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NOTICE OF ENTITLEMENT

679783

We DENSO CORPORATION

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being the Applicant and Nominated Person, in respect of Application No. 76653/94, entitled ALUMINUM HEAT EXCHANGER state the following:

Mikio Fukuoka; Yoshifumi Aki and Ryuji Morishita are the actual inventors of the invention the subject of the Application.

The applicant and nominated person is the assignee of the invention from the actual inventors.

Nippondenso Co., Ltd. is the applicant of the application listed in the declaration under Article 8 of the PCT.

Nippondenso Co., Ltd. changed its name to Denso Corporation effective from 1 October 1996.

Convention priority is claimed from the following basic application(s) referred to in the declaration under Article 8 of the PCT:

Basic Applicant	Application Number	Application Date	Country	Country Code
Nippondenso Co., Ltd.	P5-230346	16 September 1993	Japan	JP

The basic application referred to in the declaration under Article 8 of the PCT was the first application made in a Convention country in respect of the invention the subject of the Application.

DATED this 27th day of March 1997

DENSO CORPORATION
By their Patent Attorney

R. Walton

GRIFFITH HACK

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ALUMINUM HEAT EXCHANGER

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(56) Prior Art Documents
JP 56-144996
JP 3-63799
JP 58-23566

(57) Claim

1. A heat exchanger comprising:

a laminated core portion including a plurality of spaced apart tubes arranged to have heat exchange liquid flow therein alternately laminated with a plurality of fins contacting adjacent ones of the tubes to improve heat exchange efficiency;

a first tank including a sheet metal base having a plurality of insert holes in which a respective one end portion of the tubes is received;

a second tank including a sheet metal base having a plurality of insert holes in which a respective one other end portion of the tubes is received; and

a pair of reinforcing plates disposed in flanking relationship at respective widthward sides of the core portion and extending between the first and the second tank;

the core portion and the bases of the first and second tank being made of an aluminium-type metallic material being lightweight and having low strength;

the reinforcing plates being made of a metallic

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material having a higher fusing point and higher strength than the aluminium-type metallic material; wherein

the reinforcing plates have respective terminal end portions at the first and second tanks which extend substantially along the entire thickness of the core portion and which are arranged to be covered by the first and the second tank and fixedly secured thereto by being received in U-shaped receptacles formed at the first and second tank, respectively.

11. A method of manufacturing a heat exchanger comprising the steps of:

alternatingly laminating a plurality of heat exchanger tubes and heat exchanger fins to form a core;

disposing two header tanks, each having a sheet metal base having a plurality of openings, at opposite ends of the core such that the tubes are received in corresponding ones of the openings, the tanks having U-shaped receptacles at respective widthward side ends thereof; and

disposing two reinforcing plates at opposite widthward sides of the core and to extend between the two tanks such that terminal end portions of the plates, which extend substantially over the entire thickness of the core, are inserted into and maintained in the U-shaped receptacles of the tanks during brazing of the so obtained assembly.

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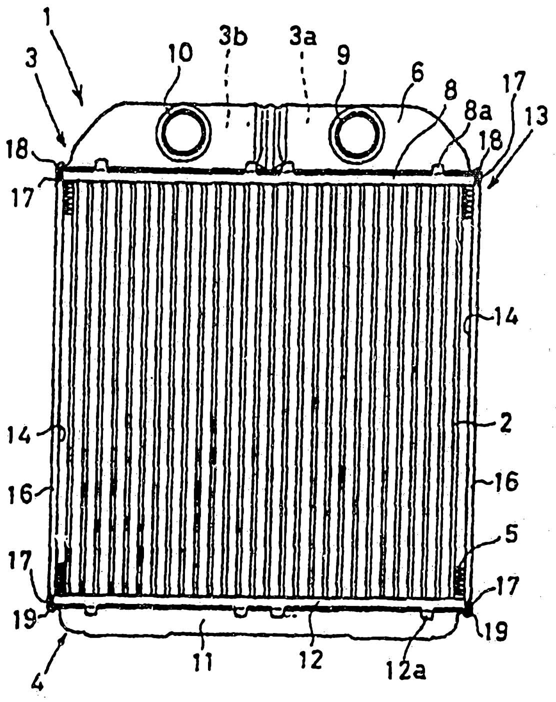
(54) Title : ALUMINUM HEAT EXCHANGER

(54) 発明の名称 アルミニウム製熱交換器

(57) Abstract

An aluminum heat exchanger (1) with improved productivity and reduced production costs is provided by such a construction that its core portion can be self-supported without using any supporting tool during a brazing operation, comprising a core portion (13) comprising in turn aluminum tubes (2) and corrugated fins (5) which are laminated in a plurality of layers, ends of the tubes (2) being inserted into sheet metals (8, 12) and inserts (14) of highly strong iron or stainless steel inserted in U-shaped folded-back portions (18, 19) of the sheet metals (8, 17) while being kept in abutment with outermost-row corrugated fins (5), whereby the plurality of tubes (2) and corrugated fins (5) are pressed against each other from the both sides of the core portion (13) by means of the two inserts (14), thereby preventing the corrugated fins (5) from coming off during a brazing operation.



(57) 要約

アルミニウム製熱交換器のろう付け作業時に保持具を使用することなく、コア部を自己保持できるようにして、アルミニウム製熱交換器の生産性の向上と製品コストの低減を実現することを目的とする。

アルミニウム製熱交換器1を、アルミニウム製のチューブ2とコルゲートフィン5とを複数積層し、チューブ2の両端部をシートメタル8、12に差し込んでなるコア部13と、このコア部13の最外列コルゲートフィン5に当接した状態でシートメタル8、12のU字状の折り返し片18、19に挿入される高強度の鉄あるいはステンレス製のインサート14とで構成した。

そして、2つのインサート14によってコア部13の両側から複数のチューブ2と複数のコルゲートフィン5とを押さえつけるように保持して、ろう付け作業中にコルゲートフィン5が脱落することを防いだ。

ALUMINUM HEAT EXCHANGER

Field of the Invention

The present invention relates to an aluminum heat exchanger and its manufacturing method where reinforcing plates of the heat exchanger are assembled on both widthward sides in a lamination direction of a core portion which comprises a plurality of alternatingly laminated layers of tubes, in which liquid flows, and fins, which improve heat exchange efficiency. The reinforcing plates provide a "jig function" when the heat exchanger is brazed.

Background Art

When a lamination type heat exchanger having a core portion having alternating layers of tubes and fins disposed therein is manufactured, an undesirable expansion of the core portion due to elasticity of the tubes and the fins in the temporary jig assembly before brazing operation may take place and possible detachment and falling out of fins due to diminished elastic holding force of the tubes and the fins during the brazing operation under high temperature may occur. Therefore, as shown in Fig. 11, core portion 104 of heat exchanger 100 is fastened and held by jig 105 and a band 106 so that the shape of the core portion 104 can be maintained until the brazing operation is over. Also as shown in Fig. 12, the core portion 104 is fastened and held by winding a wire 108 around the inserts 107 which are fixed at the outside of the outermost fins 102 of the core portion 104 so that the core portion 104 can retain its shape until the brazing operation is over. In Figs. 11 and 12, tubes 101 allow liquid to flow therein and sheet metals bases 103 support both end portions of the tubes 101.

Thus, in the manufacturing method of the heat exchanger mentioned above, supporting tools such as the jig 105, the band 106, and the wire 108, etc., are required to maintain the shape of the core portion 104 until the brazing operation is over so that operation efficiency becomes bad and the number of process steps increase. Consequently, productivity of manufacture of core portions declines. Also, since costs are associated in providing the jig 105, the band 106 and the wire 108, which are scrapped after the end of the brazing operation, the cost of the end product becomes high.

Thus, in order to eliminate fixing jigs such as jig 105, band 106, and wire 108, a technique has been disclosed in Japanese examined patent publication no. 62-45478, where the side plates of the core portion have a jig function and are pressed and held in place by a core plate. This technique is effective for soldering the core portion of a copper heat exchanger. The melting point of copper is much higher than that of solder so that a copper member can maintain a jig function at around the temperature at which solder melts. However, when the core portion of the aluminum heat exchanger is brazed, both melting points of the aluminum core material and the aluminum brazing filler metal are roughly the same so that the aluminum core material softens around a temperature at which the brazing metal melts, thereby losing its jig function. Thus, it is improper to apply the technique mentioned above in the manufacture of an aluminum heat exchanger.

It would be advantageous, if the present invention, in at least preferred embodiments thereof, could provide a heat exchanger with a core portion which has a self-holding or jigging function without use of special tools during brazing operation of the core portion in a manufacturing process of an aluminum heat exchanger, and a method of manufacturing such heat exchanger which realizes improved productivity and enables a reduction of product costs.

<u>Summary of the Invention</u>

Accordingly, the present invention provides, in a first aspect thereof, a heat exchanger comprising:

a laminated core portion including a plurality of spaced apart tubes arranged to have heat exchange liquid flow therein alternately laminated with a plurality of fins contacting adjacent ones of the tubes to improve heat exchange efficiency;

a first tank including a sheet metal base having a plurality of insert holes in which a respective one end portion of the tubes is received;

a second tank including a sheet metal base having a plurality of insert holes in which a respective one other end portion of the tubes is received; and

a pair of reinforcing plates disposed in flanking relationship at respective widthward sides of the core portion and extending between the first and the second tank;

the core portion and the bases of the first and second tank being made of an aluminium-type metallic material being lightweight and having low strength;

the reinforcing plates being made of a metallic material having a higher fusing point and higher strength than the aluminium-type metallic material; wherein

the reinforcing plates have respective terminal end portions at the first and second tanks which extend substantially along the entire thickness of the core portion and which are arranged to be covered by the first and the second tank and fixedly secured thereto by being received in U-shaped receptacles formed at the first and second tank, respectively.

In a second aspect, the present invention provides a method of manufacturing a heat exchanger comprising the steps of:

alternatively laminating a plurality of heat exchanger tubes and heat exchanger fins to form a core;

disposing two header tanks, each having a sheet metal base having a plurality of openings, at opposite ends of the core such that the tubes are received in corresponding ones of the openings, the tanks having U-shaped receptacles at respective widthward terminal ends thereof; and disposing two reinforcing plates at opposite widthward sides of the core and to extend between the two tanks such that terminal end portions of the plates, which extend substantially over the thickness of the core, are inserted into and maintained in the U-shaped receptacles of the tanks during brazing of the so obtained assembly.

Prior to high temperature brazing, a temporary assembly operation is carried out to assemble the core portion of the heat exchanger using the reinforcing side plates or inserts made of metallic material which has a higher strength than the aluminum material of the other components of the core portion. Therefore, even if the core portion tries to expand in the direction in which lamination of the core was accomplished, due to the elasticity of the corrugated fins and tubes of the core portion, the core portion does not expand because it is prevented from doing so by the two inserts, which firmly press the tube fin core assembly together, thus avoiding deviation in dimensions of the core portion during manufacture.

During the subsequent brazing operation, the aluminum heat exchanger is placed in a heating furnace and heated until around 600°C and brazing filler metal is fused thereto so that the aluminum heat exchanger is brazed. The stack of tubes and fins of the core portion is held firmly pressed together from both widthward sides by the reinforcing inserts which have a higher melting point and strength than aluminum. Also, since the inserts do not soften at around the melting point of an aluminum type brazing metal and still have enough strength, an adequate jig function is maintained by the inserts even under high temperatures during the brazing operation.

The inserts are fixed such that their respective terminal end portions are held from outside by the first and the second tank. That is, the receptacle portions of the tanks are (temporarily) fixed to the inserts to cover the terminal ends thereof such that the brazing operation metal, in which the brazing melts, can be caried out without additional jigs. Advantageously, the terminal f portions are received in the respective U-shaped receptacles at the tanks in such a manner that the inserts are free to move in the direction of the extension of the tubes during the brazing operation when the aluminum tank material, and therefore of the receptacles, is softening. Thus, differencial thermal expansion due to differences in expansion coefficients between aluminum and a high melting point and high strength material (iron or stainless steel in a preferred embodiment) under high temperature can be absorbed.

Thus, an aluminum heat exchanger in accordance with the present invention can improve the strength of the core portion by use of the two inserts made of a high strength material. Since the jig function is maintained even under high temperature during the brazing operation, special tools like a band and a wire are unnecessary so that the number of assembly steps and, subsequently, manufacturing costs can be reduced.

Further advantages of the invention will become apparent to those skilled in the art by having recourse to the following description of preferred embodiments of heat exchangers in accordance with the invention, which is given with reference to the accompanying drawings.

Brief Description of Drawings

Fig. 1 is a front view illustrating an aluminum heat exchanger in accordance with a first embodiment of the invention;

Fig. 2 is a perspective cut-away view illustrating a detail of the aluminum heat exchanger of figure 1;

Fig. 3 is a front view illustrating a core portion of the aluminum heat exchanger of figure 1;

Fig. 4 is a plan view illustrating an insert (or reinforcing side plate) as used in the heat exchanger core portion of figure 1;

Fig. 5 is a view illustrating in an exaggerated manner a possible deformation of the core portion after assembly before a brazing operation;

Fig. 6 is a view illustrating the core portion of figure 5 during the brazing operation;

Fig. 7 is a view similar to figure 2 illustrating a detail of an aluminum heat exchanger in accordance with the second embodiment of the present invention;

Fig. 8 is a perspective part-view illustrating a widthward side end portion of the core portion of an aluminum heat exchanger in accordance with a third embodiment of the invention;

Fig. 9 is a cross-sectional of an insert in accordance with the invention;

Fig. 10 is a top plan view of the core portion of the aluminum heat exchanger illustrating one possible cross-sectional shape of an insert in accordance with the invention;

Fig. 11 is a front elevation illustrating a core portion of an aluminum heat exchanger in accordance with the prior art; and

Fig. 12 is a front elevation illustrating a further aluminum heat exchanger in accordance with the prior art.

Best Mode for Carrying our the Invention

Hereinafter, embodiments of the invention will be described by way of example based on a heater core of an automotive air-conditioner and with reference to the accompanying drawings.

Fig. 1 through Fig. 6 illustrate the first embodiment of an aluminum heat exchanger in accordance with the present invention.

Aluminum heat exchanger 1 of the first embodiment is used as a heater core for an automotive hot water type heating system having as its heat source engine cooling water. The aluminum heat exchanger 1 comprises a plurality of tubes 2 arranged to have engine cooling water flow therein, an upper tank 3 receiving the top ends of tubes 2 and a lower tank 4 receiving the lower ends of tubes 2.

The tubes 2 heat air blowing past them by exchanging heat with the engine cooling water flowing through the tubes, the heated air being blown to the interior of the vehicle. The tubes 2 are made from a clad material having a brazing metal on a surface of a core material and are formed into a flattened tubular shape. The core material of the tubes 2 is an aluminum material (the first metallic material") having a thickness of about 0.3mm to 0.35mm, for example, 3000 series aluminum composition metal, having a melting point of about 650°C. The brazing metal is an aluminum system metal having a melting point that is lower than that of the core material, for example, 4000 series aluminum composition metal having a melting point of about 600°C.

Corrugated fins 5 are connected by brazing between all adjacent tubes 2 in order to improve heat exchange efficiency. The corrugated fins 5 are made of the same aluminum material as the tubes 2 and are made from a band formed into a corrugated shape.

The upper tank 3 is formed by brazing a base 8 to a top capsule 6 having an open box-shape so as to close the opening. The base 8 includes a sheet metal member having a plurality of insert holes 7 formed therein which are arranged to receive therein the upper ends of the tubes 2. The top capsule 6 and the sheet metal member 8 are made of a clad material having a brazing metal applied to the surface of a core material of the same aluminum material as the tubes 2.

The inside of the upper tank 3 is divided by partition walls (not shown in the figure) into an inflow chamber 3a for receiving engine cooling water entering via an engine water jacket, and an outflow chamber 3b, which has engine cooling water returning to the engine water jacket therefrom. Inflow pipe 9 is connected at a side wall to the inflow chamber 3a of the upper tank 3 by brazing. A cooling water pipe leading engine cooling water coming from the engine water jacket to the aluminum heat exchanger 1 is connected to the inflow pipe 9.

The inflow pipe 9 and outflow pipe 10 are connected to opposite surfaces of the upper tank 3 opposing the air flow direction between the tubes 2. Moreover, the top capsule 6 and the sheet metal member 8 are temporarily assembled by temporary crimping using claw portion 8a formed at the sheet metal member 8 before the subsequent brazing operation to which the aluminum heat exchanger 1 is subjected.

The lower tank 4 is formed by brazing a base 12 to a bottom capsule 11 having an open box shape so as to close the opening side of the bottom capsule 11. The base 12 includes a sheet metal member having a plurality of insert holes formed therein in order to receive therein the bottom end portions of the tubes 2. The bottom capsule 11 and the sheet metal member 12 are made of a clad material having a brazing metal applied to a surface of a core material of the same aluminum material as the tubes 2. Moreover, the bottom capsule 11 and the sheet metal member 12 are temporarily assembled by temporary crimping using claw portion 12a formed at the sheet metal member 12 before the subsequent brazing operation of the aluminum heat exchanger 1.

In the first embodiment as shown in Fig. 3, the core portion 13 of the aluminum heat exchanger 1 is formed by laminating the tubes 2 and the corrugated fins 5 together and assembling the sheet metal members 8 and 12 to the top and bottom end portions of the tubes 2. Each of two inserts 14 made of a second metallic material having a higher melting point and higher strength than the aluminum material used for the tubes 2 and the corrugated fins 5 are assembled and fixed to the core portion 13 at a respective outermost widthward side in lamination direction of the tubes 2.

The two inserts 14 are the reinforcing plates mentioned elsewhere and are made of a metallic material like iron or stainless steel. They have a plate length of about 100mm to 260mm, a plate width of about 16mm to 36mm and a plate thickness of about 0.6mm. As shown in

Fig. 4, two reinforcing ribs 15 and two reinforcing flanges 16 extend in longitudinal direction of and are formed internally with the inserts 14. The ribs 15 are formed such as to bulge away from the widthward end wise located tubes 2 and both flanges 16 are also bent to the outside, e.g. face away from the tubes 12.

Insert pieces 17 are formed at each terminal end in longitudinal direction of the two inserts 14. During temporary assembly of the core portion 13, that is, before brazing of the aluminum heat exchanger 1 takes place in an oven under high temperature, the insert pieces 17 are inserted to be held from the outside by U-shaped receptacles 18 and 19 formed by foldings at the widthwise terminal end sections of the sheet metal members 8 and 12. The insert pieces 17 contact the widthwise outermost corrugated fins 5. Also, inserts 14 press the tubes 2 and the corrugated fins 5 together in laminating direction.

The final assembly and brazing operation carried out to obtain the finished aluminum heat exchanger 1 in accordance with the first embodiment will now be explained by having reference to Fig. 1 through Fig. 6. The top end portions of the tubes 2 are inserted into the insert holes 7 formed in the sheet metal member 9 of the upper tank 3. Also, the bottom end portions of the tubes 2 are inserted into the insert holes 7 formed in the sheet metal member 12 of the lower tank 4. The corrugated fins 5 are inserted between adjacent one of the tubes 2 and both terminal end portions of the two inserts 14 are inserted to be held from the outside by the U-shaped receptacles 18 and 19 formed at the sheet metal members 8 and 12, respectively, so that they contact the respectively adjoining outermost corrugated fin 5. Moreover, the top capsule 6 is temporarily assembled to the sheet metal member 8 by temporary crimping with the claw portion 8a as is the bottom capsule 11 to the sheet metal member 12 by means of claw portion 12a.

Thus, as shown in Fig. 1, aluminum heat exchanger 1 is temporarily assembled as mentioned above. At this time, even if the core portion 13 tries to expand in widthward direction, eg toward the outside along the lamination direction of the core portion 13, due to the elasticity of the tubes 2 and the corrugated fins 5, the core portion 13 is prevented from expanding since the two inserts 14 made of the high strength material tend to suppress such motion. Other than that, the more the core portion 13 seeks to expand along the lamination direction, the more pressure is exerted onto the core portion 13 by the side inserts 14, whereby the dimensions of the core portion 13 are maintained and do not deviate even after the subsequent soldering/brazing operation is over since the inserts 14 hold the core portion 13 firmly together.

Next, flux is spread on the surfaces of the aluminum heat exchanger 1 by spraying powdered flux or by spreading flux dissolved in water so that the brazing/filler metal material is spread uniformly. After that, the aluminum heat exchanger 1 is put in a heating furnace and heated up to around 600°C whereby the brazing metal is melted and the brazing/soldering operation is performed. At that stage, since the melting point of the core materials of tubes 2 and corrugated fins 5 is about 650°C, which is close to the melting point of the brazing metal, the aluminum core material with claded metal also softens quite a bit. Therefore, conventionally, if the same aluminum material is used for the inserts 14 as for the other parts, the jig function of the inserts 14 and the holding function provided by the elasticity of the tubes 2 and the corrugated fins 5 will be lost, and consequently the corrugated fins 5 will tend to lose contact with the tubes 2 during the brazing operation if an additional jig 105, band 106 or wire 108 is not used, as described above with reference to Figs. 11 and 12. However, since in accordance with the present invention the core portion 13 is held firmly pressed together by the inserts 14 made of iron or stainless steel, which have a higher melting point and higher strength than the aluminum parts, no such failures will take place. The inserts 14 will still maintain enough strength without softening at the melting point of the aluminum type brazing metals used.

Although the core portion 13 is firmly held from both widthward sides by the iron or stainless steel parts, due to the thermal expansion of the aluminum and iron/stainless steel parts, which is different under the high temperatures present during the brazing operation, the following design measures are provided in order to accommodate the differences in thermal expansion coefficients.

Before the brazing operation, as shown in Fig. 5, the core portion 13 tends to expand in lamination direction due to the elasticity of the tubes 2 and the corrugated fins 5. If the core portion 13 is exposed to high temperature in the heating furnace during brazing, the core portion 13 formed by the tubes 2, the corrugated fins 5 and the sheet metal members 8 and 12 expands due to thermal expansion of the aluminum material not only in lamination direction 50 but also in a direction 51 parallel to the tubes 2. At that time, since the iron or stainless steel inserts 14 have a smaller thermal expansion coefficient than aluminum, the inserts 14 will not entirely follow the expansion of the core portion 13, in particular expansion in the direction 51 which extends parallel to the tubes 2. Therefore, if during the above described temporary assembly, before brazing takes place, the sheet metal members 8 and 12 and the inserts 14 are fixed firmly to one another, a force F1 will act on the connection portion 52 between the receptacles at the sheet metal member 8 (and 12) and the terminal ends of the inserts 14 in a direction which will tend to prevent expansion of the core portion 13, and a force F2, due to the thermal expansion of the core portion 13 will act on the other portion of sheet metal member 8 (and 12). Thus, sheet metal member 8 (and 12) will become buckled. Therefore, it is better to fix the inserts 14 temporarily to the sheet metal members 8 and 12, with only a small gripping force.

As shown in Fig. 2, in accordance with the present invention, the inserts 14 are inserted so as to be covered from the outside by the folded, U-shaped receptacles 18 and 19 formed at the widthward terminal ends of the sheet metal members 8 and 12. Therefore, during the brazing operation in which the brazing metal melts and the aluminum sheet metal member 8 softens, the joint portion 52 (shown in Fig. 6) between sheet metal member 8 and inserts 14 is actually ineffective along the direction parallel to the inserts 14. Thus force F1, which tends to prevent thermal expansion, will not act on the sheet metal member 8, and consequently the sheet metal member 8 will not buckle. On the other hand, as regards the expansion of the core portion in lamination direction 50 due to thermal forces, since the sheet metal member 8 is made of an aluminum material just like the tubes 2 and the corrugated fins 5 of the core potion 13, the core portion 13 and the sheet metal member 8 will expand with the same degree of thermal expansion so that the above mentioned problem does not present itself.

In the present invention, the material used for the inserts 14 is iron or stainless steel and not aluminum as used conventionally. The thickness of the inserts 14 can therefore be reduced to about 60% of that of conventional aluminum inserts. Since iron or stainless steel has a higher strength than aluminum, such thickness is enough to ensure the jig function during the brazing operation. As shown in Fig. 5, before the brazing operation, the core portion 13 tries to expand in lamination direction 50 due to the elasticity of the tubes 2 and the corrugated fins 5. If the thickness of the inserts 14 of high strength material is the same as in a conventional insert, the force preventing expansion of core portion 13 may act excessively and the tubes 2 and corrugated fins 5 forming the core portion 13 may become buckled.

The brazing operation is finished by removing the aluminum heat exchanger 1 from the heating furnace and cooling it down to room temperature.

In operation, the aluminum heat exchanger 1 in accordance with the described embodiment in accordance with the invention is similar to that of a conventional heater core of an automotive air conditioner so that the engine cooling water which is warmed up in the engine water jacket flows into the inflow chamber 3a at the capsule 6 of the upper tank 3 via the inflow pipe 9. The engine cooling water flowing into the inflow chamber 3a flows in tubes 2a along an approach route, goes toward the lower tank 4 and flows into the bottom capsule 11 of the lower tank 4. The engine cooling water flowing into the bottom capsule 11 then flows into the outflow chamber 3b by way of tube 2b along a return route connected to the inflow chamber 3b. The engine cooling water flowing into the inflow chamber 3b from tube 2b goes to the engine water jacket by way of outflow pipe 10 fixed at the top of the capsule 6. At this time, the engine cooling water flowing in the tubes 2a and 2b heats up the air flowing in a blow duct by heat exchange therewith. Thus, the interior of a vehicle can be heated.

As mentioned above, when the aluminum heat exchanger 1 is heated-up in the heating furnace to effect brazing, the core portion 13 is held by the two inserts 14 so that the core portion 13 can be brazed without using additional holding tools such as a jig, a band or a wire for the core portion 13. That is, since the core portion 13 is maintained in a temporarily assembled state without using holding tools, the corrugated fins 5 will not fall out between adjacent the tubes 2. Thus, joint defects between the tubes 2 and the corrugated fins 5 will not occur. Also, no deviation of dimensions of the finished aluminum heat exchanger 1 will take place during manufacturing.

Since the brazing operation can be simplified by omitting holding tolls to reinforce the core portion 13, the efficiency of the brazing operation is improved and manufacturing productivity of aluminum heat exchangers is improved. The product unit cost is accordingly reduced, also because costs associated with additional holding tools become unnecessary.

Fig. 7 illustrates a second embodiment of a heat exchanger in accordance with the present invention.

In the first embodiment described above, as shown in Fig. 2, although inserts 14 are inserted to be held from the outside by U-shaped foldings "receptacles") 18 and 19 formed on the sheet metal members 8 and 12, respectively, in the second embodiment, a step portion 18 is formed at the joint portion on the top capsule 6 of the upper tank 3. The terminal end of the insert 14 is inserted between the step portion 18 and an upright standing rim portion 8b formed at the joint portion on the sheet metal member 8. The widthward lateral sides of the lower tank 4 also have the same construction.

With this construction, which is similar to the first embodiment in that it provides U-shaped receptacles for the terminal ends of the inserts 14, step portion 18 of the top capsule 6 is assembled to cover from the outside the insert 14. Thus, during the brazing operation in which the brazing metal melts and the sheet metal member 8 (and 12) softens, since the terminal ends of the insert 14 become loose while received between the step portion 18 and the rim portion 8b, the difference of thermal expansion between the aluminum and iron or stainless steel parts of the assembly can be absorbed.

Fig. 8 illustrates an improved embodiment of the core portion of an aluminum heat exchanger 1 in accordance with the present invention.

In this embodiment, during temporary assembly of the aluminum heat exchanger 1, an aluminum brazing foil 21 is fastened between insert 14 and corrugated fin 5 at the widthwise outermost end of the core portion 13; these parts are then connected to one another by putting the assembly in a heating furnace. Therefore, since the core portion 13 can be perfectly unified with the insert 14, an improved reinforcing effect is provided to the core portion 13 as compared to the first embodiment described above. That is, pressure tightness between tubes 2 and the rigidity of corrugated fins 5 can be improved.

Fig. 9 illustrates an improved insert 14, in cross-section, for use in an aluminum heat exchanger 1 in accordance with the invention.

Insert 14 comprises a metallic core 22 which is plated with a metallic plating 23 of aluminum-silicon type on the outside surfaces of the core 22. This insert 14 is thus protected from rusting and durability is improved. Since aluminum-silicon type plating has almost the same components as a brazing metal and the melting point is also similar to that of the brazing metal, aluminum-silicon type plating can be used as a brazing/filler metal. Like embodiments described above, the widthwise outermost corrugated fin 5 of the core portion 13 and the insert 14 will be connected by brazing. However, according to the inventors of the present invention, about 35μm in thickness of plating is not enough for brazing so that about 70μm in thickness is necessary.

A modified insert cross-section as compared to the one illustrated in Figs. 2 or 7 will now be explained with reference to Fig. 10, which also shows a modified tube design.

In the embodiments described above, in order to keep pressure tightness of the tubes 2, the rigidity of the core portion 13 of the aluminum heat exchanger 1 using iron or stainless steel inserts 14 is increased by plating the inserts 14 with a predetermined amount of aluminum-silicon type plating material and/or adding a brazing foil so as to improve brazing between the insert 14 and the adjoining corrugated fin 5. In the embodiment illustrated in Fig. 10, pressure tightness of the tubes 2 is improved by using tubes 2 having the illustrated bent

60 in one of the walls and rigidity of the insert 14 can be improved by integrally forming an undulated rib 61 with it. Therefore, pressure tightness of the tubes 2 can be kept without additionally brazing the iron or stainless steel insert 14 to the widthwise outermost corrugated fin 5 as described above.

Although the invention has been described in its application to aluminum heat exchangers, the invention can be also applied to a heat exchanger with a resin top and bottom capsule. In this case, only the core portion of the exchanger, without the capsules, is put in a heating furnace for the brazing operation.

Further, although the invention has been described in its application to a heater core of an automotive hot water heater, the invention can also be applied to an automotive radiator, an automotive oil cooler, a condenser or an evaporator of an air-conditioner for vehicles, houses or factories. Also, the invention may be applied to a different type of heat exchangers which require a pair of reinforcing plates to maintain a rigid core structure during the lamination process. The inserts, which serve as reinforcing plates, can also incorporate a bracket for installing the heat exchanger at a casing or non-assembly members of a vehicle.

Industrial Applicability

An aluminum heat exchanger in accordance with the present invention can be used, for example, as an automotive heater core of a hot water heater having engine cooling water as a heat source.

THE CLAIMS DEFINING THE INVENTION AS FOLLOWS:

1. A heat exchanger comprising:

a laminated core portion including a plurality of spaced apart tubes arranged to have heat exchange liquid flow therein alternately laminated with a plurality of fins contacting adjacent ones of the tubes to improve heat exchange efficiency;

a first tank including a sheet metal base having a plurality of insert holes in which a respective one end portion of the tubes is received;

a second tank including a sheet metal base having a plurality of insert holes in which a respective one other end portion of the tubes is received; and

a pair of reinforcing plates disposed in flanking relationship at respective widthward sides of the core portion and extending between the first and the second tank;

the core portion and the bases of the first and second tank being made of an aluminium-type metallic material being lightweight and having low strength;

the reinforcing plates being made of a metallic material having a higher fusing point and higher strength than the aluminium-type metallic material; wherein

the reinforcing plates have respective terminal end portions at the first and second tanks which extend substantially along the entire thickness of the core portion and which are arranged to be covered by the first and the second tank and fixedly secured thereto by being received in U-shaped receptacles formed at the first and second tank, respectively.

2. A heat exchanger according to claim 1, wherein the sheet metal bases have widthward end portions which are bent and folded to form the U-shaped receptacles for fixing the reinforcing plates at each of the sheet metal bases of the first tank and the second tank, respectively.

3. A heat exchanger according to claim 1, wherein the first and second tank each include a capsule mounted

on and arranged to cover the respective sheet metal base, the capsule having a step formed at a joint portion between the capsule and the sheet metal base at opposing widthward sides, the sheet metal base having widthward end portions which are bent to provide an upstanding rim at the joint portion, the step and the rim arranged to form jointly the U-shaped receptacles for fixing the reinforcing plates at each of the first tank and the second tank, respectively.

4. A heat exchanger according to claim 1, 2 or 3, wherein the aluminium-type metallic material forming the core portion, the first tank and the second tank is an aluminium composition metal, the reinforcing plates being made of one of iron and stainless steel.

5. A heat exchanger according to any one of claims 1 to 4, wherein the fins are corrugated fins, and wherein an aluminium brazing foil is fastened betwee' the corrugated fins which are arranged at the widthward outermost ends of the core portion and the respectively adjoining reinforcing plate during brazing.

6. A heat exchanger according to any one of claims 1 to 5, wherein the reinforcing plates comprise an iron or a stainless steel core which is plated with an aluminium-silicon type plating on at least one outer surface thereof.

7. A heat exchanger according to any one of claims 1 to 6, wherein at least one of the reinforcing plates includes means adapted to increase stiffness of the plate in the direction extending between the first and the second tank.

8. A heat exchanger according to claim 7, wherein the reinforcing plate has at least one edge flange extending substantially along the length of a main portion of the plate.

9. A heat exchanger according to claim 7 or 8, wherein the reinforcing plate has at least one integral rib protruding therefrom and extending in longitudinal direction of the plate.

10. A heat exchanger according to any one of the preceding claims, wherein the U-shaped receptacles and the terminal end portions of the reinforcing plates are dimensioned such that the terminal end portions, when fixedly inserted in the receptacles, are able to move within the receptacles in direction of the longitudinal extension of the plates upon the heat exchanger being subjected to a temperature required for brazing the heat exchanger.

11. A method of manufacturing a heat exchanger comprising the steps of:

alternatingly laminating a plurality of heat exchanger tubes and heat exchanger fins to form a core;

disposing two header tanks, each having a sheet metal base having a plurality of openings, at opposite ends of the core such that the tubes are received in corresponding ones of the openings, the tanks having U-shaped receptacles at respective widthward side ends thereof; and

disposing two reinforcing plates at opposite widthward sides of the core and to extend between the two tanks such that terminal end portions of the plates, which extend substantially over the entire thickness of the core, are inserted into and maintained in the U-shaped receptacles of the tanks during brazing of the so obtained assembly.

12. The method of claim 11, wherein the reinforcing plates are fixed within the U-shaped receptacles in such a manner that in a cold state of the assembly prior to brazing the core and the tanks are prevented from moving with respect to one another in direction of the longitudinal extension of the tubes and reinforcing plates, but in a manner such that the terminal end portions of the reinforcing plates are free to slide within the U-shaped receptacles in a hot state during brazing of the assembly to accommodate differential thermal expansion of the tanks, core and reinforcing plates.

13. The method of claim 12, wherein the terminal end portions of the reinforcing plates are received within the U-shaped receptacles in such a manner that after brazing and cooling of the assembly the reinforcing plates are tightly fixed to the tanks.

14. A heat exchanger substantially as herein described with reference to any one embodiment as shown in the accompanying drawings.

15. A Method of manufacturing a heat exchanger substantially as herein described with reference to any one embodiment as shown in the accompanying drawings.

Dated this 27th day of March 1997

NIPPONDENSO CO., LTD.

By their Patent Attorneys

GRIFFITH HACK

S:14339AW/27.3.97

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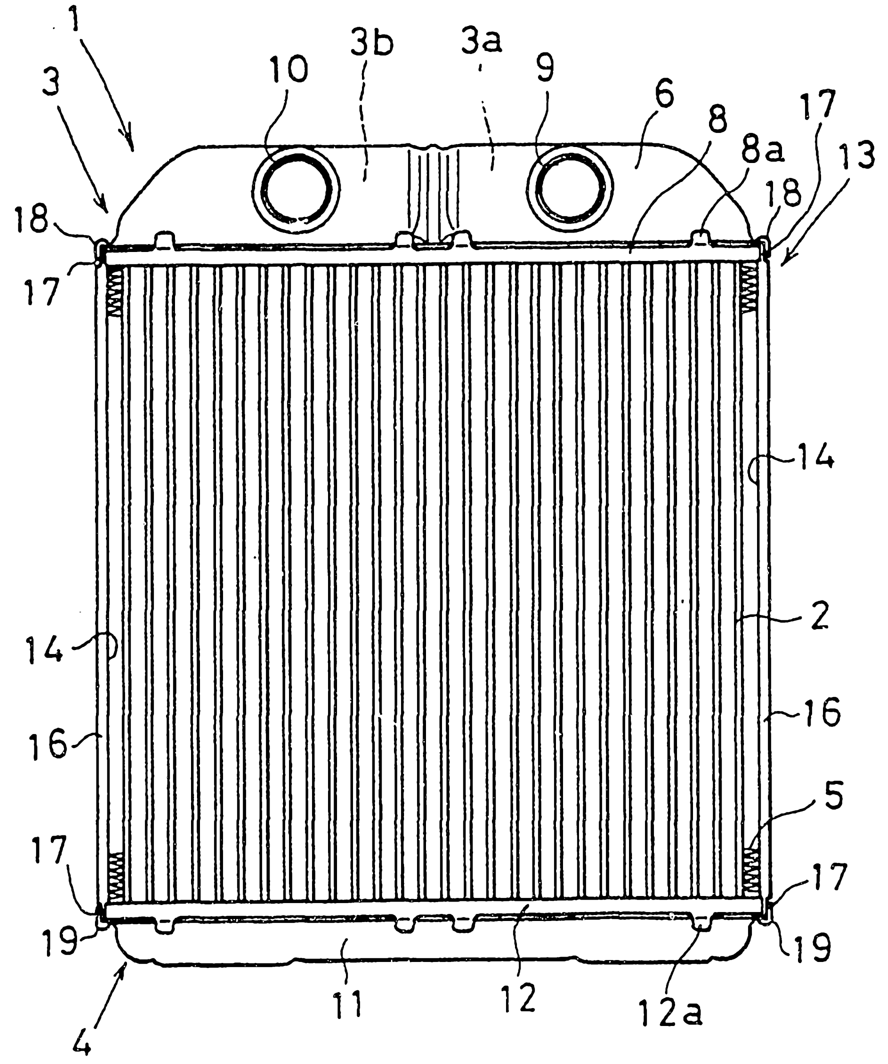

FIG. 1

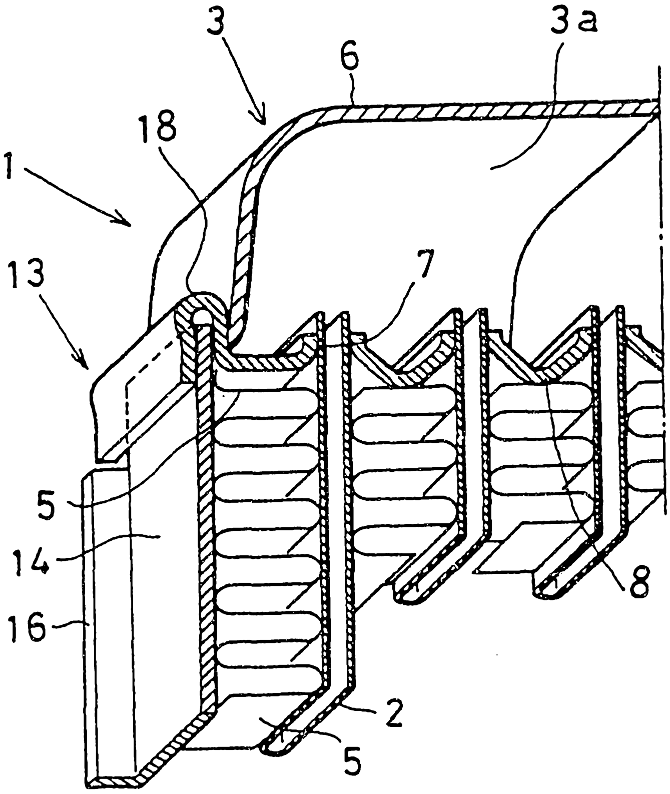

FIG. 2

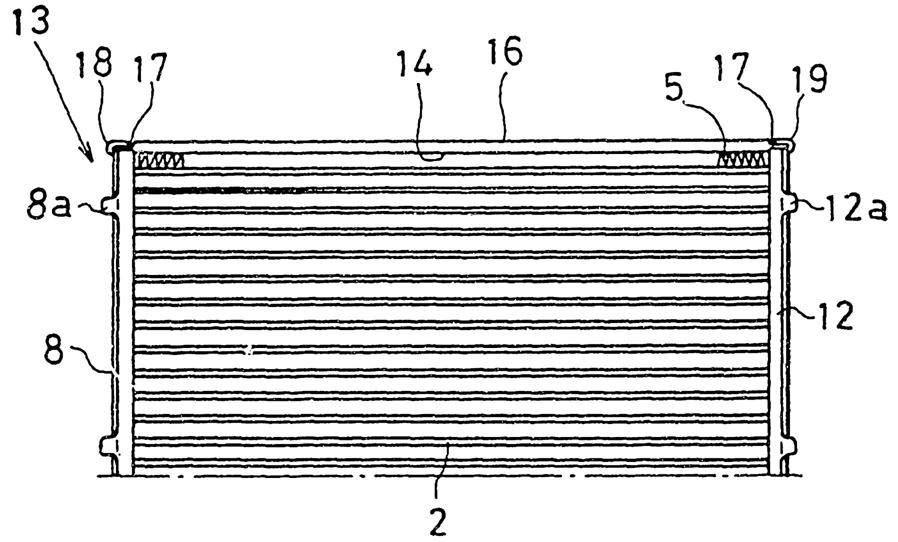

FIG. 3

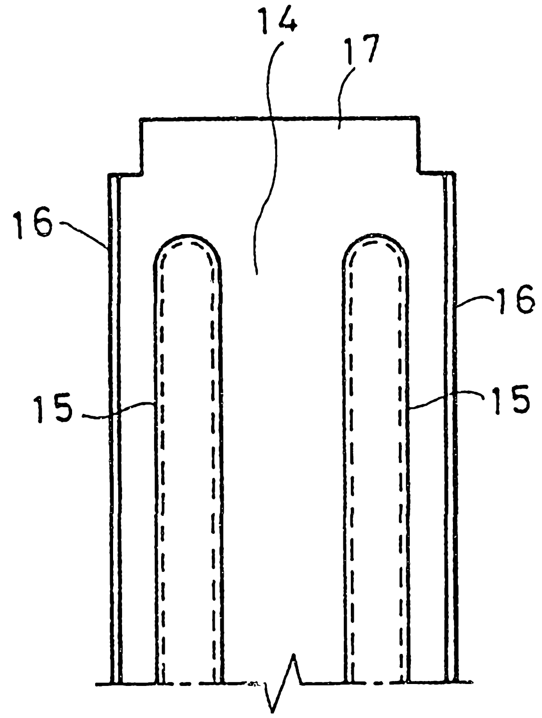

FIG. 4

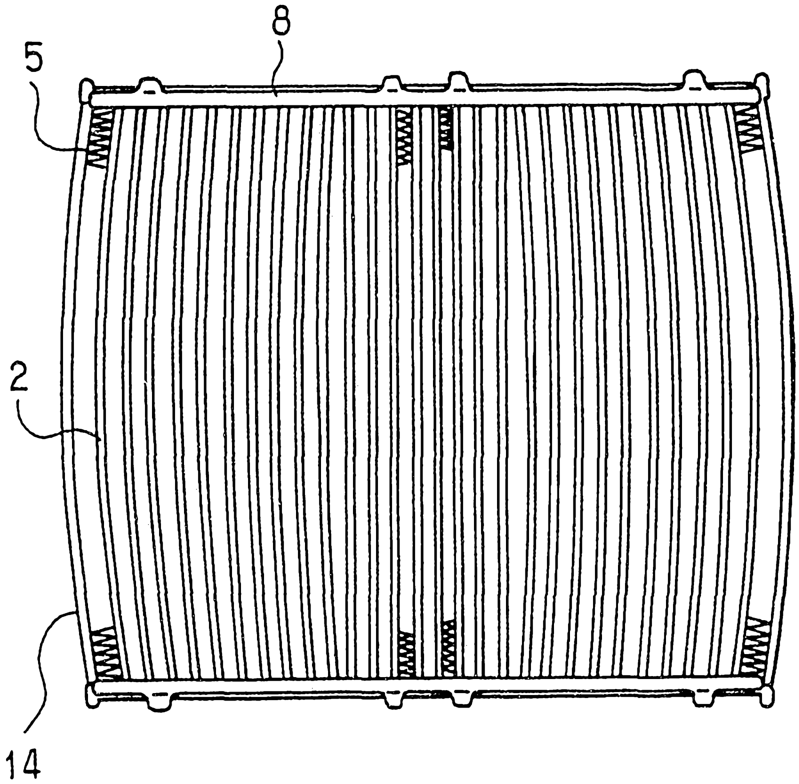

FIG. 5

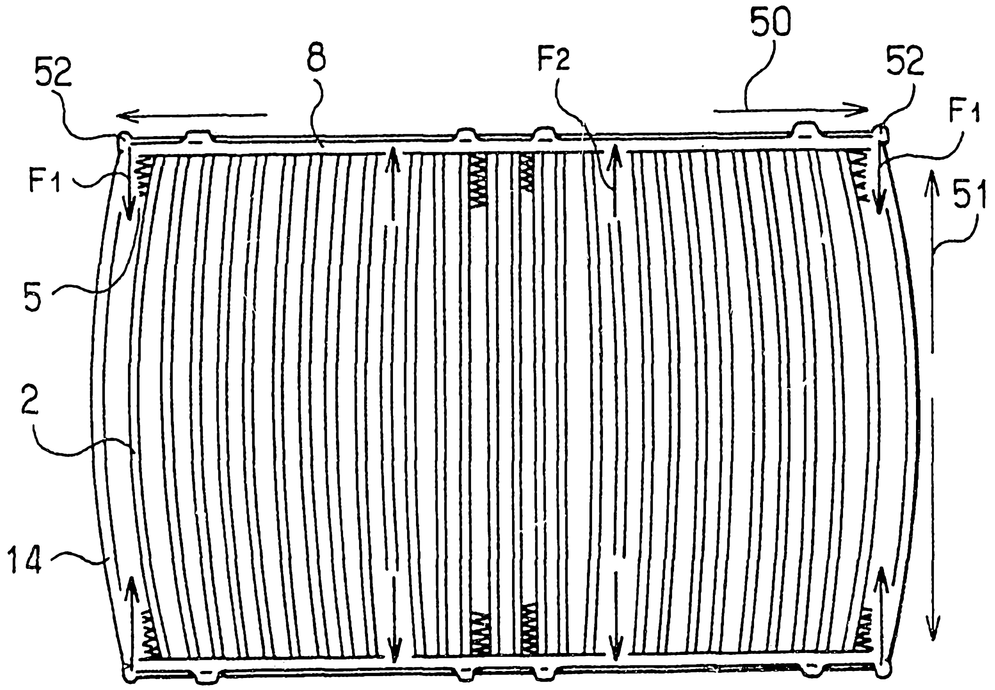

FIG. 6

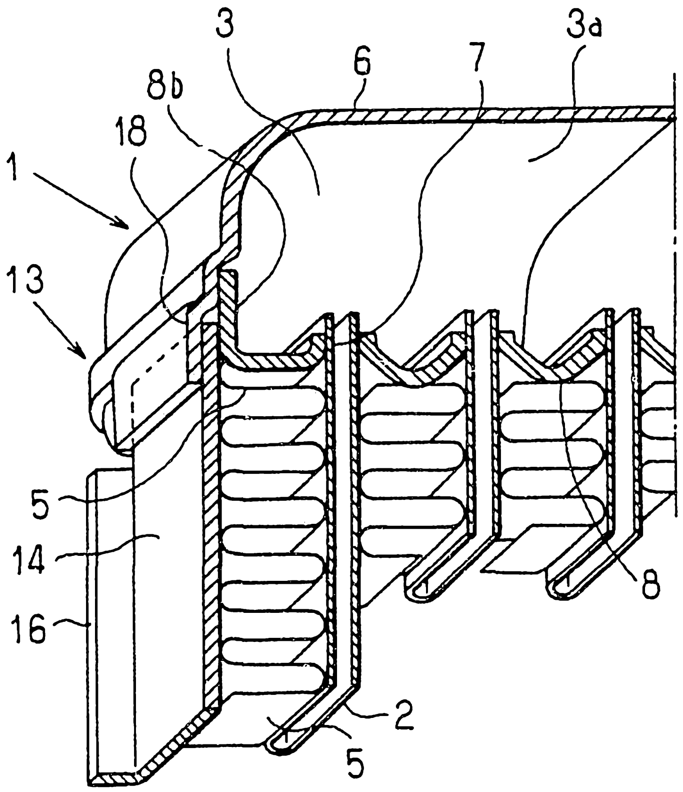

FIG. 7

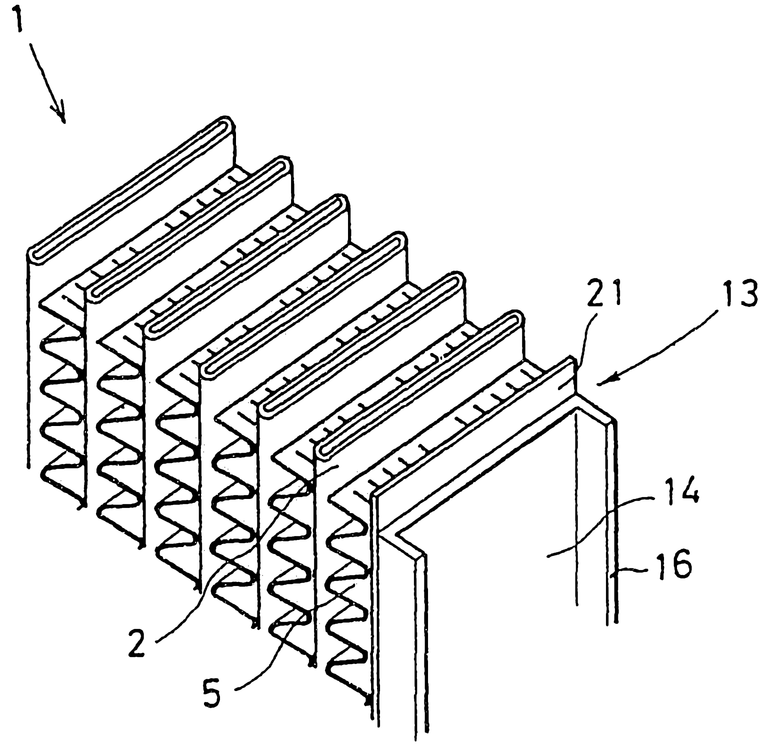

FIG. 8

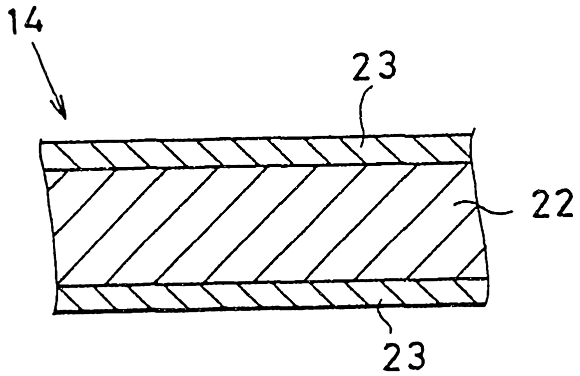

FIG. 9

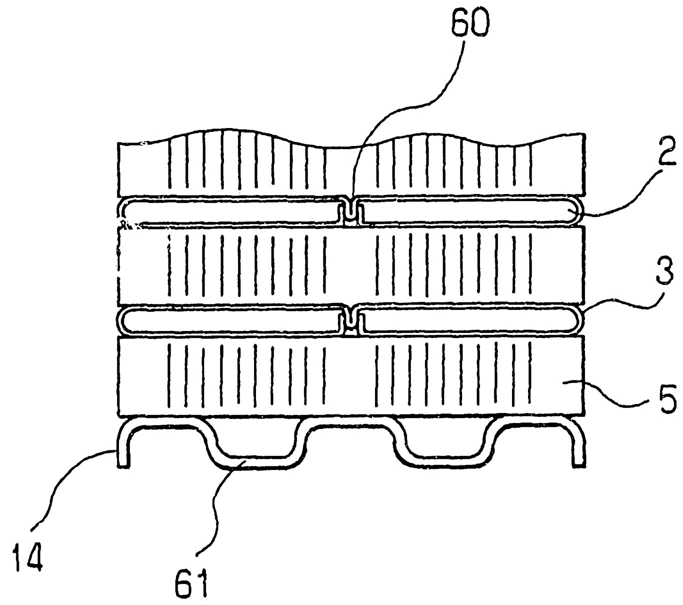

FIG. 10

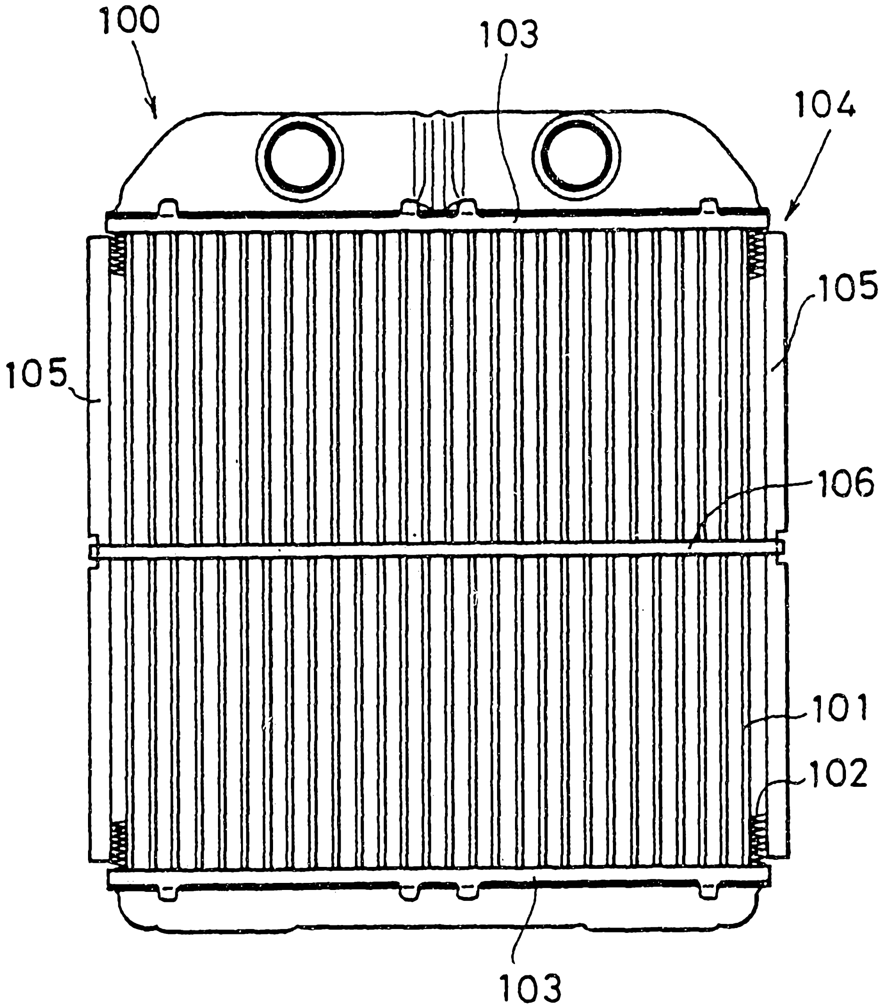

FIG. 11

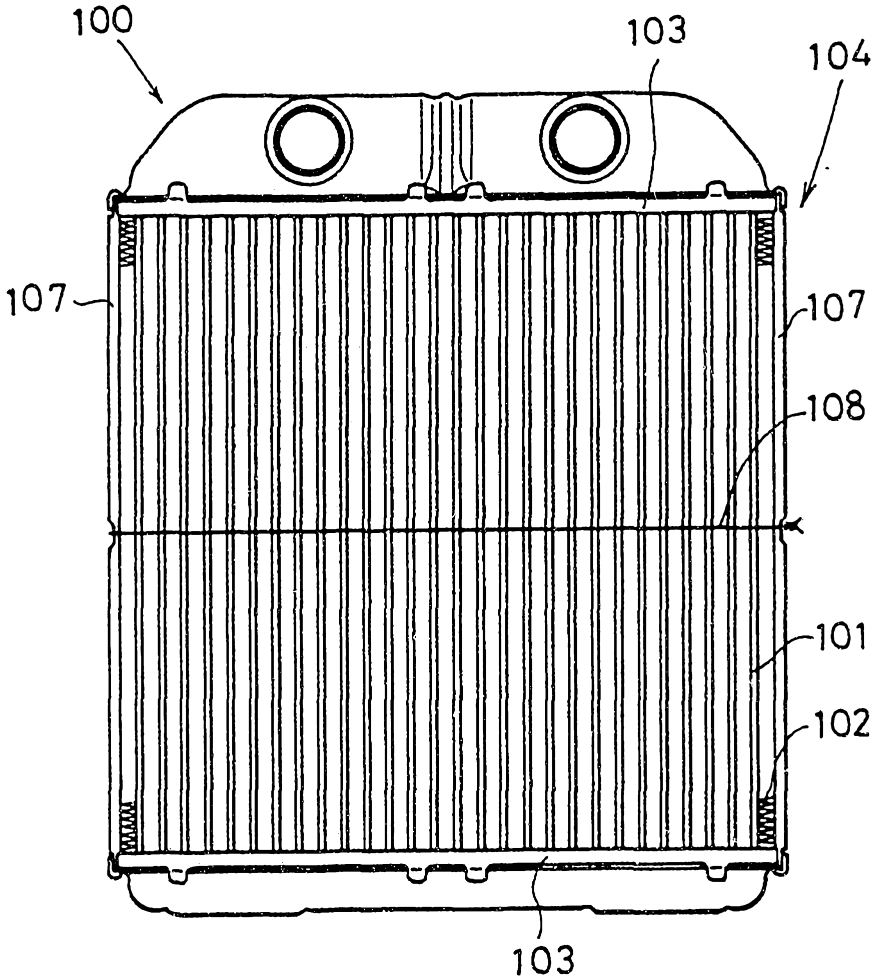

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP94/01534

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl[6] F28F9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl[6] F28F9/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1960 - 1994
Kokai Jitsuyo Shinan Koho 1972 - 1994

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP, U, 56-144996 (Showa Aluminum Co., Ltd.), October 31, 1981 (31. 10. 81), Lines 10 to 15, page 6, (Family: none)	1, 4
Y	JP, A, 3-13799 (Nippondenso Co., Ltd.), January 22, 1991 (22. 01. 91), Lines 11 to 19, upper right column, page 3, (Family: none)	1, 4, 6
Y	JP, A, 58-23566 (Tsuchiya Seisakusho K.K.), February 12, 1983 (12. 02. 83), (Family: none)	5
Y	JP, U, 63-5287 (Toyo Radiator Co., Ltd.), January 14, 1988 (14. 01. 88), (Family: none)	2, 3

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
November 29, 1994 (29. 11. 94)	December 20, 1994 (20. 12. 94)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

国際調査報告 | 国際出願番号 PCT/JP 94/01534

A. 発明の属する分野の分類（国際特許分類（IPC））

Int. Cl^6 F28F9/00

B. 調査を行った分野

調査を行った最小限資料（国際特許分類（IPC））

Int. Cl^6 F28F9/00

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報　　1960－1994年
日本国公開実用新案公報　　1972－1994年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

C. 関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求の範囲の番号
X	JP，U，56－144996（昭和アルミニウム株式会社），31．10月．1981（31．10．81），第6ページ第10－15行目（ファミリーなし）	1，4
Y	JP，A，3－13799（日本電装株式会社），22．1月．1991（22．01．91），第3ページ右上欄第11－19行目（ファミリーなし）	1，4，6
Y	JP，A，58－23566（株式会社　土屋製作所），	5

☑ C欄の続きにも文献が列挙されている。　☐ パテントファミリーに関する別紙を参照。

＊ 引用文献のカテゴリー
「A」特に関連のある文献ではなく、一般的技術水準を示すもの
「E」先行文献ではあるが、国際出願日以後に公表されたもの
「L」優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献（理由を付す）
「O」口頭による開示、使用、展示等に言及する文献
「P」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献
「T」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
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「Y」特に関連のある文献であって、当該文献と他の1以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの
「&」同一パテントファミリー文献

国際調査を完了した日	国際調査報告の発送日
29．11．94	20.12.94

名称及びあて先	特許庁審査官（権限のある職員）
日本国特許庁（ISA/JP） 郵便番号100 東京都千代田区霞が関三丁目4番3号	3L 9141 清水富夫 印 電話番号 03-3581-1101 内線 3338

様式PCT/ISA/210（第2ページ）（1992年7月）

C（続き）．関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求の範囲の番号
	12．2月．1983（12．02．83）（ファミリーなし）	
Y	JP，U，63－5287（東洋ラジエータ株式会社），14．1月．1988（14．01．88）（ファミリーなし）	2，3