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(54) MANIFOLD FOR A HEAT EXCHANGER ASSEMBLY AND METHOD FOR MANUFACTURING SUCH A MANIFOLD

(57) The present invention relates to a manifold (2) for a heat exchanger assembly (1), which comprises a cover (23), a header (21) applied on said cover (23) and an internal plate sandwiched between the cover (23) and the header (21). Prior to assembly of the manifold (2) an

internal surface (217) of the header (21) has a radius R_{ish} , an internal surface (237) of the cover (23) has a radius R_{isc} , a first surface (223) and a second surface (224) of the internal plate (22) have a radii R_{ip1} and R_{ip2} , respectively, and $R_{ish} > R_{ip1} \geq R_{ip2} > R_{isc}$.

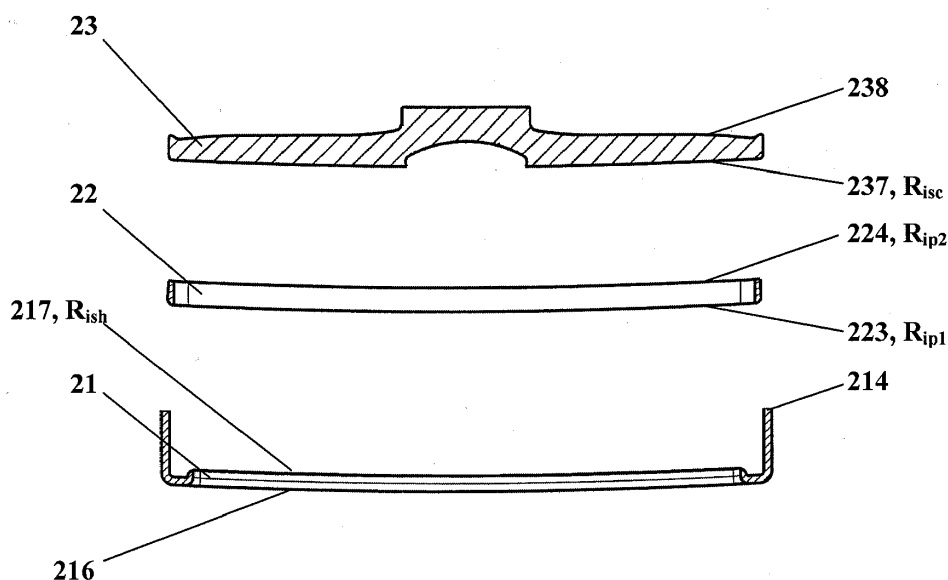


Fig. 5

Description

Technical Field

[0001] The present invention relates to a manifold for a heat exchanger assembly, especially to a high pressure manifold for automotive heat exchanger assemblies, and a method for manufacturing such a manifold.

Prior Art

[0002] A prior art manifold generally comprises a cover and a header applied and bent on the cover. The cover comprises at least one channel defined therein. The header comprises a series of through slots, which receive a series of flow ducts of a heat exchanger and are in fluid communication with the channel of the cover. Cooperating surfaces of the header and the cover as well as an external surface of the header are bent in a direction opposite to a direction in which the flow ducts are inserted into the manifold.

[0003] However, a series of weak points between the header and the cover can be present in the prior art manifold described above. This is caused by the fact that a brazing material is unevenly distributed over the cooperating surfaces what in turn lead to brazing failures and brazing voids in areas critical for structural strength of the manifold, which operates under very high pressures, typically 120-170 bars with burst up to 250 bars.

[0004] Therefore, during the manifold assembly and brazing process special attention must be paid to the way in which the brazing material is spread over the cooperating surfaces of the manifold. Moreover, special measures must be taken to keep all components of the manifold in tight contact with each other during the assembly and brazing process.

Aims of Invention

[0005] One aim of the present invention is to provide a manifold for a heat exchanger assembly, which eliminates or at least significantly reduces the drawbacks of the prior art solution described above.

[0006] Another aim of the present invention is to provide a manifold for a heat exchanger assembly, which is more durable, easier to manufacture and more cost-effective.

[0007] The above and other aims are achieved by a manifold and a method as defined in the accompanying claims.

Disclosure of Invention

[0008] A manifold for a heat exchanger assembly comprises a cover, which in turn comprises at least one channel defined therein. The manifold further comprises a header applied on the cover. The header comprises a plurality of slots. The cover and the header are bent in a

direction extending from the cover towards the header. The manifold further comprises an internal plate sandwiched between the cover and the header and comprising a plurality of slots in fluid communication with the slots of the header and the at least one channel of the cover. The internal plate is bent in the direction extending from the cover towards the header.

[0009] In another embodiment of the present invention the cover includes an internal surface, which has a radius R_{isc} prior to assembly of the manifold. The header includes an internal surface, which has a radius R_{ish} prior to assembly of the manifold. The internal plate includes a first surface facing the internal surface of the header and a second surface facing the internal surface of the cover. Prior to assembly of the manifold the first surface of the internal plate has a radius R_{ip1} , the second surface of the internal plate has a radius R_{ip2} and $R_{ish} > R_{ip1} \geq R_{ip2} > R_{isc}$.

[0010] Further advantageous embodiments of the present invention are defined in dependent claims.

[0011] Another object of the present invention is a method for manufacturing a manifold for a heat exchanger assembly as defined in claims 6 and 7.

[0012] The manifold constructed according to the present invention is more robust compared to the prior art solutions. Additionally, elastic forces generated by tensioning the components of the manifold ensure that they are tightly kept together what in turn means that non-brazed voids/isles are not formed between surfaces to be brazed.

Brief Description of Drawings

[0013] The invention will be discussed in more detail below, with reference to the annexed drawings, which show nonlimiting embodiments of the invention, wherein:

Fig. 1 shows a perspective view of a heat exchanger assembly,

Fig. 2 shows a perspective exploded view of a manifold used in the heat exchanger assembly of figure 1, Fig. 3 shows an another perspective exploded view of the manifold of figure 2,

Fig. 4 shows yet another perspective exploded view of the manifold of figure 2,

Fig. 5 shows a cross-section exploded view of the manifold,

Fig. 6 shows a cross-section view of the manifold just before its final assembly,

Fig. 7 shows a cross-section view of the manifold, once assembled,

Fig. 8 shows a detail of figure 7,

Fig. 9 shows an another embodiment of a cover.

Embodiments of Invention

[0014] Generally, a heat exchanger assembly 1 comprises two manifolds 2 and a plurality of flat hollow flow

ducts 3. Ends of the flow ducts 3 are received in corresponding slots provided in the manifolds 2. A plurality of coolant turbulators 4 can be placed between the flow ducts 3 in such a way that one coolant turbulator 4 is situated between and in contact with two adjacent flow ducts 3. In the embodiment shown in figure 1 one of the manifolds 2 is an inlet manifold, while the other is an outlet manifold.

[0015] In another embodiments of the invention, one of the manifolds 2 can operate both as the inlet manifold and the outlet manifold, whereas the other is in fact an intermediate manifold. It means that the intermediate manifold receives a fluid to be cooled down from some flow ducts 3 and guides it back to the other flow ducts 3 so that an U-shaped flow path is created. The other manifold 2 is configured to both receive a hot fluid from a vehicle and deliver a cool fluid back to the vehicle. Generally, all components of the manifold 2 are brazed to each other.

[0016] The manifold 2 comprises a header 21, an internal plate 22 and a cover 23. The internal 22 plate is sandwiched between and is in tight contact with the header 21 and the cover 23. The internal plate 22 functions as an interface between the header 21 and the cover 23. The cover 23 can define therein at least one longitudinal channel 231 for a fluid to be cooled down. The number of longitudinal channels 231 depends on whether the manifold 2 operates as the intermediate manifold (one longitudinal channel) or as the inlet/outlet manifold (two longitudinal channels). The function of the longitudinal channel 231 is to distribute the fluid to be cooled down along the manifold 2. The longitudinal channel 231 is open towards the internal plate 22. The longitudinal channel 231 can also be open to longitudinal faces of the cover 23 or can end in a distance from the longitudinal faces of the cover 23. If the channel 231 opens to both longitudinal faces the manifold 2 can be provided with a plug 24 at each of its ends. The plugs 22 cover and close the ends of the manifold 2, thus ensuring that the manifold 2 is fluid-tight once assembled.

[0017] The header 21 and the internal plate 22 comprise a plurality of slots 211 and 221, respectively. The number and the shape of the slots 211, 221 correspond to the number and the shape of the flow ducts 3. The flow ducts 3 fit inside the slots 211, 221 and are in fluid communication with the longitudinal channel 231 of the cover 23. The cover 23 is provided with a through port 233 that is in fluid communication with the at least one longitudinal channel 231 of the cover 23. However, in another embodiment of the invention, if the manifold 2 operates as the intermediate manifold the cover 23 does not comprise the through port 233. Moreover, if the manifold 2 operates as the inlet/outlet manifold the cover 23 is provided with two through ports 233, each being in fluid communication with one longitudinal channel 231. In the latter case, the heat exchanger assembly 1 can be provided with two rows of the flow ducts 3, two rows of the slots 211 and two rows of the slots 221 in both manifolds 2, two separate

longitudinal channels 231 in the first manifold 2, one longitudinal channel 231 in the second manifold 2 and two through ports 233 in the first manifold 2. The second manifold 2 comprises no through ports 233. The manifold 2 can further comprise a connection block 25 placed over and in fluid communication with each of the through ports 233 of the cover 23.

[0018] The header 21 is an U-shaped longitudinal element provided with one row of the slots 211. Of course, if more than one row of the flow ducts 3 are used, for example two, the header 21, as well as the internal plate 22, is provided with a corresponding number of rows of the slots 211, in this case two. Additionally, the number of the longitudinal channels 231 of the cover 23 also corresponds to the number of the rows of the flow ducts 3 and the slots 211, 221, each longitudinal channel 231 being in fluid communication with one of the rows of the flow ducts 3 and the slots 211, 221. The header 21 comprises two side walls 213, which are longer than the summarized length of the internal plate 22 and the cover 23 stacked together. Ends 214 of the side walls 213 are bent on ends 234 of the cover 23 to assemble all components of the manifold 2 into one unit and keep them together.

[0019] The header 21, the internal plate 22 and the cover 23 and bent on their cooperating surfaces. The header 21 has an external surface 216 and an internal surface 217. The internal surface 217 faces the internal plate 22. The external surface 216 and the internal surface 217 are both bent towards the flow ducts 3, namely the external surface 216 is convex and the internal surface 217 is concave when viewed in cross-section. Prior to assembly of the manifold 2 the internal surface 217 has a radius R_{ish} .

[0020] The internal plate 22 has first and second surfaces 223, 224. The first surface 223 faces the internal surface 217 of the header 21. The second surface 224 faces the cover 23. The first and second surfaces 223, 224 are bent towards the flow ducts 3, namely the first surface 223 is convex and the second surface 224 is concave when viewed in cross-section. Prior to assembly of the manifold 2 the first surface 223 has a radius R_{ip1} , while the second surface 224 has a radius R_{ip2} .

[0021] Similarly, the cover 23 has an internal surface 237 and an external surface 238. The internal surface 237 faces the second surface 224 of the internal plate 22. The internal surface 237 is bent towards the flow ducts 3, namely the internal surface 237 is convex when viewed in cross-section. Prior to assembly of the manifold 2 the internal surface 237 has a radius R_{isc} .

[0022] In short, the header 21, the internal plate 22 and the cover 23 are bent in a direction D1, which extends from the cover 23 towards the header 21 and through their centers, when viewed in cross-section. It means that physical points on the external surface 216, the first surface 223 and the internal surface 237 located at or near a transverse axis A of the manifold 2 are situated farther away, in respect of the dimension D1, than ends of the header 21, the internal plate 22 and the cover 23, respec-

tively. In other words, the direction D1 is opposite to a direction D2, in which the flow ducts 3 are to be inserted into the manifold 2.

[0023] Prior to assembly of the manifold 2, the radii described above meet the following relationship:

$$R_{ish} > R_{ip1} > R_{ip2} > R_{isc}$$

[0024] The above relationship can be fulfilled not only by appropriate selection of radius values, but also by appropriate selection of dimensional tolerances of the radii.

[0025] During first steps of the manifold assembly process the relationship referred to above secures physical contact between the header 21, the internal plate 22 and the cover 23 in their central area near the transverse axis A of the manifold 2. Then, a pressing force F is exerted on the components of the manifold 2 to bring them together and guarantee complete physical contact between corresponding brazing areas, namely between a brazing area 212 of the header 2 and a first brazing area 222a of the internal plate 22 as well as between a second brazing area 222b of the internal plate 22 and a brazing area 232 of the cover 23. To ensure that the header 21, the internal plate 22 and the cover 23 are in tight contact during the CAB (Controlled Atmosphere Brazing) brazing process the ends 214 of the side walls 213 of the header 21, as discussed above, are bent at a bending angle α on the ends 234 of the cover 23 so that a bend 215 is created. The bending angle α is defined as an angle between the extension of the wall 213 of the header 21 and the end 214 itself after bending.

[0026] This particular relationship of the radii, combined with the fact that the ends 214 of the side walls 213 of the header 21 are bent on the ends 234 of the cover 23, guarantees excellent matching of the mating surfaces of the manifold 2, namely the brazing areas 212, 222a, 222b and 232, without any voids (non-brazed isles) between them. This ensures that, when the manifold 2 has been assembled, all cooperating surfaces of the manifold 2 are in tight contact with each other. The shape and surface area of the mating surfaces are configured in such a way that they are sufficient to withstand working conditions of the manifold 2. Moreover, elastic forces arising from the tension of the header 21, the internal plate 22 and the cover 23 ensure that all components of the manifold 2 are held as a single unit.

[0027] The cover 23 can be provided at both its ends 234 with a recess 235 and a protruding edge 236 adjacent to the recess 235. The protruding edge 236 of the cover 23 defines a precise bending line for the ends 214 of the side walls 213 of the header 21. The recesses 235 receive the ends 214 of the side walls 213. This means that the bending angle α is in fact greater than the required minimum bending value of 90° , preferably greater than or equal to 100° , more preferably greater than or equal to 120° , for stable crimping purpose. This way a stable

configuration of the manifold 2 during CAB thermal treatment is ensured. In addition, this ensures that the risk of loosening the connection between the header 21, the internal plate 22 and the cover 23, and thus the risk of creating gaps between them, is significantly reduced.

[0028] In the embodiments described above it has been indicated that the internal plate 22 comprises two surfaces 223, 224 with two different radii R_{ip1} and R_{ip2} , respectively. However, in another embodiment of the invention the internal plate 22 still has first and second surfaces 223, 224 but their radii are equal to each other, namely R_{ip1} equals R_{ip2} . In this case, prior to assembly of the manifold 2 the relationships between all radii take the following forms:

$$R_{ish} > R_{ip1}$$

$$R_{ip1} = R_{ip2}$$

$$R_{ip2} > R_{isc}$$

[0029] Taking into account the relationship where $R_{ip1} > R_{ip2}$, as discussed earlier, prior to assembly of the manifold 2 the general relationship between all radii in different embodiments of the invention can be expressed in the following form:

$$R_{ish} > R_{ip1} \geq R_{ip2} > R_{isc}$$

[0030] The manifold 2 is manufactured in the following way. First, the header 21, the internal plate 22 and the cover 23, as described above, are provided. At this stage, generally, the radius relationships defined above apply. Next, the header 21 is applied on the cover 23 and the internal plate 22 so that the internal plate 22 is sandwiched between the header 21 and the cover 23 and all these three elements are kept together. Also, the pressing force F is exerted on the header 21, the internal plate 22 and the cover 23 to bring all these elements to complete tight contact with each other at their corresponding brazing areas. At the end, the ends 214 of the header 21 are bent on the ends 234 of the cover 23 and the brazing process takes place.

[0031] As described earlier in this description, the cover 23 can comprise at least one longitudinal channel 231. The longitudinal channel 231 distributes the fluid to be cooled down, especially CO_2 , along the manifold 2. The longitudinal channel 231 can be circular or oval in cross-section. The longitudinal channel 231 is arranged in the cover 23 so that the largest dimension LD of the channel 231 in a direction B between two ends 234 of the cover 23 is contained within the cross-section of the channel 231. In other words an open side 231a of the channel

231 does not include the largest dimension LD of the channel 231. The width of the open side 231a in the direction B is smaller than the largest dimension LD of the cover 23 in the same direction. This way a protrusion 231b is formed at both edges of the longitudinal channel 231 and the protrusions 231b are separated by a distance that is smaller than the largest dimension LD of the channel 231. Furthermore, the stresses arising from mechanical deformations due to the pressure of the fluid to be cooled down concentrate at an area C of the longitudinal channel 231 and not at the protrusions 231b. This in turn means that the projections 231b are subjected to less stress compared to other parts of the longitudinal channel 231, which in turn makes the connection between the internal surface 237 of the cover 23 and the second surface 224 of the internal plate 22 more durable, especially in an area near the projections 231b, and increases the durability of the manifold 2. In addition, by applying this feature, the thickness of the cover 23 can be reduced because the cover 23 itself is more robust. Moreover, this configuration of the cover 23 ensures that the whole manifold 2 is very durable despite bending and tensioning of its components.

[0032] Additionally, a bulge 239 is formed on the external surface 238 of the cover 23. The position of the bulge 239 corresponds to and is a result of the position of the longitudinal channel 231. As shown in the figures, the bulge 239 can take different shapes and enables easier attachment of the connection block 25 and/or other elements like hooks, brackets, etc. In fact the connection block 25 can be integrated in the bulge 239 itself. Moreover, the shape of the bulge 239 can be chosen to match the shape of surrounding components of a vehicle. This feature offers high flexibility in forming the longitudinal channel 231 and makes it possible to control and minimize an internal volume of the whole manifold 2.

[0033] In the embodiments described above and shown in the figures the through port 233 for the connection block 25 is formed on the external surface 238 of the cover 23. However, in another embodiment of the present invention, not shown in the figures, the through port 233 can be defined in the plug 24. In this case, the longitudinal channel 231 opens to longitudinal faces of the cover 23, which are closed by the plugs 24. One of the plugs 24, or both, comprises at least one through port 233, which is in fluid communication with the longitudinal channel 231. This in turn means that the connection block(s) 25 is(are) placed over the through port 233 in the plug 24 and is(are) connected to the plug 24 itself, either directly or via additional intermediate tubes.

Claims

1. A manifold (2) for a heat exchanger assembly (1) comprising:

a cover (23), which comprises at least one chan-

nel (231) defined therein;

a header (21) applied on said cover (23), said header (21) comprising a plurality of slots (211); wherein said cover (23) and said header (21) are bent in a direction (D1) extending from said cover (23) towards said header (21);

characterized in that

it further comprises an internal plate (22) sandwiched between said cover (23) and said header (21) and comprising a plurality of slots (221) in fluid communication with said slots (211) of said header (21) and said at least one channel (231) of said cover (23), said internal plate (22) being bent in said direction (D1) extending from said cover (23) towards said header (21).

2. The manifold (1) according to claim 1, **characterized in that** said cover (23) includes an internal surface (237), which has a radius R_{isc} prior to assembly of said manifold (2), said header (21) includes an internal surface (217), which has a radius R_{ish} prior to assembly of said manifold (2), and said internal plate (22) includes a first surface (223) facing said internal surface (217) of said header (21) and a second surface (224) facing said internal surface (237) of said cover (23), wherein prior to assembly of said manifold (2) said first surface (223) of said internal plate (22) has a radius R_{ip1} , said second surface (224) of said internal plate (22) has a radius

$$R_{ip2} \text{ and } R_{ish} > R_{ip1} \geq R_{ip2} > R_{isc}.$$

3. The manifold according to any of claims 1 and 2, **characterized in that** said cover (23) includes an external surface (238) and two ends (234), said cover (23) being provided on said external surface (238) and at said ends (234) with recesses (235) so that two protruding edges (236) are formed adjacent to said recesses (235), said recesses (235) receiving ends (214) of side walls (213) of said header (21).
4. The manifold according to claim 3, **characterized in that** said ends (214) of said header (21) are bent on said cover (23) at a bending angle (α), which is greater than 90° , preferably greater than 100° , more preferably greater than 120° .
5. The manifold according to any of the preceding claims, **characterized in that** said at least one channel (231) of said cover (23) has the largest dimension (LD), which extends in a direction (B) between said ends (234) of said cover (23) and is included in a cross-section of said at least one channel (231) so that two protrusions (231b) are formed at both edges of said at least one channel (231), said protrusions (231b) are separated by a distance smaller than the

largest dimension (LD) of said at least one channel (231).

6. A method for manufacturing a manifold (2) for a heat exchanger assembly (1) including the steps of: 5

a: providing a cover (23) comprising at least one channel (231) defined therein, a header (21) having a plurality of slots (211) and an internal plate (22) intended to be sandwiched between said cover (23) and said header (21) and having a plurality of slots (221); said header (21), said internal plate (22) and said cover (23) each being bent in a direction (D1) extending from said cover (23) towards said header (21) ; 10 15

b: applying said header (21) on said internal plate (22) and said cover (23) so that said header (21), said internal plate (22) and said cover (23) are kept together and said internal plate (22) is sandwiched between said header (21) and said cover (23); and 20

c: brazing said header (21), said internal plate (22) and said cover (23) together.

7. The method according to claim 6, wherein said cover (23) includes an internal surface (237), which has a radius R_{isc} prior to step b, said header (21) includes an internal surface (217), which has a radius R_{ish} prior to step b, and said internal plate (22) includes a first surface (223) facing said internal surface (217) of said header (21) and a second surface (224) facing said internal surface (237) of said cover (23), and wherein prior to step b said first surface (223) of said internal plate (22) has a radius R_{ip1} , said second surface (224) of said internal plate (22) has a radius R_{ip2} and $R_{ish} > R_{ip1} \geq R_{ip2} > R_{isc}$, and wherein step b also includes exerting a force F on said header (21), said internal plate (22) and said cover (23) to bring their corresponding brazing areas into complete contact. 25 30 35 40

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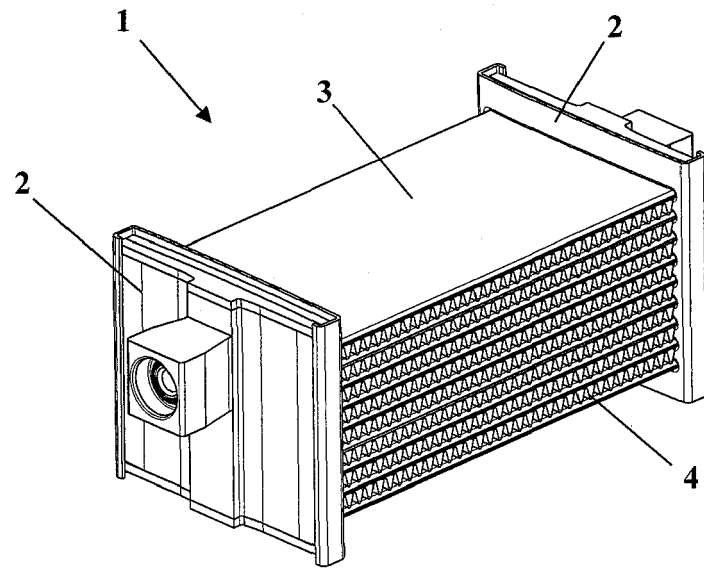


Fig. 1

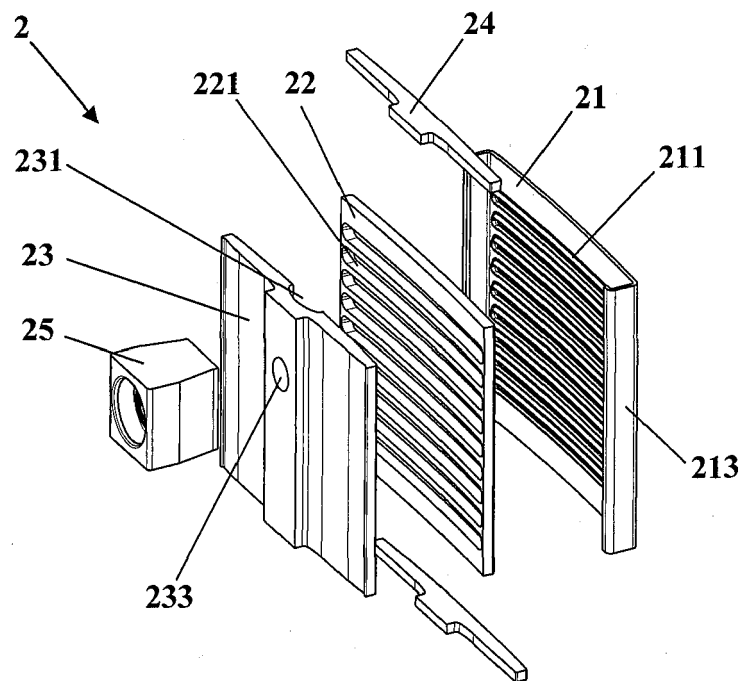


Fig. 2

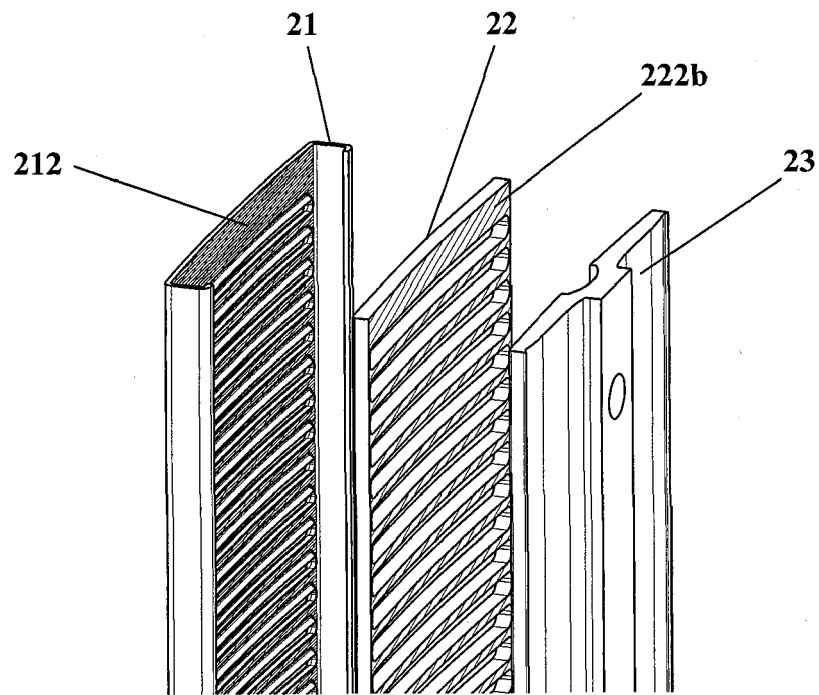


Fig. 3

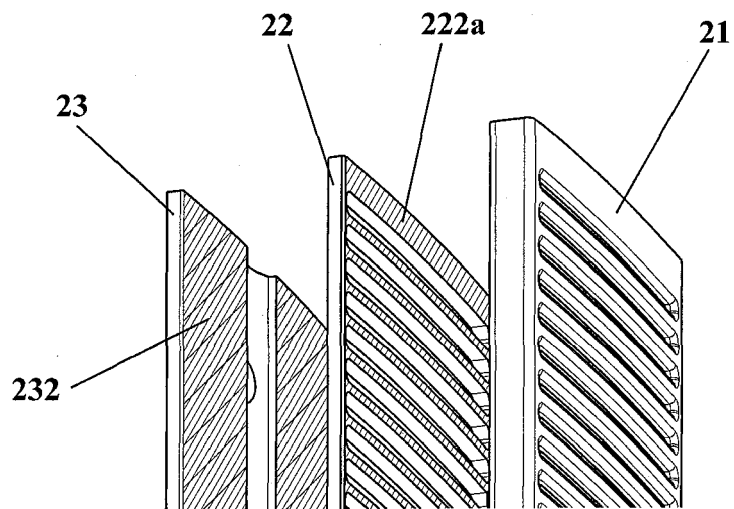


Fig. 4

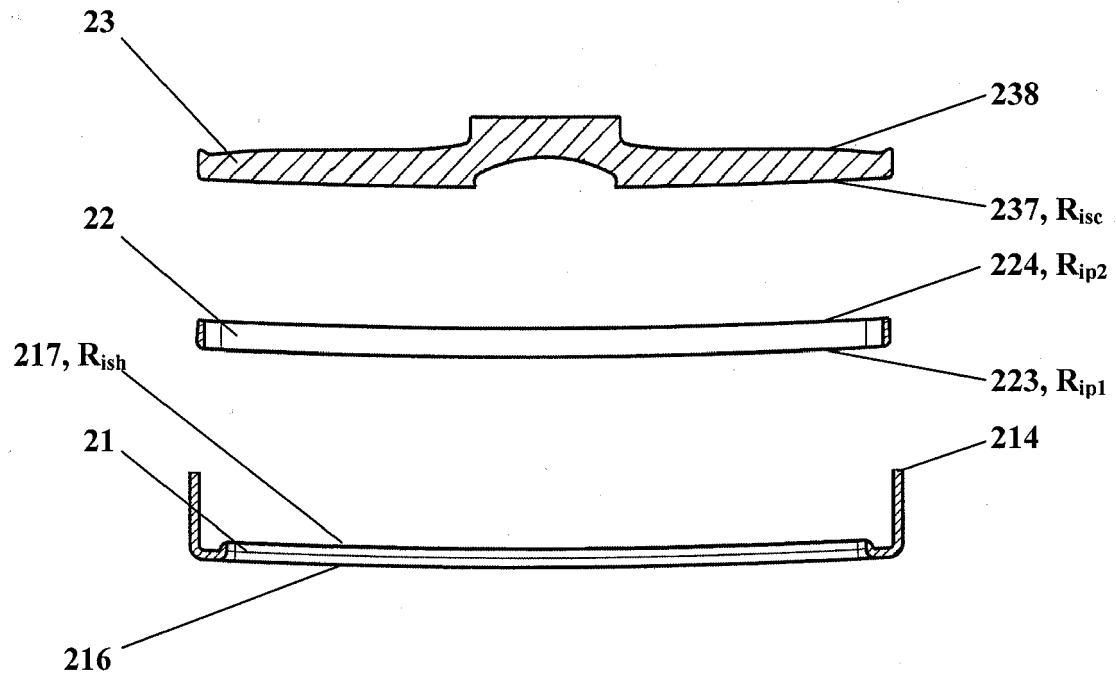


Fig. 5

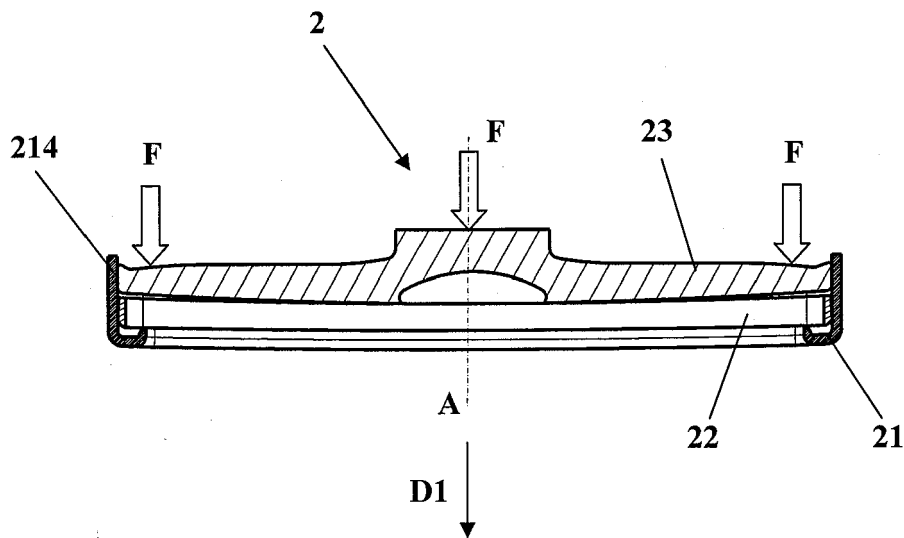


Fig. 6

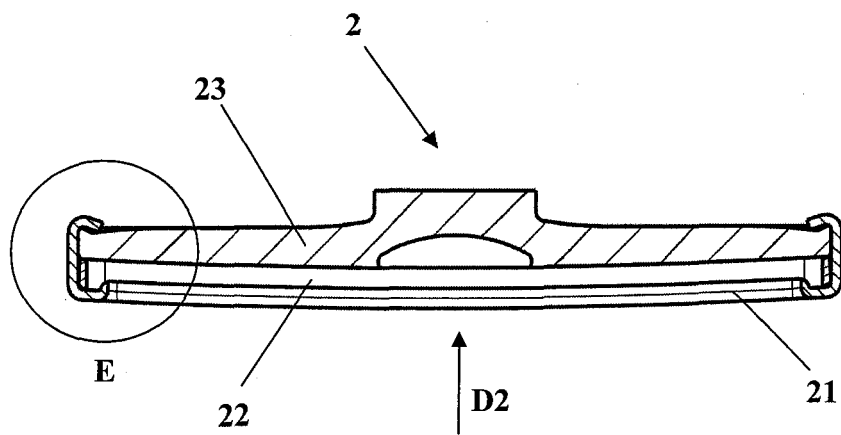
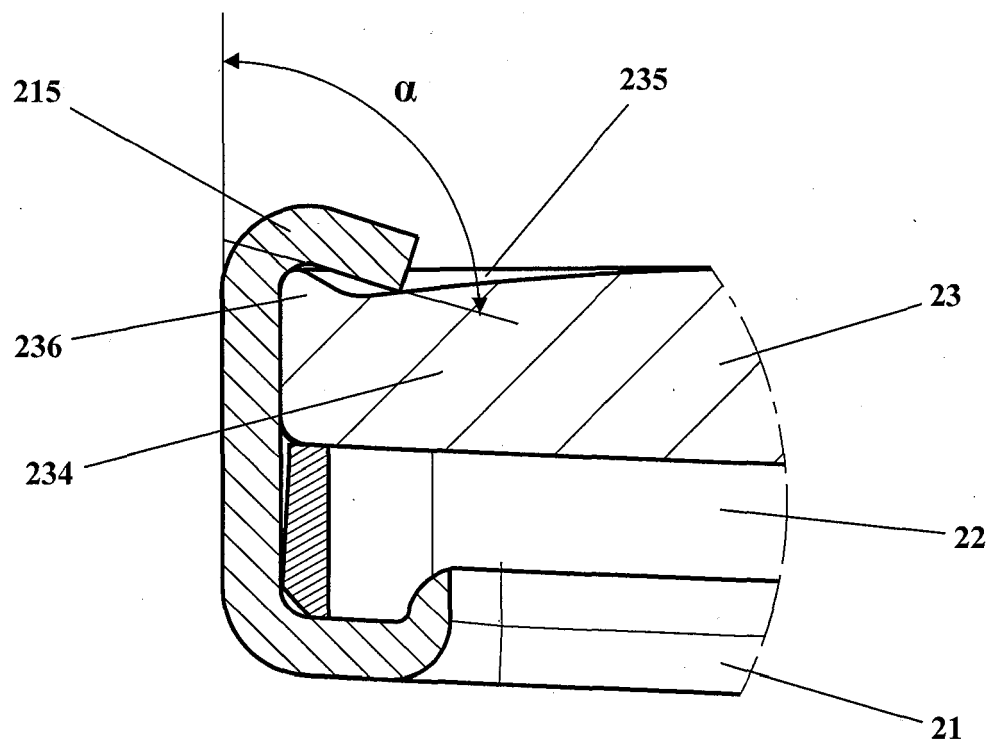


Fig. 7



DETAIL E

Fig. 8

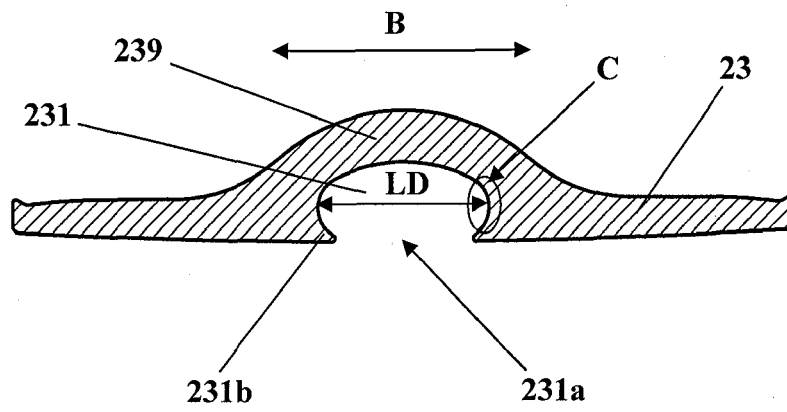


Fig. 9



EUROPEAN SEARCH REPORT

Application Number
EP 17 46 1606

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DOCUMENTS CONSIDERED TO BE RELEVANT			
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			TECHNICAL FIELDS SEARCHED (IPC)
			F28F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 20 March 2018	Examiner Jessen, Flemming
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 17 46 1606

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