28F
F28D

1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 February 2022	Delaitre, Maxime

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 21 19 9440

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10-02-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2020011606 A1	09-01-2020	CN 110671949 A	10-01-2020
		DE 102019117883 A1	09-01-2020
		US 2020011606 A1	09-01-2020
US 2009050306 A1	26-02-2009	DE 102007039292 A1	26-02-2009
		EP 2028431 A2	25-02-2009
		US 2009050306 A1	26-02-2009
DE 102008007597 A1	06-08-2009	NONE	

EPO FORM P0459

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