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(54) **FLAT TUBE**

(57) The invention relates to a flat tube (1) for a heat exchanger. The flat tube (1) has two broad sites (2a, 2b) and two narrow sites (3a, 3b) which are connected to each other and delimit a flow space (4). The flow space (4) extends in a longitudinal direction (LR).

According to the invention, at least one barrel-shaped region (8) is formed on at least one of the

broad sites (2a, 2b) of the flat tube (1). The barrel-shaped region (8) extends in the longitudinal direction (LR) and is convex transversely to the longitudinal direction (LR) and outwardly with respect to the flow space (4).

The invention also relates to a heat exchanger with the flat tube (1).

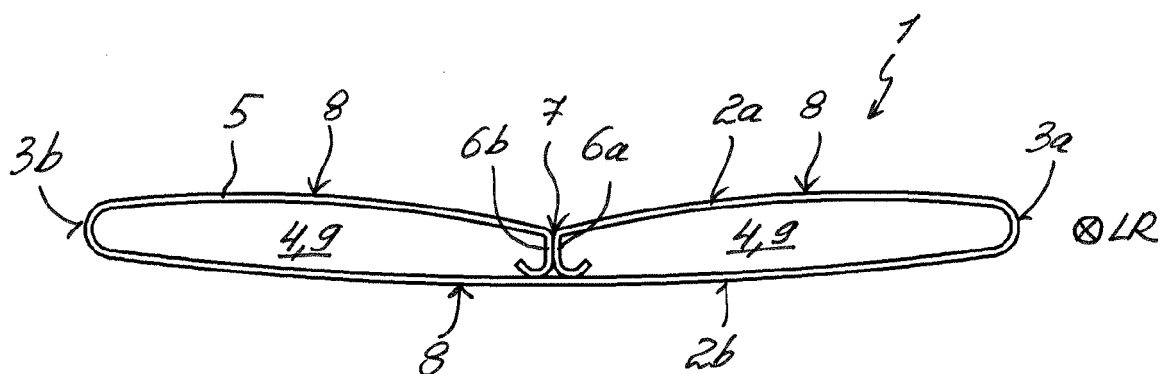


Fig. 1

Description

[0001] The invention relates to a flat tube for a heat exchanger according to the generic term of claim 1. The invention also relates to the heat exchanger with the flat tube.

[0002] A heat exchanger - for example for a motor vehicle - usually comprises a heat exchanger core with several flat tubes and several corrugated fins. The flat tubes are designed to be flowed through by a gaseous or liquid fluid and the corrugated fins are designed to be flowed through by air. The flat tubes and the corrugated fins are stacked on top of each other so that heat can be exchanged between the air and the fluid. When the heat exchanger core is manufactured, the flat tubes and the corrugated fins are pressed together and soldered. If the pressure is too high, the corrugated fins may deform. If the pressure is too low, the flat tubes and the corrugated fins are not joined together in places. In both cases, heat transfer between the flat tubes and the corrugated fins in the manufactured heat exchanger core is reduced. To eliminate these problems, tight tolerances are needed on flat tubes and corrugated fins. However, this increases the cost of the heat exchanger.

[0003] It is therefore the object of the invention to provide an improved or at least alternative embodiment for a flat tube of the type described and a heat exchanger with the flat tube of the type described, in which the disadvantages described are overcome.

[0004] This object is solved according to the invention by the object of the independent claims. Advantageous embodiments are the subject of the dependent claims.

[0005] The present invention is based on the general idea of making the wall of a flat tube resilient in order to improve pressing with the corrugated fins during manufacture of the heat exchanger and thereby to avoid manufacturing defects.

[0006] A flat tube is provided for a heat exchanger. The flat tube has two opposite broad sites and two opposite narrow sites. The broad sites and the narrow sites are connected to one another and delimit a flow space of the flat tube to the outside. The flow space extends in a longitudinal direction which is parallel to the broad sites and to the narrow sites. According to the invention, at least one barrel-shaped region is formed on at least one of the broad sites of the flat tube. The at least one barrel-shaped region extends in the longitudinal direction. Transversely to the longitudinal direction, the at least one barrel-shaped region is convex or bulbous outwardly with respect to the flow space.

[0007] The barrel-shaped region is resilient transversely to the longitudinal direction because of its shape. The at least one barrel-shaped region can extend over a whole length of the flat tube defined in the longitudinal direction. As a result, the flat tube can be resilient over the whole length. When manufacturing the heat exchanger, continuous contact between the flat tube and the adjacent corrugated fin can thus be achieved. This avoids

manufacturing defects in the heat exchanger. Furthermore, tolerance requirements for the flat tube and thereby also the costs of the flat tube and the heat exchanger can be reduced. The design of the flat tube according to the invention is particularly suitable for flat tubes with a wall thickness of less than 1 mm.

[0008] In an advantageous embodiment of the flat tube, it may be provided that the flat tube has at least one wall region extending in the longitudinal direction. The at least one wall region is formed on one of the broad sites and projects into the flow space of the flat tube. The wall region thereby forms two flow channels in the flow space. The flow channels are separated from each other by the wall region and extend in the longitudinal direction. The two flow channels can divide the fluid flowing through the flat tube and better heat transfer can be achieved.

[0009] The flat tube can be folded from a single piece of material with two opposite longitudinal edges. The longitudinal edges of the piece of material can be firmly fixed to one another and can form the at least one wall region of the flat tube. The wall region formed in this way closes the flat tube fluid-tightly to the outside, on the one hand, and separates the flow space into the flow channels, on the other hand. Alternatively, the at least one wall region can be formed by a fold on the respective broad site. As described above, the fold can project from the broad site into the flow space and divide the flow space into the flow channels.

[0010] At least two wall regions adjacent to each other transversely to the longitudinal direction may be formed in the flat tube. The respective adjacent wall regions are then respectively formed on the opposite broad sites of the flat tube. As a result, a plurality of flow channels arranged side by side transversely to the longitudinal direction may be formed in the flat tube.

[0011] In this case, one of the wall regions may be formed by the longitudinal edges of the piece of material that are fixed to one another, and the remaining wall regions may be formed by the folds of the respective broad sites. Alternatively, all of the wall regions may be formed by the folds of the respective broad sites. The longitudinal edges of the piece of material that are fixed to one another can then protrude outwardly from the respective broad site and accordingly not divide the flow space.

[0012] In an advantageous embodiment of the flat tube, it can be provided that a width of the respective barrel-shaped region defined transversely to the longitudinal direction corresponds to a width of the respective flow channel of the flat tube defined transversely to the longitudinal direction. The respective barrel-shaped region then lies transversely to the longitudinal direction above - in particular exactly above - the respective flow channel. Accordingly, the respective barrel-shaped region is assigned to the respective single flow channel. The barrel-shaped regions can be formed on both broad sites in areas which delimit the respective flow channel.

[0013] Alternatively, a width of the respective barrel-shaped region defined transversely to the longitudinal

direction can be several times, preferably twice, larger than a width of the respective flow channel defined transversely to the longitudinal direction. The respective barrel-shaped region then lies transversely to the longitudinal direction above - in particular exactly above - the several, preferably two, adjacent flow channels. Accordingly, the respective barrel-shaped region is associated with the respective several, preferably two, flow channels. The barrel-shaped regions can be formed on both broad sites in areas which delimit the respective flow channel.

[0014] It is understood that the above-described barrel-shaped regions can be combined with one another in the flat tube. Thus, on the respective broad site, the deviating barrel-shaped regions can be arranged adjacent to each other transversely to the longitudinal direction. On the respective broad site, the respective barrel-shaped region then lies deviating over the single flow channel or over several, preferably two, flow channels. In addition, the barrel-shaped regions on one broad site can be designed differently to the barrel-shaped regions on the other broad site.

[0015] In particular, the at least one barrel-shaped region may be located above the two flow channels separated by the at least one wall region. The at least one barrel-shaped region is then formed on one broad site and the at least one wall region is formed on the other broad site. The barrel-shaped region then bridges the respective wall region. In this embodiment, the flat tube may have a simplified shape.

[0016] The invention also relates to a heat exchanger for a motor vehicle. The heat exchanger has a heat exchanger core with at least two flat tubes described above for the flow of a gaseous or liquid fluid therethrough and with at least two corrugated fins for the flow of air therethrough. The flat tubes and the corrugated fins are stacked alternately in a stacking direction. The flat tubes and the corrugated fins may be soldered together. The flat tubes have the at least one barrel-shaped region that springs outwardly transversely to the longitudinal direction. This allows the flat tubes and the corrugated fins to be resiliently pressed together, so that continuous contact between the flat tubes and the corrugated fins can be achieved and manufacturing defects can be avoided. In addition, the tolerance requirements for the flat tubes and thus manufacturing costs can be reduced.

[0017] Further important features and advantages of the invention are apparent from the subclaims, from the drawings, and from the accompanying figure description based on the drawings.

[0018] It is understood that the above features and those to be explained below can be used not only in the combination indicated here, but also in other combinations or on their own, without departing from the scope of the present invention.

[0019] Preferred embodiments of the invention are shown in the drawings and will be explained in more detail in the following description, wherein identical reference signs refer to identical or similar or functionally identical

components.

[0020] It shows, in each case schematically

- Fig. 1 a sectional view of a flat tube according to the invention in a first embodiment;
- Fig. 2 a sectional view of the flat tube according to the invention in a second embodiment;
- Fig. 3a sectional view of the flat tube according to the invention in a third embodiment.

[0021] Fig. 1 shows a sectional view of a flat tube 1 for a heat exchanger according to the invention in a first embodiment. The flat tube 1 has two broad sites 2a, 2b and two narrow sites 3a, 3b. The broad sites 2a, 2b and the narrow sites 3a, 3b each lie opposite one another and delimit a flow space 4 with a longitudinal direction LR to the outside. The longitudinal direction LR is aligned parallel to the broad sites 2a, 2b and to the narrow sites 3a, 3b. The flat tube 1 can have a wall thickness of less than 1 mm.

[0022] Here, the flat tube 1 is folded from a single piece of material 5 with two opposing longitudinal edges 6a, 6b. The longitudinal edges 6a, 6b are firmly fixed to each other and form a wall region 7 of the flat tube 1. The wall region 7 extends parallel to the longitudinal direction LR and divides the flow space 4 into two flow channels 9. The two flow channels 9 extend parallel to the longitudinal direction and are arranged side by side transversely to the longitudinal direction LR.

[0023] In the first embodiment of the flat tube 1, two barrel-shaped regions 8 are formed on the broad site 2a and one barrel-shaped region 8 is formed on the broad site 2b. The respective barrel-shaped region 8 on the broad site 2a has a width corresponding to a width of the respective flow channel 9. The respective barrel-shaped region 8 on the broad site 2a is associated with the respective flow channel 9. On the other hand, the barrel-shaped region 8 on the broad site 2b has a width that corresponds to a summed width of the two flow channels 9. The respective barrel-shaped region 8 on the broad site 2b is assigned to the two flow channels 9. The wall region 7 is formed on the broad site 2a and is directed into the center of the barrel-shaped region 8 on the broad site 2b.

[0024] The respective barrel-shaped region 8 extends over an entire length of the flat tube 1 in the longitudinal direction LR and is convex or bulbous outwardly and transversely to the longitudinal direction LR. As a result, the flat tube 1 is resilient and can be resiliently pressed between two adjacent corrugated fins in a heat exchanger. When manufacturing the heat exchanger, continuous contact between the flat tube 1 and the adjacent corrugated fins can thus be achieved and manufacturing defects in the heat exchanger can thereby be avoided.

[0025] Fig. 2 shows a sectional view of the flat tube 1 according to the invention in a second embodiment. De-

viating from the first embodiment, two barrel-shaped regions 8 are formed on the broad site 2b. The respective barrel-shaped region 8 on the broad site 2b has a width corresponding to a width of the respective flow channel 9. The respective flow channel 9 is thus associated with a respective barrel-shaped region 8 on the broad site 2a and on the broad site 2b. In all other details, the first embodiment and the second embodiment are identical.

[0026] Fig. 3 shows a sectional view of the flat tube 1 according to the invention in a third embodiment. Deviating from the first and second embodiments, two further wall regions 7 are formed on the broad site 2b. The wall regions 7 are thereby formed by a fold of the material piece 5 and extend parallel to the longitudinal direction LR. The respective wall region 7 thereby protrudes from the broad site 2b into the flow space 4 and divides the flow space 4 in each case into two flow channels 9. In total, three wall regions 7 are formed in the flat tube 1 and the flow space 4 is divided into four flow channels 9.

[0027] The respective mutually adjacent wall regions 7 of the flat tube 1 are formed on the opposite broad sites 2a and 2b, respectively. On the broad site 2a, a total of two barrel-shaped regions 8 are formed. In this way, the respective barrel-shaped region 8 is assigned to the two adjacent flow channels 9 and bridges the respective edge-side wall region 7. On the broad site 2b, a total of three barrel-shaped regions 8 are formed. The two edge-side barrel-shaped regions 8 are assigned to the respective edge-side flow channels 9 and the central barrel-shaped region 8 is assigned to the two central flow channels 9. The central barrel-shaped region 8 bridges the central wall region 7. In all other details, the third embodiment is identical to the first and second embodiments.

Claims

1. Flat tube (1) for a heat exchanger,

- wherein the flat tube (1) has two opposite broad sites (2a, 2b) and two opposite narrow sites (3a, 3b),
- wherein the broad sites (2a, 2b) and the narrow sites (3a, 3b) are connected to each other and delimit a flow space (4) of the flat tube (1) to the outside,
- wherein the flow space (4) extends in a longitudinal direction (LR) parallel to the broad sites (2a, 2b) and to the narrow sites (3a, 3b),

characterized

- **in that** at least on one of the broad sites (2a, 2b) of the flat tube (1), at least one barrel-shaped region (8) is formed, and
- **in that** the at least one barrel-shaped region (8) extends in the longitudinal direction (LR) and is convex transversely to the longitudinal direc-

tion (LR) and outwardly with respect to the flow space (4).

2. Flat tube according to claim 1,
characterized

in that the at least one barrel-shaped region (8) extends over a whole length of the flat tube (1) defined in the longitudinal direction (LR).

3. Flat tube according to claim 1 or 2,
characterized

- **in that** the flat tube (1) has at least one wall region (7) extending in the longitudinal direction (LR), and

- **in that** the at least one wall region (7) is formed on one of the broad sites (2a, 2b) and projects into the flow space (4) of the flat tube (1), and

- **in that** the wall region (7) forms two flow channels (9) in the flow space (4) which are separated from one another and extend in the longitudinal direction (LR).

4. Flat tube according to claim 3,
characterized

- **in that** the flat tube (1) is folded from a single piece of material (5) with two opposite longitudinal edges (6a, 6b), and

- **in that** the longitudinal edges (6a, 6b) of the piece of material (5) are firmly fixed to one another and form the at least one wall region (7) of the flat tube (1).

5. Flat tube according to claim 3 or 4,
characterized

in that the at least one wall region (7) is formed by a fold at the respective broad site (2a, 2b).

6. Flat tube according to any one of claims 3 to 5,
characterized

- **in that** a width of the respective barrel-shaped region (8) defined transversely to the longitudinal direction (LR) corresponds to a width of the respective flow channel (9) defined transversely to the longitudinal direction (LR), and

- **in that** the respective barrel-shaped region (8) lies transversely to the longitudinal direction (LR) above the respective flow channel (9).

7. Flat tube according to any one of claims 3 to 6,
characterized

- **in that** a width of the respective barrel-shaped region (8) defined transversely to the longitudinal direction (LR) is several times, preferably twice, greater than a width of the respective flow

channel (9) defined transversely to the longitudinal direction (LR), and

- **in that** the respective barrel-shaped region (8) lies transversely to the longitudinal direction (LR) above the several, preferably two, adjacent flow channels (9). 5

8. Flat tube according to any one of claims 3 to 7, **characterized**

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- **in that** the at least one barrel-shaped region (8) lies above the two flow channels (9) which are separated from one another by the at least one wall region (7), and

- **in that** the at least one barrel-shaped region (8) is formed on the one broad site (2a, 2b) and the at least one wall region (7) is formed on the other broad site (2b, 2a). 15

9. Flat tube according to any one of claims 3 to 8, **characterized** 20

- **in that** at least two wall regions (7) adjacent to one another transversely to the longitudinal direction (LR) are formed in the flat tube (1), and 25

- **in that** the respective adjacent wall regions (7) are respectively formed on the opposite broad sites (2a, 2b) of the flat tube (1).

10. Heat exchanger for a motor vehicle, 30

- wherein the heat exchanger comprises a heat exchanger core with at least two flat tubes (1) for the flow of a gaseous or liquid fluid according to one of the preceding claims and with at least two corrugated fins for the flow of air, 35

- wherein the flat tubes (1) and the corrugated fins are stacked on top of each other alternately in a stacking direction. 40

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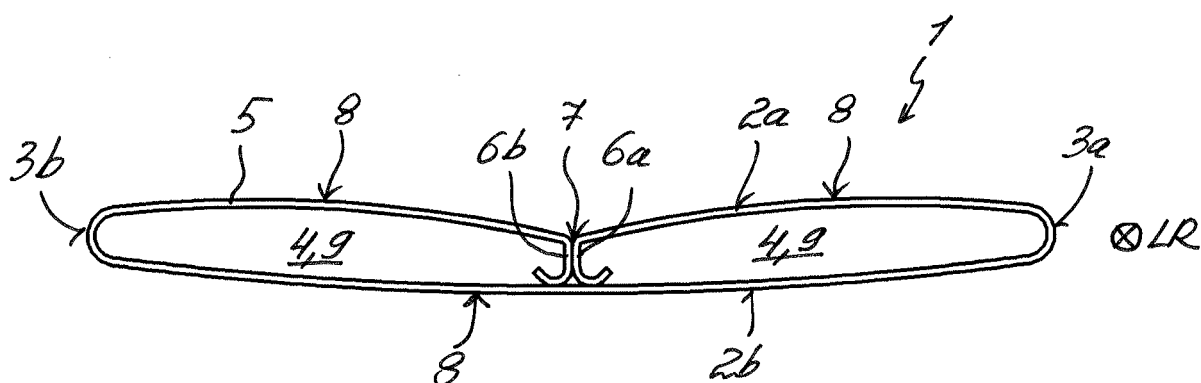


Fig. 1

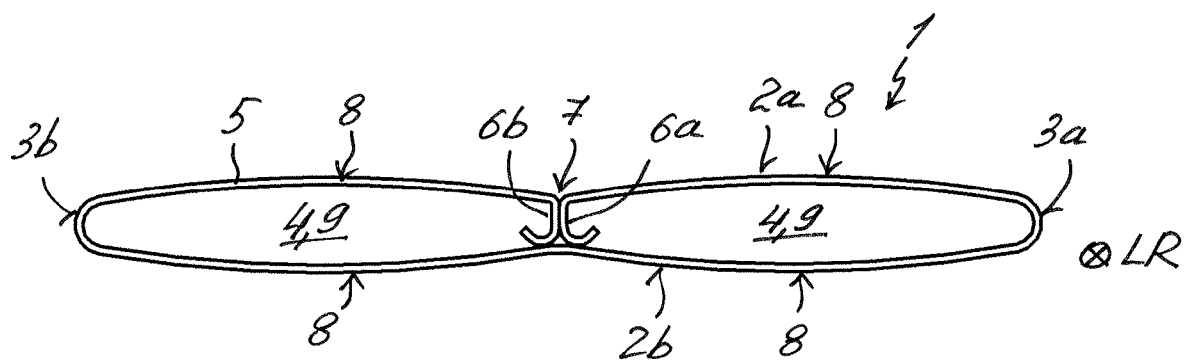


Fig. 2

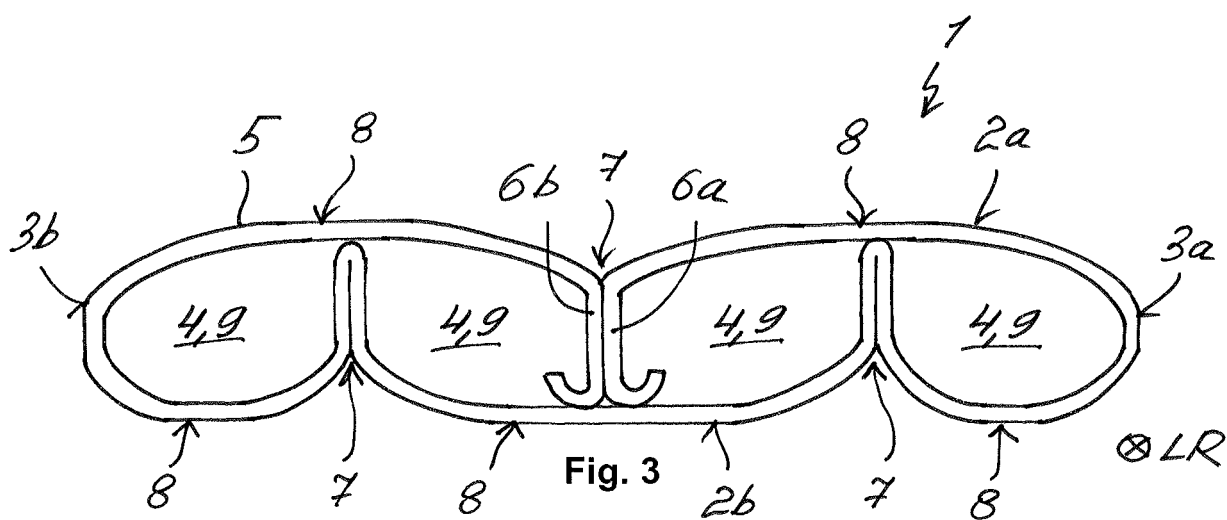


Fig. 3



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Application Number

EP 21 19 6856

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EPO FORM 1503 03.82 (P04C01)

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 7 February 2022	Examiner Martínez Rico, Celia
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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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
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