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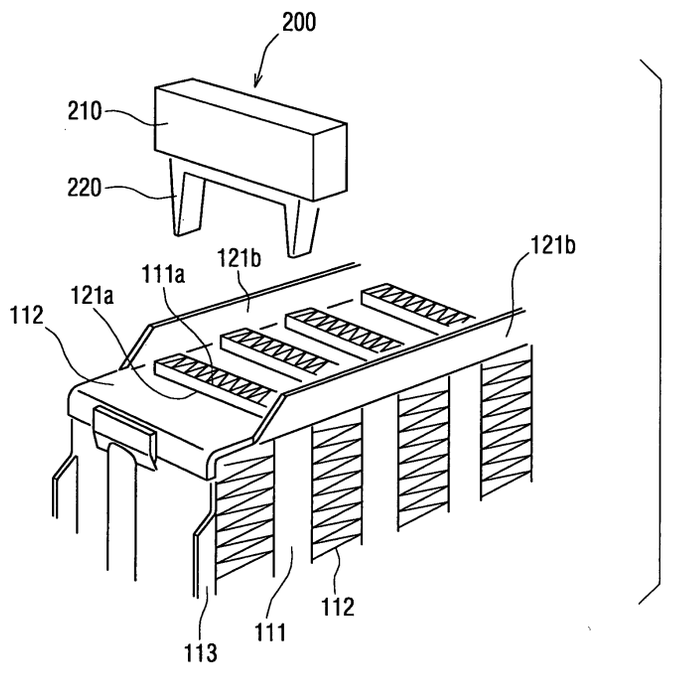
(54) Jig for expanding opening of heat exchanger tube

(57) A jig for expanding an opening of a heat exchanger tube, the jig includes an expanding blade (220) and a main body (210). The expanding blade (220) protrudes from the main body (210) toward an opening side (111a) of the tube (111). The expanding blade (220) is disposed on a predetermined position corresponding to a narrow side (111b) of the tube (111). The expanding blade is capable of moving inside of the tube (111) so that the narrow side (111b) of the tube (111) is expanded. The expanding blade (220) includes a surface (220a) having a taper shape, which inclines on the narrow side (111b) toward a top end (220b) of the expanding blade (220) in a case where the blade (220) is inserted into the tube (111). The tube (111) has a rectangular flat cross section so that the narrow side (111b) is determined by the rectangular flat cross section of the opening (111a). The tube (111) disposed inside of a tube hole (121a) includes an inner fin (114) therein.

FIG. 6



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Description

[0001] The present invention relates to a jig for expanding an opening of a heat exchanger tube.

[0002] A jig (i.e., device) for expanding an opening of a heat exchanger tube according to a related art is disclosed in Japanese Patent Publication No. 2793337. Specifically, the jig for expanding the opening of the tube press-expands the opening of the tube toward a tube hole side by cutting and separating a narrow side of the tube with two expanding blades for the opening after the tube is inserted into a tube hole of a plate (i.e. , a base plate). Here, the plate provides a tank. The tube has an oval cross section. The expanding blades protrude toward the opening side of the tube.

[0003] The related art discloses that an inner fin is inserted into the tube so that the expanding blade is inserted into a space between a tube narrow side having a half circle shape and a periphery of the inner fin.

[0004] However, it is required to increase a cross section of the tube as large as possible in a limited accommodation space so that a flowing resistance of an inner fluid flowing through the tube is reduced. Therefore, the cross section of the tube is formed to be a flat square shape, and further, an accommodation amount of the inner fin is increased. In this case, a part of the inner fin is broken down by the expanding blade when the narrow side of the opening of the tube is expanded. Therefore, the flowing resistance of the fluid, which is already reduced, may be increased again.

[0005] In view of the above-described problem, it is an object of the present invention to provide a jig for expanding an opening of a heat exchanger tube. Specifically, the jig can expand a narrow side of an opening of the tube with limiting a collapse of the inner fin after the inner fin is inserted into the tube.

[0006] A jig for expanding an opening of a heat exchanger tube, the jig includes an expanding blade and a main body. The expanding blade protrudes from the main body toward an opening side of the tube. The expanding blade is disposed on a predetermined position corresponding to a narrow side of the tube. The expanding blade is capable of moving inside of the tube so that the narrow side of the tube is expanded. The expanding blade includes a surface having a taper shape, which inclines on the narrow side toward a top end of the expanding blade in a case where the blade is inserted into the tube. The tube has a rectangular flat cross section so that the narrow side is determined by the rectangular flat cross section. The tube is disposed inside of a tube hole, and the tube includes an inner fin therein.

[0007] In the above case, a contact portion of the expanding blade contacting an inner fin becomes smaller when the expanding blade is inserted into the tube. Therefore, the tube is processed to have a rectangular flat cross section. Accordingly, the collapse of the inner fin is limited as small as possible even when the inner fin is inserted into the inside of the tube.

[0008] Preferably, the top end of the expanding blade is disposed near a periphery of a contact portion between the tube and the tube hole in a case where the blade is inserted into the tube. The periphery is disposed on a moving direction side of the blade.

[0009] In the above case, the collapse of the inner fin is reduced as smaller as possible although the opening of the tube is expanded to have at least the requisite minimum dimensions.

[0010] The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description made with reference to the accompanying drawings. In the drawings:

Fig. 1 is a front view showing an inter-cooler as an object to expand an opening thereof, according to a first embodiment of the present invention;

Fig. 2 is a cross sectional view showing the inter-cooler taken along line III-III in Fig. 1;

Fig. 3 is a cross sectional view showing the III part of the inter cooler in Fig. 1;

Fig. 4 is a view on arrow showing a tube seeing from the IV direction in Fig. 3;

Fig. 5 is an external perspective view showing the tube independently, according to the first embodiment;

Fig. 6 is an external perspective view showing an expanding jig for an opening disposed over a core, according to the first embodiment;

Fig. 7 is a cross sectional view explaining an expanding manner by the expanding jig according to the first embodiment;

Fig. 8 is a cross sectional view explaining an expanding manner by an expanding jig according to a comparison of the first embodiment; and

Fig. 9 is a graph explaining reduction effect of a deformation amount of an inner fin and reduction effect of a flowing resistance, according to the first embodiment.

(First Embodiment)

[0011] A jig (i.e., an expanding jig) 200 for expanding an opening of a heat exchanger tube, according to a first embodiment of the present invention, expands an opening of a tube 111 in an air-cooled inter-cooler (i.e., an inter-cooler) 100. Firstly, the inter-cooler 100 as an object to expand an opening thereof is described with respect to Figs. 1 to 6.

[0012] The inter-cooler 100 is a heat exchanger for exchanging heat between a cool air from the outside and a combustion air (i.e., an intake air) sucked into an engine (an internal combustion engine) of an automotive vehicle so that the intake air is cooled. Each member (described as follows) composing the inter-cooler 100 is made of aluminum or aluminum alloy. The inter-cooler 100 is formed in such a manner that a pair of header

tanks 120 is bonded to a core 110.

[0013] As shown in Figs. 1 and 2, the core 110 is formed in such a manner that the tube 111 and an outer fin 112 are laminated alternately, and that a pair of side plates 113 is formed on both sides of the core 110 in a lamination direction. Specifically, the plates 113 are disposed on utmost outside of the core 110. The inner fin 114 is inserted into the tube 111.

[0014] The tube 111 is a pipe for flowing the intake air (i.e., the inner fluid) in the tube 111. The tube 11 has a square flat cross section so that the cross section of the tube 111 can be increased in a limited space as large as possible for reducing a flowing resistance of the intake air. The inner fin 114 to be inserted into the tube 111 is formed to be a corrugated sheet obtained from a thin plate. The inner fin 114 provides turbulent effect on the intake air flow so that coefficient of heat transfer on the air intake side is improved. Here, since the tube 111 has the square flat cross section, the inner fin 114 has no dead space in the tube 111. Thus, the inner fin 114 is accommodated in the tube 111 effectively.

[0015] The outer fin 112 is formed to be a corrugated sheet obtained from a thin plate, similar to the inner fin 114. Multiple louvers 112a are disposed on a flat surface of the outer fin 112. The louvers 112a are formed by cutting and opening up. The louvers 112a expand the heat radiation area to the cool air side. Further, the louvers 112a provide the turbulent effect so that the heat exchange between the intake air and the cool air is promoted.

[0016] The side plate 113 is a reinforcing member extending in a longitudinal direction of the tube 111. The side plate 113 is formed to have a C-shaped cross section. A rib is formed on the inside of the side plate 113 at the center of the C-shaped cross section. The rib extends in the longitudinal direction.

[0017] The tube 111 is formed in such a manner that a plate is folded and then both sides of the plate are electrically welded (i.e., the tube 111 is a seam-welded pipe). Preliminarily, the plate is cladded (i.e., covered) with a brazing filler metal on both surfaces thereof. The outer fin 112 and the inner fin 114 are brazed on the tube 111 with the brazing filler metal. A side wall of the side plate 113 on the outer fin 112 side is preliminarily cladded with the brazing filler material. The outer fin 112 disposed on utmost outside thereof is brazed on the side plate 113 with the brazing filler metal.

[0018] A pair of header tanks 120 (which correspond to a tank) is disposed on both periphery 111a (i.e., both tube periphery 111a) sides of the tube 111 in the longitudinal direction. Each header tank 120 extends in the laminated direction of the tube 111, and connects to the tube 111. The header tank 120 includes a core plate 121 (which corresponds to a plate) and a tank body 122. The tube 111 is bonded to the core plate 121. The tank body 122 is bonded to the core plate 121 so that an inner tank space is formed.

[0019] As shown in Figs. 3 and 6, a pair of edge shields 121b is disposed on both sides of the core plate 121. The edge shields 121b are disposed on wide sides of a long and thin plate, both sides of which are preliminarily cladded with the brazing filler metal. The tube hole 121a is disposed on a part of the core plate 121, which corresponds to the tube periphery 111a. The tube periphery 111a is inserted into the tube hole 121a so that the narrow side 111b of the opening of the tube 111 is expanded to have a circular arc shape by a later described jig 200 for expanding the opening, as shown in Figs. 4 and 5. The circular arc shape protrudes outside of the tube 111. The tube 111 has a square flat cross section as a primary shape. The narrow side 111b of the tube 111 is provided by the square flat cross section. Here, the circular arc shape has a radius R1, which is almost the same dimension as a distance W between the wide sides 111c.

[0020] The above expanding process provides the tube 111 to press-contact the tube hole 121a so that brazing characteristics between the tube 111 and the tube hole 121a are improved. Further, the expanding process provides that an angle of an edge 111d of the tube 111 is increased so that a stress is limited from concentrating at an edge 111d of the tube 111. The stress is applied to the tube 111 by repeating to apply a pressure (i.e., inner pressure) and/or a heat of the intake air to the tube 111.

[0021] The tube 111 and the core plate 121 contact and connect each other at a contact portion 131 (which corresponds to a contact region). They 111, 121 are brazed at the contact portion 131 with the brazing filler metal. The brazing filler metal is cladded on the tube 111 and the core plate 121. The brazed portion of the contact portion 131 forms a so-called base portion 130 of the tube 111. Both periphery sides of the side plate 113 in the longitudinal direction are brazed on the core plate 121 with the brazing filler metal coated on the core plate 121.

[0022] The core plate 121 connected to the tube 111 is welded to the tank body 122, as shown in Fig. 1. The tank body 122 provides a receiver having an opening 122a disposed on the core plate 121 side. Specifically, the opening 122a is formed on a periphery side in the longitudinal direction. Here, the header tank 120 disposed on the right side of the drawing in Fig. 1 supplies and distributes the intake air. The header tank 120 disposed on the left side of the drawing in Fig. 1 collects and retrieves the intake air discharged from the tube 111.

[0023] Next, the expanding manner of the opening of the tube 111 by the expanding jig 200 is described together with a manufacturing method of the inter-cooler 100. Firstly, a plate is folded, and then, the tube 111 is formed by an electric welding method. The outer fin 112, the side plate 113, the inner fin 114 and the core plate 121 are formed by a press method. Thus, the tube 111, the outer fin 112, the side plate 113, the inner fin 114 and the core plate 121 are prepared preliminarily. The

tube 111 is formed to have a square flat cross section through whole longitudinal direction at this time. The tube hole 121a of the core plate 121 is formed to have a certain shape corresponding to the cross section of the tube 111 having a circular arc with the radius R1, which is described in Figs. 4 and 5.

[0024] The inner fin 114 is inserted into the tube 111. Then, the tube 111 is pressed in a direction of the narrow side 111b so that the inner wall of the wide side 111c of the tube 111 contacts the inner fin 114 completely.

[0025] Then, the side plate 113 is mounted on the utmost down side with using a lamination jig as a guide, which is not shown. A predetermined number of the outer fins 112, the tubes 111, the outer fins 112 are alternately laminated on the side plate 113 in this order. Then, the other side plate 113 is mounted on the utmost up side of the outer fin 112. Thus, the core 110 is assembled.

[0026] The tube periphery 111a is inserted into the tube hole 121a of the core plate 121, and then, the core plate 121 is press-inserted by a press machine, which is not shown.

[0027] As shown in Figs. 6 and 7, the expanding jig 200 is inserted into the tube periphery 111a side (which corresponds to an opening side) so that the tube hole 121a of the tube 111 is expanded. The tube periphery 111a is protruded from the core plate 121.

[0028] Here, the expanding jig 200 according to the present invention is composed of a main body 210 having a block shape and two expanding blades 220. The expanding blades 220 protrude from the main body 210 to the tube periphery 111a side. The expanding blade 220 corresponds to the position of the narrow side 11b of the tube 111.

[0029] An outer side surface 220c to be disposed on the narrow side 111b of the expanding blade 220 is formed to have a taper shape, which inclines to the center of the cross section of the tube 111 toward the top end 220b. The outer side surface 220c corresponds to the cross section (i.e., the circular arc shape of the narrow side 111b) of the tube 111 shown in Figs. 4 and 5 at the outer periphery of near the main body 210 side. Additionally, the characteristics of the present invention are such that the inner surface 220a disposed on the inverse narrow side of the expanding blade 220 is formed to have a taper shape, which inclines to the narrow side 111b. Further, the top end 220b of the expanding blade 220 is disposed near the edge 131a of the contact portion 131 in the inserting direction when the expanding blade 220 is inserted into the tube 111.

[0030] This expanding jig 200 expands the narrow side 111b of the opening of the tube 111 in such a manner that the narrow side 111b is formed to be the circular arc shape near the tube hole 121a, and that the narrow side 111b is press-contacted to the tube hole 121a side completely.

[0031] Thus, the assembly of the core 110 is formed after the expanding jig 200 expands the opening. Then, the assembly of the core 110 is degreased and coated with a flux. Then, the assembly is set in a brazing furnace so that each member of the assembly is brazed integrally. Further, the tank body 122 is welded to the core plate 121 so that the inter-cooler 100 is completed. The tank body 122 is formed by a casting method.

[0032] Thus, in this embodiment, the inner surface 220a of the expanding blade 220 in the expanding jig 200 is formed to have a taper shape. Therefore, the contact region of the expanding blade 220 contacting the inner fin 114 becomes smaller when the expanding blade 220 is inserted into the tube 111. Further, since the tube 111 is formed to have the square flat cross section, the collapse of the inner fin 114 is suppressed as small as possible when the inner fin 114 is inserted into the tube 111.

[0033] Furthermore, the position of the top end 220a is set to be near the edge 131a of the contact portion 131 between the tube 111 and the tube hole 121a when the expanding blade 220 is inserted into the tube 111. Therefore, the expanding blade 220 expands the opening of the tube 111 to the requisite minimum dimensions, and the collapse of the inner fin 114 becomes much smaller.

[0034] Here, the inventor has preliminarily studied about an expanding jig 201 (of which an inner surface 220a of the expanding blade 220 is parallel to the vertical direction so that the top end 220b is inserted into the tube 111 to be deeper than the edge 131a of the contact portion 131, as shown in Fig. 8). A deformation amount (i.e., a collapse amount) of the inner fin 114 in case of the expanding jig 201 is compared with that in case of the expanding jig 200. As shown in Fig. 9, the average of the deformation amounts of the inner fin 114 at twenty positions in case of the jig 201 is 4.98mm, and that in case of the jig 200 is 1.14mm; and therefore, the deformation amount becomes smaller. It is confirmed that the flowing resistance of the inter-cooler 100 according to the reduction of the deformation amount is reduced by 9.2%.

(Other Embodiments)

[0035] Although jig 200 expands the inter-cooler 100 as the object in the above embodiment, the jig 200 according to the present invention can expand other heat exchangers (e.g., a condenser and a radiator), which have a square flat cross section, so that an opening of a tube is expanded, wherein an inner fin is inserted into the tube.

[0036] The length of the expanding blade 220 can be determined from a condition of a relationship between an expanding state of the opening and the deformation amount of the inner fin 114.

[0037] Although the narrow side 111b to be expanded has the circular arc shape, the narrow side 111b can be expanded with maintaining the primary square flat cross section.

[0038] Such changes and modifications are to be understood as being within the scope of the present invention as defined by the appended claims.

Claims

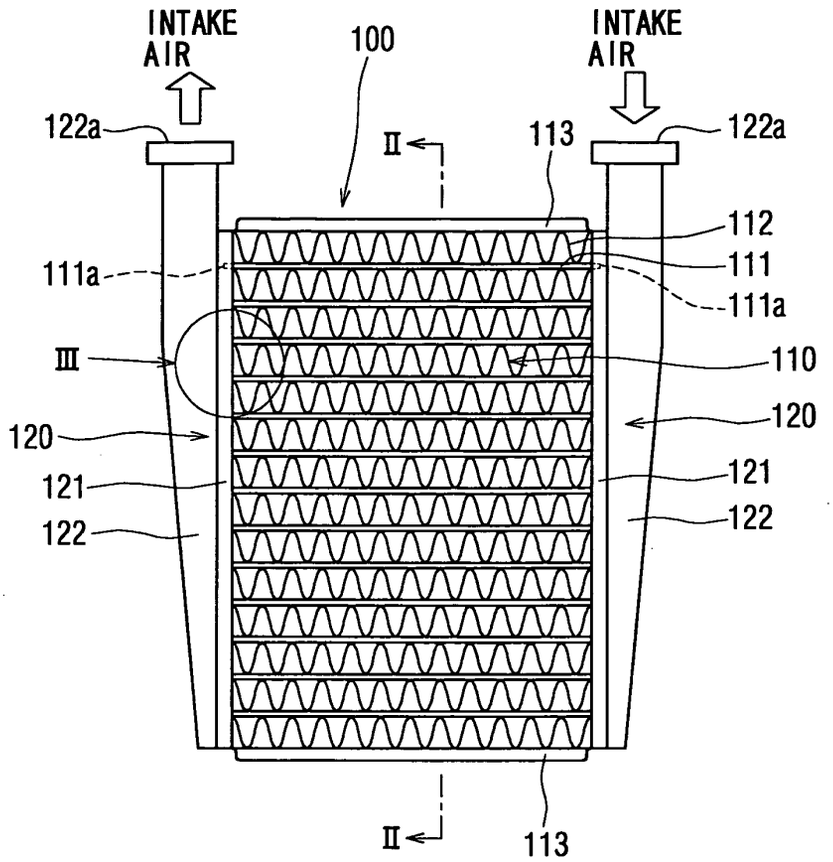
1. A jig for expanding an opening of a heat exchanger tube, the jig comprising:

an expanding blade (220); and
a main body (210), wherein
the expanding blade (220) protrudes from the main body (210) toward an opening (111a) of the tube (111),
the expanding blade (220) is disposed on a predetermined position corresponding to a narrow side (111b) of the opening (111a) of the tube (111),
the expanding blade is capable of moving inside of the tube (111) so that the narrow side (111b) of the tube (111) is expanded,
the expanding blade (220) includes a surface (220a) having a taper shape, which inclines on the narrow side (111b) toward a top end (220b) of the expanding blade (220) in a case where the blade (220) is inserted into the tube (111),
the tube (111) has a rectangular flat cross section so that the narrow side (111b) is determined by the rectangular flat cross section of the opening (111a),
the tube (111) is disposed inside of a tube hole (121a), and
the tube (111) includes an inner fin (114) therein.

2. The jig according to claim 1,
the blade (220) has a flat cross section.

3. The jig according to claim 1,
the top end (220a) of the expanding blade (220) is disposed near a periphery (131a) of a contact portion (131) between the tube (111) and the tube hole (121a) in a case where the blade (220) is inserted into the tube (111), and
the periphery (131a) is disposed on a moving direction side of the blade (220).

FIG. 1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100
INTAKE AIR
122a
II
113
122a
112
111a
111
111a
III
110
120
120
121
121
122
122
II
113

FIG. 2

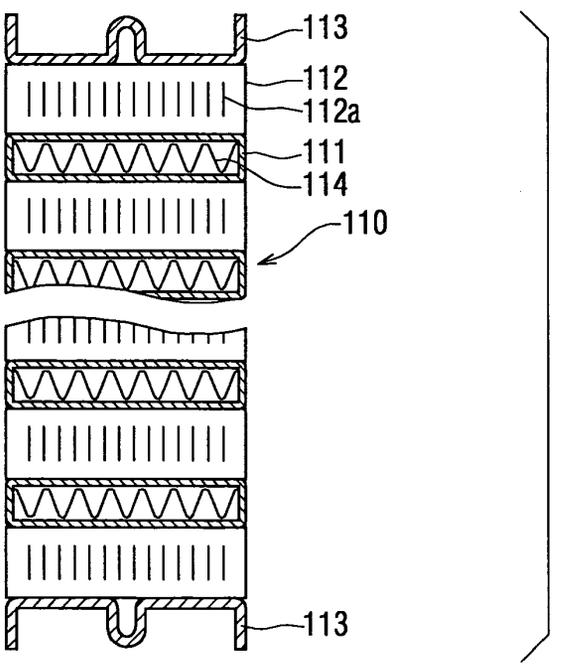

113
112
112a
111
114
110
113

FIG. 3

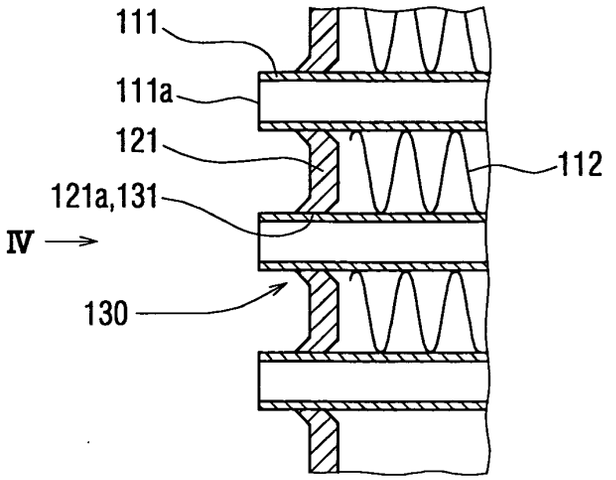


FIG. 4

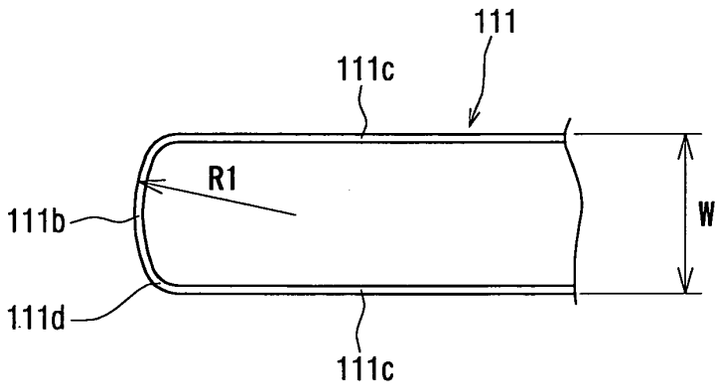


FIG. 5

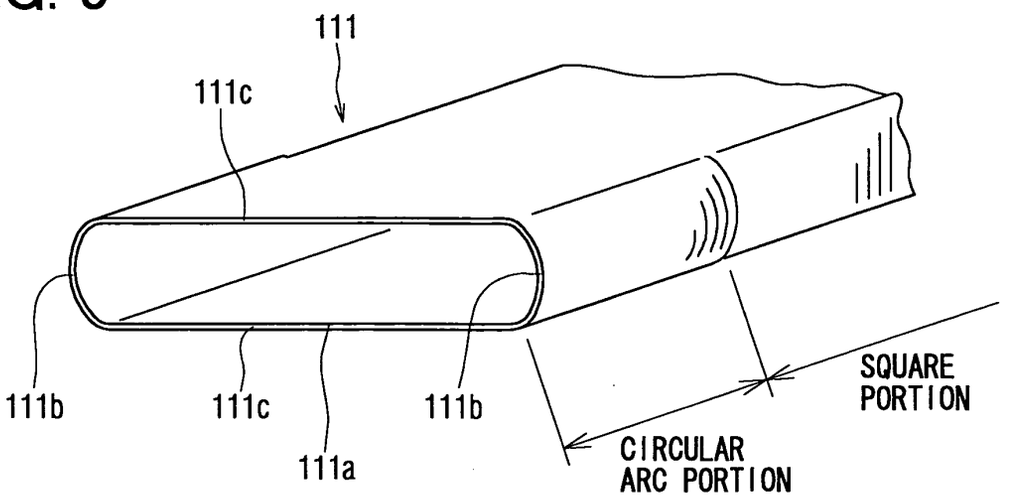


FIG. 6

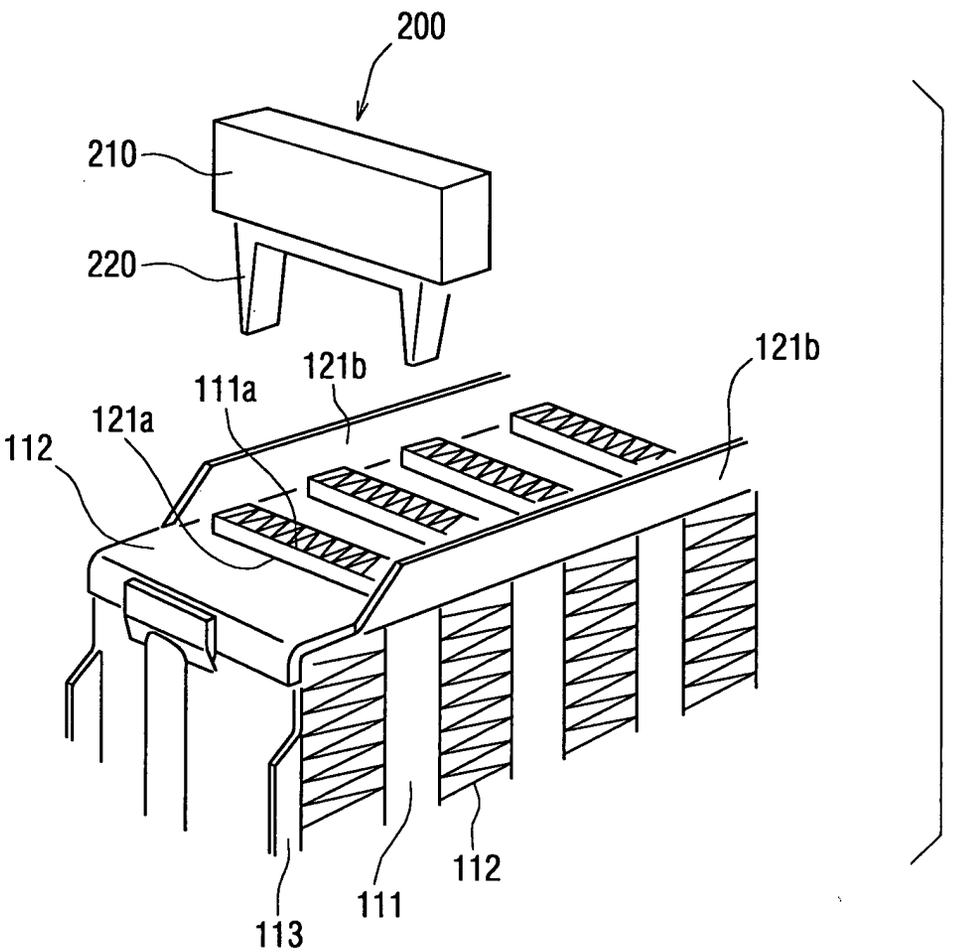


FIG. 7

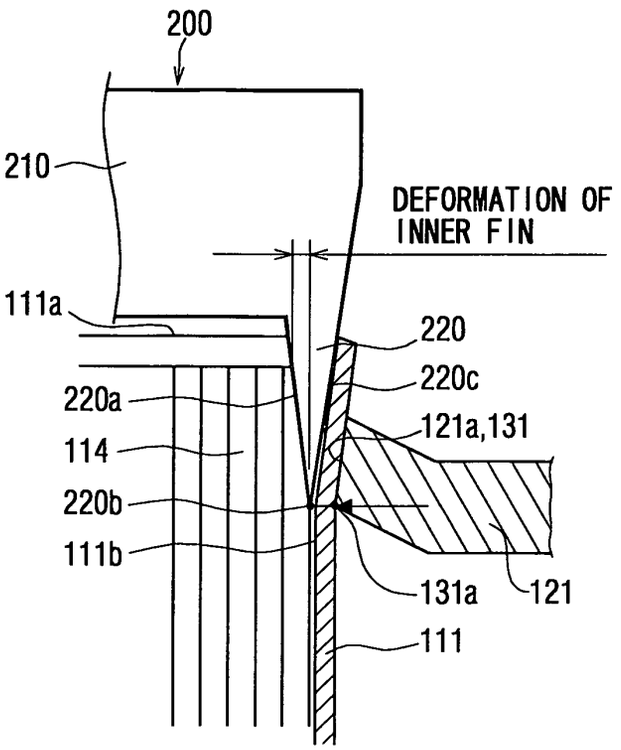

200
210
DEFORMATION OF INNER FIN
111a
220
220c
220a
121a,131
114
220b
111b
131a
121
111

FIG. 8

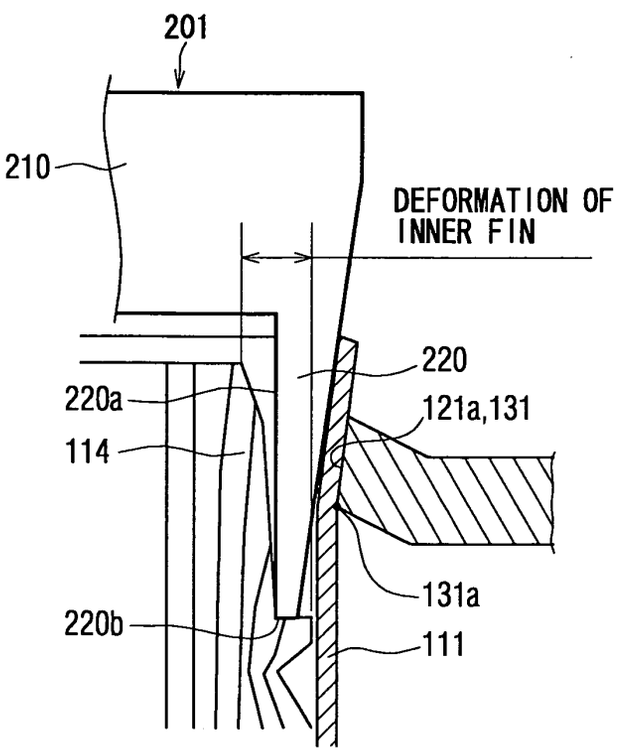
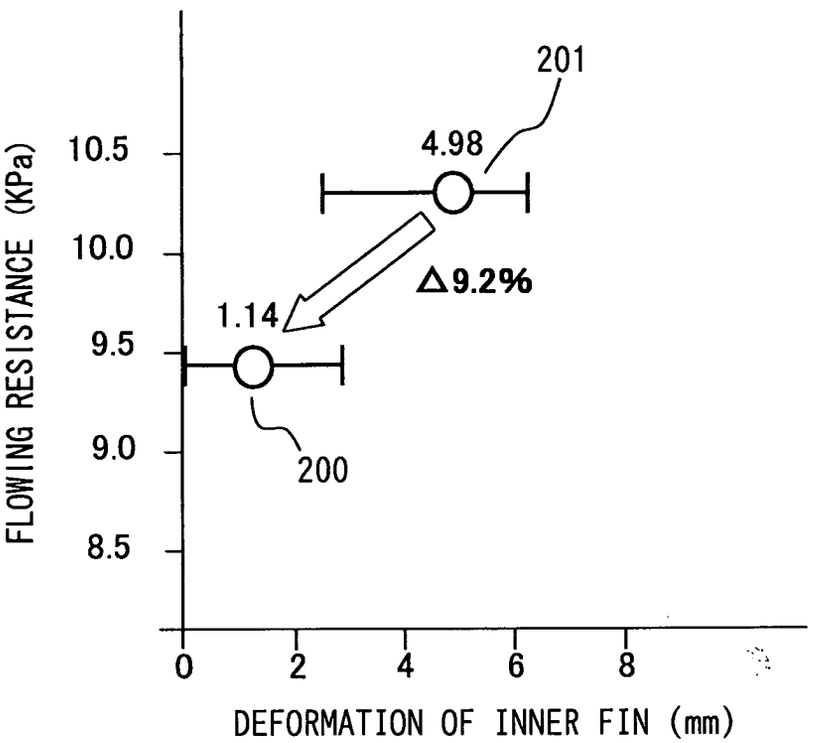

201
210
DEFORMATION OF INNER FIN
220
220a
121a,131
114
131a
220b
111

FIG. 9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4.98
10.5
10.0
Δ9.2%
1.14
9.5
9.0
200
8.5
FLOWING RESISTANCE (KPa)
0
2
4
6
8
DEFORMATION OF INNER FIN (mm)

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 25 0552

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	9 May 2005	Peeters, L

CATEGORY OF CITED DOCUMENTS

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