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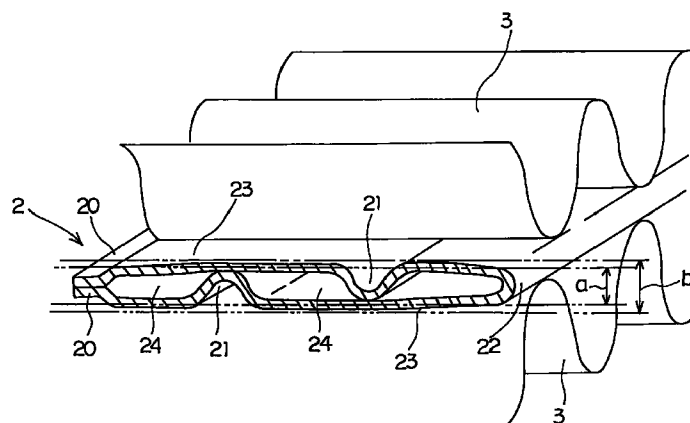
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(54) HEAT EXCHANGER AND METHOD OF MANUFACTURING SAME

(57) A heat exchanger (1) formed by laminating tube elements (2) in parallel manner with fins (3) therebetween, the tube elements being formed by folding a single plate or by overlapping two plates and formed integral therein with beads (21), which compartment an interior of the tube element into a plurality of flow passages (24), an intermediate portion of the tube elements having a greater thickness (b) before such lamination than a thickness (a) of an intermediate portion on a tube surface of the tube elements after such lamination. A method of manufacturing a heat exchanger, according to the invention, comprises beforehand forming an intermediate portion of the tube

elements (2) prior to lamination into a configuration, in which it expands toward the fins (3), then laminating these tube elements one upon another with the fins therebetween to compress the tube elements to form an assembly of a heat exchanger, applying flux on the assembly, and feeding the assembly into a furnace to subject it to integral brazing by heat treatment. Accordingly, the expanded portion is suitably compressed by pressure welding of the fins at the time of lamination of the tube elements such that top portions of the tube elements or the beads and inner wall portions of the tube elements are corrected to permit brazing.

FIG. 3



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Description

TECHNICAL FIELD

The invention relates to a heat exchanger, which has tubes stacked in parallel with fins intervened therebetween and to a method for manufacturing the same.

BACKGROUND ART

A conventionally known stack type heat exchanger has tubes stacked with fins intervened therebetween, ends of the respective tubes connected to distributing and recovering members such as header pipes, and a heat exchange medium meandered a plurality of times to flow between outlet and inlet joints disposed on the distributing and recovering members.

The tubes for the stack type heat exchanger have a plurality of passages therein to improve a heat exchange rate and a pressure resistance. Especially, the tubes for a heat exchanger used as a condenser are required to have a remarkable heat exchange rate and pressure resistance.

Such a tube proposed is a bead type which divides the inner passage of the tube by circular or oblong beads formed to protrude from a flat portion toward the tube interior, or an inner fin type which has an inner fin having a corrugated cross section inserted into the tube to push the tube so to hold the inner fin between the inner walls of the passage, thereby dividing the inner passage into a plurality of sections as disclosed in, for example, Japanese Utility Model Application Laid-Open Publication No. Hei 5-52565.

Particularly, the bead type tube does not need a separate inner fin and has a small number of components as compared with the inner fin type tube. Therefore, a process for inserting the inner fin and a tube pushing process for holding the inner fin between the inner walls of the passage are omitted, and it is advantageous that the production cost becomes inexpensive. And, it is also possible to enhance a heat exchange rate by causing turbulence in a heat exchange medium flowing through the tube by virtue of the arrangement and shape of the beads.

Such tubes are formed by, for example, bending a plate which is made of an aluminum or aluminum alloy material having a thickness of about 0.4 mm or stacking two of the plate, to form a tube having a width of 16 - 20 mm.

Fig. 5 is a sectional perspective view of a conventional tube. This tube 13 is formed by bending a single long plate shaped to have a predetermined size along its center in the breadth direction with a predetermined round radius. And, the plate has been formed in advance with a flat bonding section 20 on both edges in the breadth direction of the plate and long grooved beads 21 by rolling or pressing. The plate is also bent along a center bending section 22 so to join the bonding

sections 20 mutually to form the tube into a flat shape.

Fig. 6 is a sectional perspective view of another conventional tube 13, which is formed by laminating two plates. This tube 13 is formed by forming bonding sections 20 and beads 21 on the two plates and laminating them so to join the bonding sections 20, 20 mutually.

These tubes are shaped to have a flat form with the breadth direction longer than the thickness direction, and the outer wall interval (a thickness of the tube 13) of the mutually faced flat sections 23, 23 is evenly formed to a predetermined thickness (e.g., about 1.7 mm when its width is 16 to 20 mm) corresponding to a fin and a header pipe.

Since it is necessary to join the bonding sections 20 mutually and to join the peaks of the beads 21 with the inner wall of an opposed passage 24 by brazing, the tubes are stacked with the fin intervened therebetween to pressure-contact the flat section 23 with the fin to keep them in a contacted state or a state that the plates are mutually approached to allow the melted brazing material enter from the surface of the plates during brazing. And, if required, a jig or the like is used to press the layer of tubes with the fins intervened therebetween from both sides. The beads 21 are formed as illustrated to contact their peaks with the inside of the flat section 23 which is the inner wall of the passage 24 or to contact their peaks with other beads formed on opposed portions.

The tubes 13 thus formed are stacked with the fins intervened therebetween and their ends are connected to distributing and recovering members such as the header pipes.

And, an assembly (Assy) comprising the tubes 13, the distributing and recovering members and the fins is thermally treated and brazed integrally one body. The brazing material is clad at required portions prior to the heating treatment. Generally, the plate for forming the tube has a brazing material clad on the front and back faces of the plate in advance.

However, the brazing of the stacked heat exchanger having the tubes described above into one body had disadvantages that the bead peaks and the inner wall of the passage are unsatisfactorily defectively brazed partly, resulting in lowering a heat exchange rate or causing a defective pressure resistance.

Such disadvantages are caused because the height of the bonded sections, the height of the beads and the corresponding sizes of the respective parts are deviated to some extent, the mating of the respective tubes is slightly deviated due to a condition of assembling of the distributing and recovering members and the fins, the bead peaks are slightly separated from the inner wall of the passage, and there are some portions where the brazing material cannot be provided sufficiently.

In this case, the bonding sections can be brazed relatively well because the melted brazing material also enters between them from the outer faces of the plates.

But, the peaks of beads and the inner walls of the passages have the brazing material melted from only the inner walls of the plates between them, so that if their contacts get loose even slightly, the brazing becomes defective noticeably.

Therefore, such a tube had disadvantages that its performance was poor in reliability and its yield was low, and even if it was used for a condenser, a sufficient heat exchange rate and pressure resistance could not be obtained.

Accordingly, an object of the present invention is to provide a heat exchanger by applying a pushing force from fins to flat sections to correct appropriately a butt contact between the peaks of beads and the inner walls opposed to the peaks into a brazable state and to reduce a failure of brazing.

SUMMARY OF THE INVENTION

The invention relates to a heat exchanger having tube elements, which are formed by bending a single plate or by bonding two plates and have beads integrally formed to form a plurality of passages therein, and stacked in parallel with fins intervened therebetween, wherein the tube elements prior to be stacked have a thickness at the intermediate portion larger than that at the intermediate portion of the tube face of the stacked tube elements.

In the heat exchanger, the tube element prior to stacking has the intermediate portions of its upper and lower tube faces formed to swell toward the fins, or the tube element prior to stacking has the intermediate portion of one of the tube faces swelled to the fins.

The invention also relates to a method for manufacturing a heat exchanger having tube elements, each formed by bending a single plate or by bonding two plates and having beads integrally formed to form a plurality of passages therein, and stacked in parallel with fins interposed between adjacent tubes, comprising the steps of:

forming the intermediate portion of the tube element prior to stacking to swell toward the fins; stacking the tube elements by compressing them with the fins interposed between the adjacent tube elements to form a heat exchanger assembly; coating the heat exchanger assembly with flux; and introducing the heat exchanger assembly into an oven where it is brazed integrally by heat treatment.

Therefore, when the tubes are stacked according to the invention, the swelled portions are appropriately compressed by the forced contact with the fins, and the mutual tops of the tubes or the beads and the inner walls of the tubes are corrected to a brazable state.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic front view of the heat exchanger according to an embodiment of the invention.

Fig. 2 is a partially sectional perspective view showing a tube of this embodiment.

Fig. 3 is a partially sectional perspective view showing a temporarily assembled tube of the embodiment.

Fig. 4 is a partially sectional perspective view showing a split-plate type tube according to another embodiment of the invention.

Fig. 5 is a partially sectional perspective view showing a single-plate type tube according to a conventional art.

Fig. 6 is a partially sectional perspective view showing a split-plate type tube according to a conventional art.

BEST MODE FOR CARRYING OUT THE INVENTION

The invention will be described in detail with reference to the embodiments shown in the drawings.

Fig. 1 shows a front view of the heat exchanger of one embodiment of the invention. In the drawing, the heat exchanger 1 has a plurality of tubes 2, 2 and corrugated fins 3, 3 alternately stacked one another, both ends of the stacked flat tubes 2 inserted and connected to tube insertion ports 5, 5 of header pipes 4 which are erected on both sides. And, side plate-connecting holes 6 are formed on the header pipes 4 at portions corresponding to the upper and lower sides of the stacked tubes 2, and both ends of side plates 7 having a square C-shaped cross section are inserted and connected to the side plate-connecting holes 6. Top and bottom end openings of the header pipes 4 are sealed by caps 8. An inlet joint 9 is connected to the header pipe 4 on one side, and an outlet joint 10 is connected to the header pipe 4 on the other side. Slits 11 having a predetermined shape are formed on required portions of both header pipes 4, and partition plates 12 are inserted into the slits 11 to divide the header pipes 4 in a longitudinal direction.

In this heat exchanger 1, a heat exchange medium flows to meander a plurality of times between the inlet joint 9 and the outlet joint 10. The heat exchange medium supplied through the inlet joint 9 of the heat exchanger 1 flows to meander a plurality of times between the right and left header pipes 4, 4 through the tubes 2, performing heat exchange with outside while passing through the tubes, and is discharged from the outlet joint 10.

In Fig. 2, the tube 2 is formed by bending a single plate, which has bonding sections 20 and beads 21 formed by rolling, along a center bending part 22 of the plate in its breadth direction. And, flat portions 23 having a predetermined shape which will be described afterward are formed between the bonding sections 20

and the bending part 22.

In other words, the tube 2 is made of an aluminum brazing sheet material having good heat conductivity, formability and brazing property, and has the bonding sections 20 with the flat portions formed at both ends in its breadth direction to enlarge the bonding areas by virtue of the bonding sections 20, 20, thereby securing a satisfactory bonding strength by brazing.

The respective tubes 2 have the beads 21, having a predetermined height, are formed along their length in the longitudinal direction at least prior to be assembled into a single tube 2.

The beads 21 are alternately protruded toward the tube interior from the inner face of the tube 2 at predetermined points in the breadth direction of the tube 2, in two lines in this embodiment, to form three passages 24, 24 in the tube 2. Specifically, the beads 21 are set to protrude to substantially the same height as the inner breadth of the tube 2, and the portions of the tube 2 to oppose the beads 21 are formed flat. Accordingly, the inner faces of the tube 2 are contacted to the peaks of the beads to form a plurality of passages 24, 24 within the tube 2 to improve the heat exchange efficiency of the medium flowing through the passages 24, 24. And, the sections forming the passages serve as a reinforcing member to improve a pressure resistance against a pressure produced by the heat exchange medium.

The flat portions 23 of the tube 2 are formed to swell slightly toward the intervened fins 3 by bending the tube along the bending part 22 and gently protruding both sides along the longitudinal direction with the neighborhood of the center in the breadth direction being the highest. The tube 2 (width of 16 to 20 mm) of this embodiment has thickness a (e.g., 1.7 mm) in the neighborhood of the ends and thickness b in the neighborhood of the center in the breadth direction slightly larger (e.g., about 0.1 mm to 0.2 mm with respect to the thickness a = 1.7 mm) than the thickness a as indicated by a two-dot and dash line in Fig. 2. In this embodiment, the portions where the beads 21 are formed and the flat portions 23 at the points corresponding to the inner walls of the passages 24 to oppose the peaks of the beads 21 are swelled toward the fins 3.

As shown in a partial perspective view with a part broken of Fig. 3, the tube 2 has the fin 3 on its upper and lower faces for stacking, and a pushing force is applied from the fins 3 to the flat portions 23 of the tube 2. In other words, this fin 3 is made of a thin metallic material having a good heat conductivity into a corrugated shape to zigzag vertically. And, the fin 3 is set to zigzag to a height in the same way as the prior art so to reach the non-swelled portions of the tubes to be stacked.

Therefore, since the fin 3 is set to have a height as described above and the flat portions 23 of the tube 2 are swelled toward the fin 3, a pushing force is applied from the fin 3 when they are stacked. And, the swelled portions of the flat portions 23 are pushed, namely the tube 2 is compressed to change its vertical thickness

from the order of thickness b to the thickness a.

And, if there is a space between the peaks of the beads 21 and the inner walls of the passages 24 opposed to the peaks, the upper and lower flat portions 23 are pushed to deform, and the tube 2 itself is appropriately compressed vertically, so that the upper and lower flat portions 23 are mutually approached to be corrected into a contacted or more closely approached state. In other words, since the upper and lower portions are at least swelled in the upper and lower directions for the respective beads, the upper and lower flat portions 23 are pushed to deform. And, the inner wall faces opposed to the beads 21 are approached to the beads and the beads 21 are also approached to the opposed inner wall faces.

Accordingly, even if the corresponding sizes of the respective portions are deviated or the mating of the respective portions is deviated due to a condition of assembling, a space can be prevented from being formed between the peaks of the beads 21 and the passages 24 if the deviation is within the range that the flat portions 23 are compressed to deform.

Even if the flat portions 23 are not pushed to deform into a completely flat face, the fin 3 has its corrugated shape deformed slightly and tightly contacted to the tube 2.

The ends of the tube 2 are inserted into the insertion ports 5 of the header pipes 4, the assembly formed is applied with the flux and placed in an oven and brazed into one body by heat treatment. The mutual bonding sections 20, 20 and the peaks of the beads 21 and the flat portions 23 are brazed for bonding by a sufficient amount of the melted brazing material.

In the embodiment described above, the beads are alternately protruded from the inner faces of the upper and lower flat portions formed on the tube. But, the beads may be formed on one face only or protruded from the opposed inner faces to contact the peaks of the beads mutually.

Furthermore, the flat portions may have only one of the upper and lower faces of the tube swelled or only the required portions in the neighborhood of the beads swelled.

Therefore, since this embodiment causes to swell vertically with the neighborhood of the center of the tube as the peak, the swelled portion is appropriately compressed to deform by the pushing force of the fin. And, the mutual bonding sections and the peaks of the beads and the inner walls opposed to the beads can be corrected to have an approached or contacted state optimum for brazing, and the brazing of the pertinent portions can be improved without fail.

In other words, correction to the approached or contacted state optimum for brazing can be made even if the corresponding sizes of the respective portions, such as the height of the bonding sections and the height of the beads, are deviated to some extent or the mating of the tubes is slightly deviated due to a condi-

tion of assembling of the distributing and recovering members and the fins, and the bead peaks are slightly separated from the inner walls of the passages.

Even if the peaks of beads and the inner walls of the passages have the brazing material melted from only the inner walls of the plates between them, they can be brazed securely because they are in the approached or contacted state optimum for brazing.

As a result, the beads have a good brazing property, a yield can be improved, and the heat exchange rate and the pressure resistance can be enhanced. Accordingly, the invention can be applied to various types of stack type heat exchangers including a condenser.

The above embodiment has been described with reference to the tube which was formed by bending a single plate. But, the tube to be formed of the plate may be a tube 2 which is formed by stacking two plates so to mutually mate the bonding sections 20 as shown in Fig. 4.

INDUSTRIAL APPLICABILITY

The invention relates to a heat exchanger having tubes stacked in parallel with fins intervened therebetween and a method for manufacturing it, and particularly improving brazing of tubes having beads for dividing their inside into a plurality of passages. Accordingly, the invention is applied to general radiators, evaporators and also condensers that are required to have a pressure resistance.

Claims

1. A heat exchanger having tube elements, each formed by bending a single plate or by bonding two plates and having beads integrally formed to form a plurality of passages therein, and stacked in parallel with fins intervened therebetween, wherein:
 - the tube element prior to be stacked has a thickness at the intermediate portion larger than that at the intermediate portion of the tube face of the stacked tube elements.
2. The heat exchanger according to claim 1, wherein the tube element prior to stacking has the intermediate portions of its upper and lower tube faces formed to swell toward the fins.
3. The heat exchanger according to claim 1, wherein the tube element prior to stacking has the intermediate portion of one of the tube faces swelled to the fins.
4. A method for manufacturing a heat exchanger having tube elements, each formed by bending a single plate or by bonding two plates and having beads

integrally formed to form a plurality of passages therein, and stacked in parallel with fins interposed between adjacent tubes, comprising the steps of:

forming the intermediate portion of the tube element prior to stacking to swell toward the fins;
 stacking the tube elements by compressing them with the fins interposed between the adjacent tube elements to form a heat exchanger assembly;
 coating the heat exchanger assembly with flux; and
 introducing the heat exchanger assembly into an oven where it is brazed integrally by heat treatment.

FIG. 1

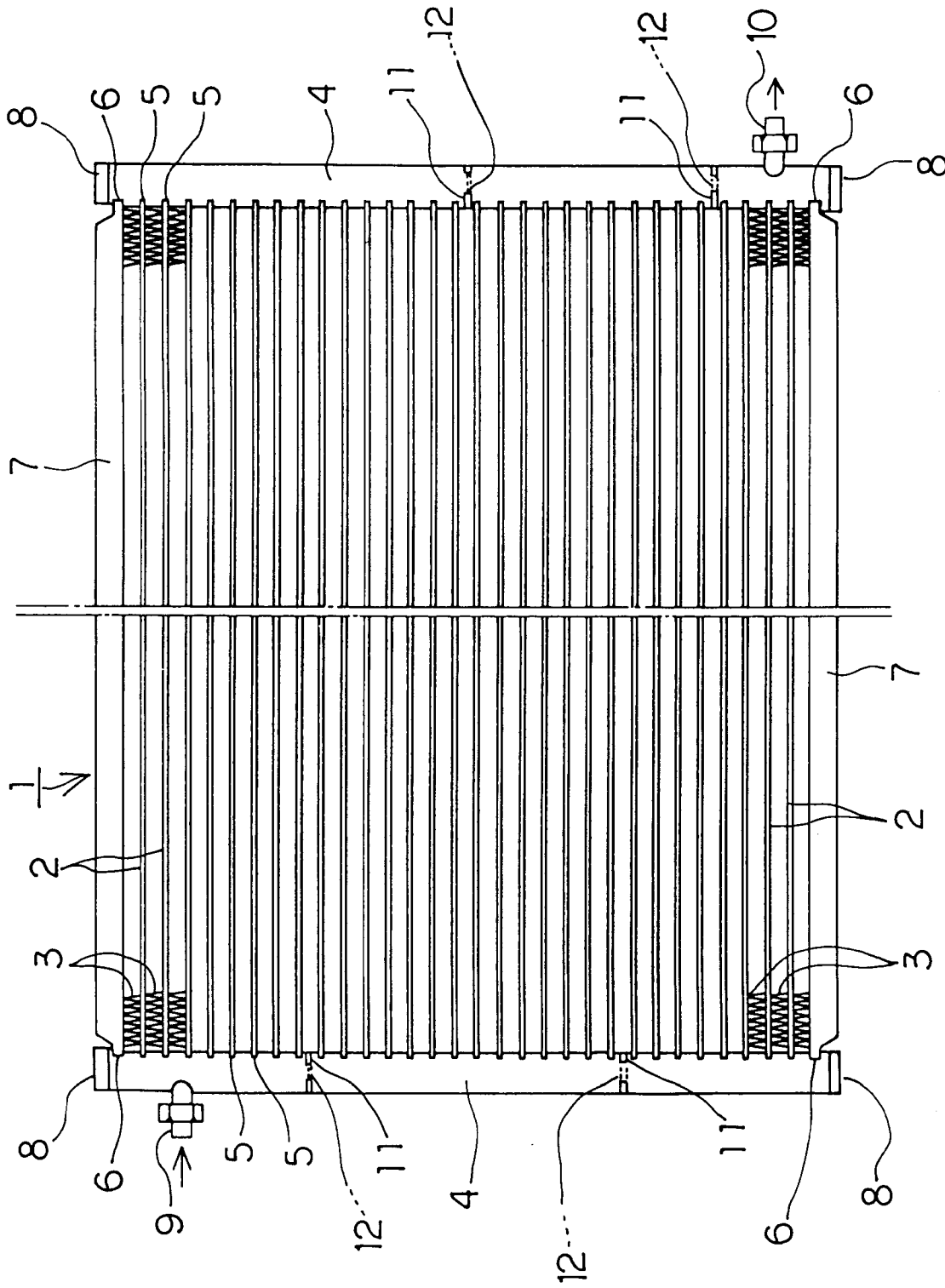


FIG. 2

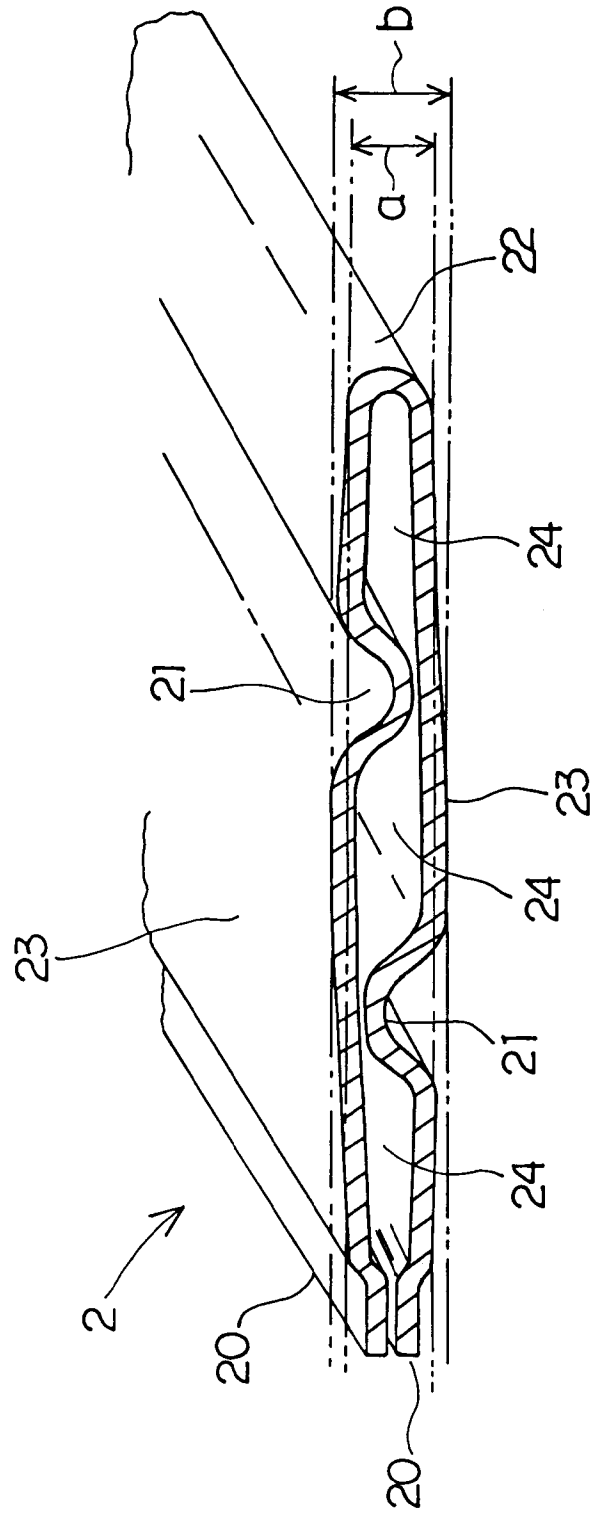


FIG. 3

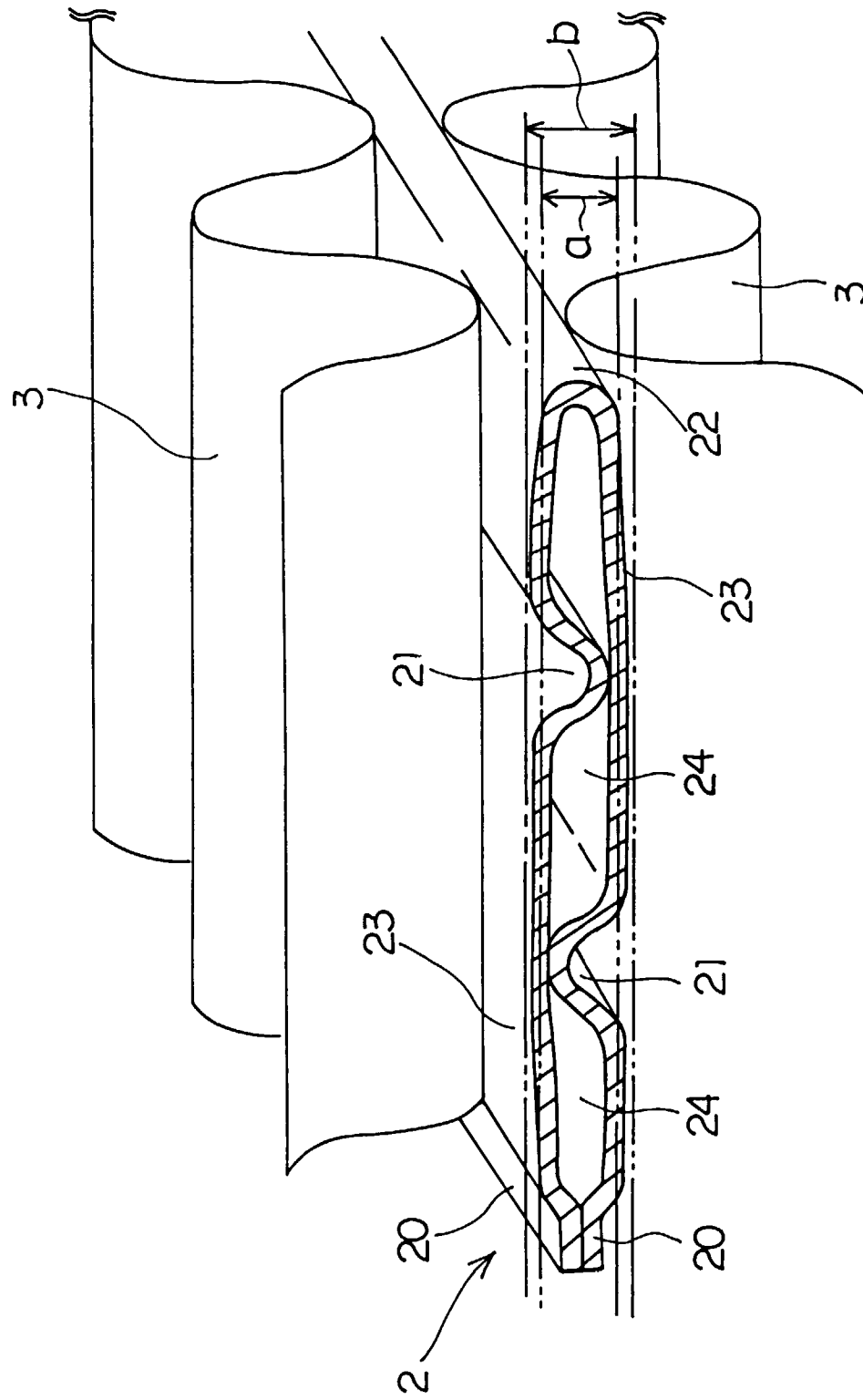


FIG. 4

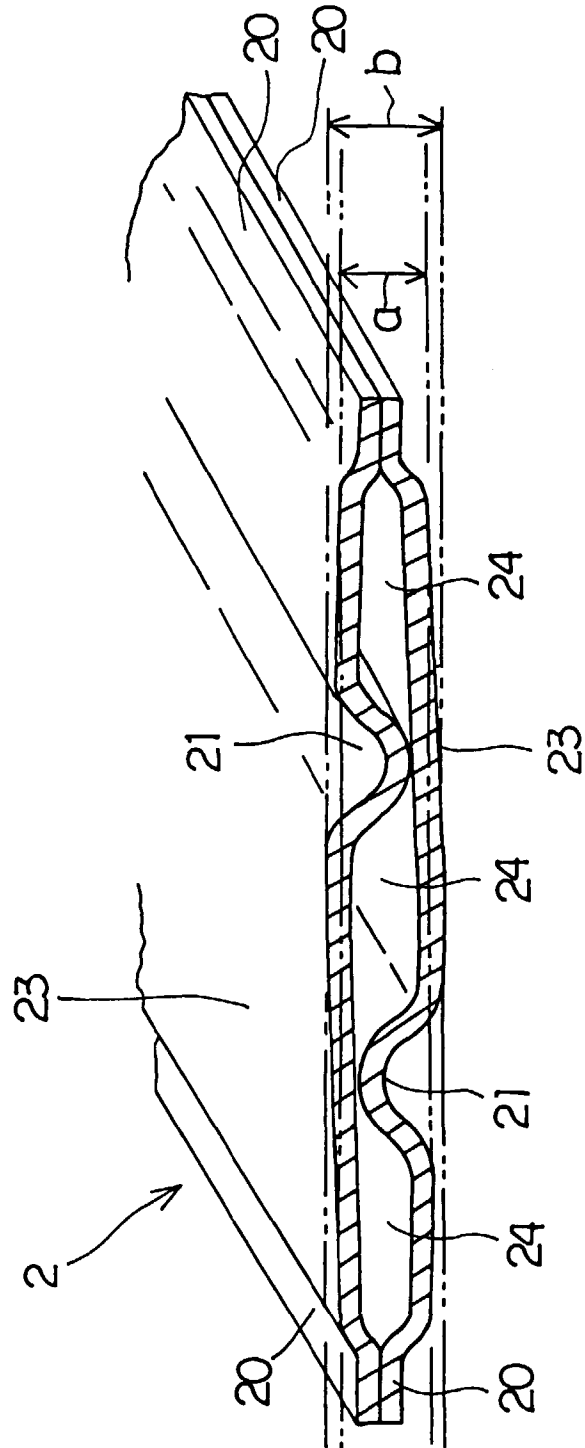


FIG. 5

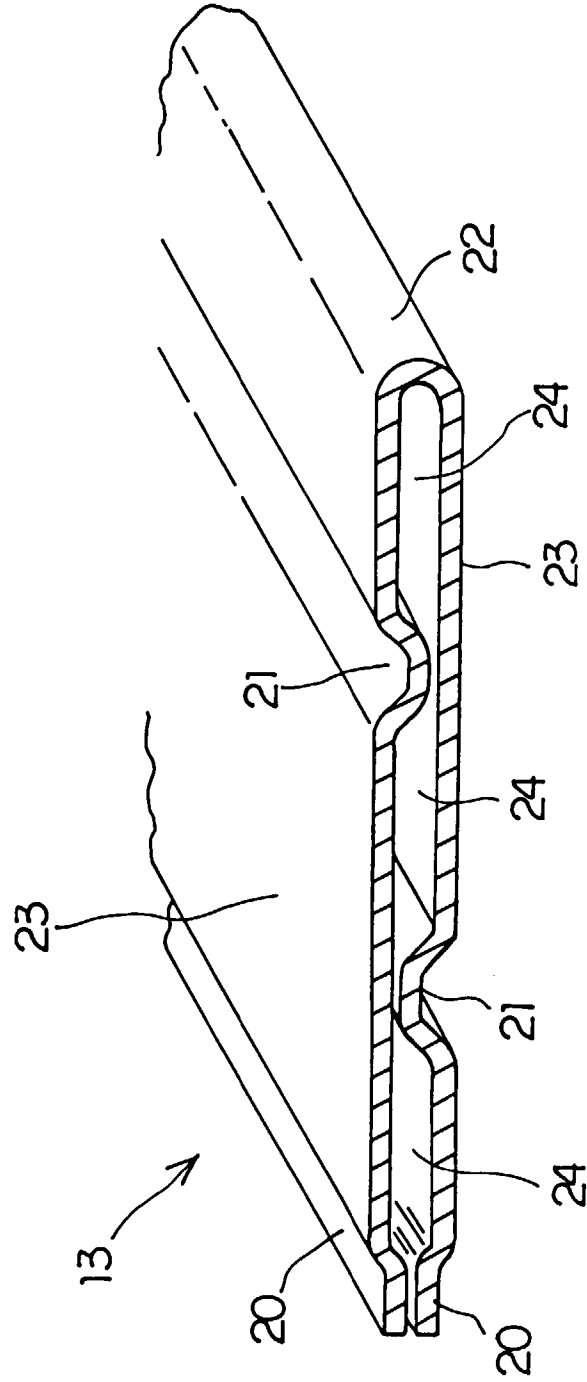
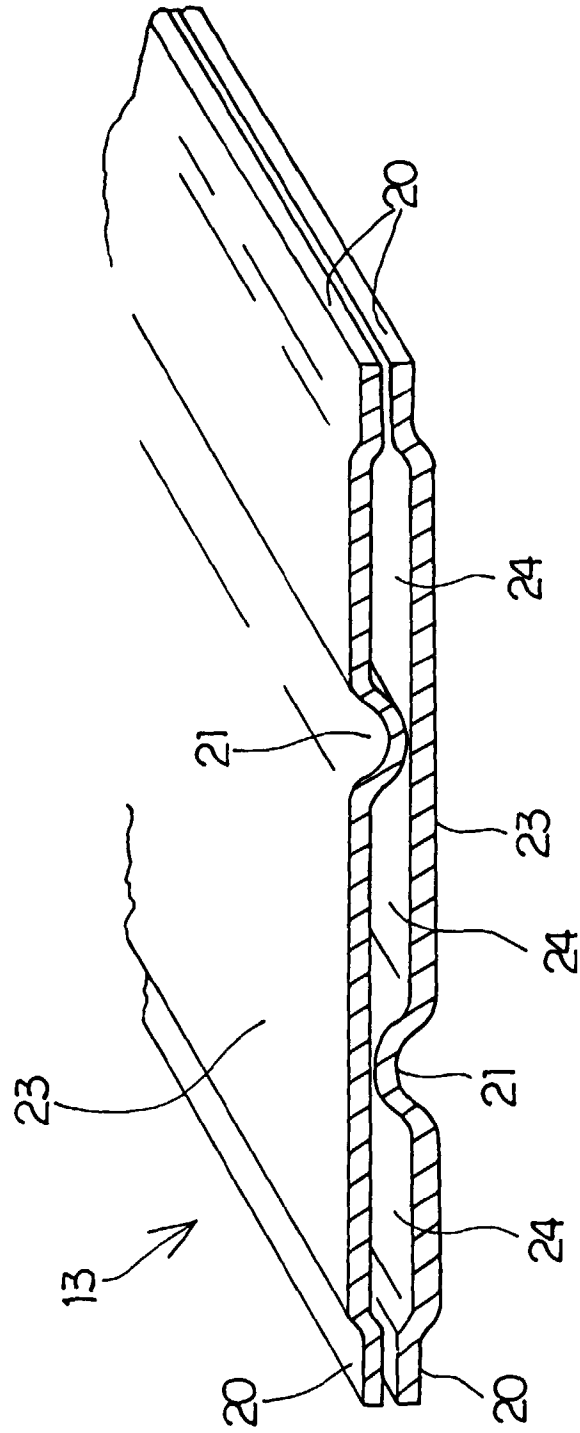


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP97/03589

A. CLASSIFICATION OF SUBJECT MATTER Int. Cl ⁶ F28F1/02 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 F28F1/02 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926 - 1997 Kokai Jitsuyo Shinan Koho 1971 - 1997 Toroku Jitsuyo Shinan Koho 1994 - 1997 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.
Y	JP, 58-13993, A (Toyo Radiator Co., Ltd.), January 26, 1983 (26. 01. 83) (Family: none)	1 - 4
Y	JP, 7-178542, A (Zexel Corp.), July 18, 1995 (18. 07. 95) (Family: none)	1 - 4
A	JP, 61-66091, A (Toyo Radiator Co., Ltd.), April 4, 1986 (04. 04. 86) (Family: none)	1 - 4
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "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 December 25, 1997 (25. 12. 97)		Date of mailing of the international search report January 13, 1998 (13. 01. 98)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.		Authorized officer Telephone No.

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