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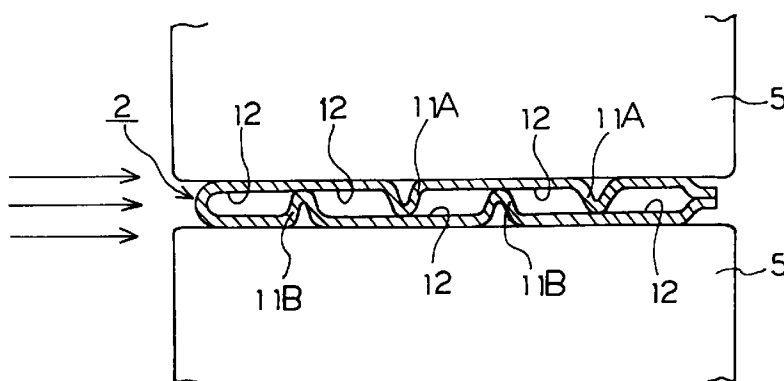
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(54) Tubes for heat exchanger

(57) To provide tubes for a heat exchanger having a higher corrosion resistance and capable of contributing to a longer life of the heat exchanger, the tubes having recesses resulting from beads or grooves formed on the upper and lower tube walls. Tubes for the heat exchanger, each tube being formed by bending a sheet of plate or by joining two sheets of plates, wherein the

tube 2 is formed with a plurality of beads 11A, 11B, the top of each bead being joined with the surface of the opposite tube wall to form a plurality of divided passages in the tube. Of the beads 11A and 11B, at least one bead located on the most upstream side of the air flow projects upwardly from the lower tube wall.

FIG. 2



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Description

Technical Field of the Invention

The present invention relates to flat tubes for a heat exchanger, wherein a plurality of recesses are formed on the outer surface of each tube by a plurality of beads provided inside the tube which define a plurality of flow passages therein. More particularly, the tube is designed to prevent the dust carried by a circulating air flow from accumulating in recesses facing upwardly, thereby to improve the corrosion resistance of the tube.

Prior Art

In general, a conventionally known heat exchanger comprises a plurality of parallelly laminated flat tubes, opposite ends of each tube being connected to two header pipes disposed on both sides thereof respectively, and an inlet joint and an outlet joint for introducing and discharging a heat exchange medium are provided at predetermined places of the header pipes respectively. In the case of such a heat exchanger, the heat exchange medium introduced into the flat tubes of the heat exchanger exchanges its heat with the air circulating outside and the like while passing through the flat tubes between header pipes back and forth several times, and is then discharged.

Each of the flat tubes used for such laminated type heat exchanger, for example, such as one whose cross section is shown in Fig. 8, is formed into a flat tubular form from a single rectangular brazing sheet. For instance, a flat tube 20 is formed by joining the lateral edges of the single rectangular brazing sheet with each other by bring. In the figure, 20a and 20b denote flat joining portions at lateral ends of the plate. These flat joining portions contribute to increase a joining area and maintenance of the adequate joining strength with brazing.

Recently, there is an increasing tendency for reducing the wall thickness of the tube as far as possible, mainly for reducing manufacturing cost by reducing the quantity of material to be used, as well as for higher heat exchange efficiency and for lighter tube weight. As the wall thickness of the flat tube 20 tends to be reduced, the structural strength of such flat tubes are maintained by integrally forming a plurality of beads 21(21A, 21B) with each flat tube.

More particularly, a plurality of beads 21A and 21B are integrally formed with the tube 20 at predetermined locations along its lateral direction, and the beads are arranged along the longitudinal direction of the tube, the beads respectively projecting to a level at which the tops of the beads abut the inner surface of the opposite tube wall, whereby these beads 21A and 21B form a plurality of heat exchange medium passages 22, 22 inside the tube not only to increase a contact area of the tube with the medium for higher heat exchange efficiency but also

to increase a pressure resistance of the tube itself by making the beads 21 to function as reinforcing members.

Besides the flat tube formed from a single plate, those formed by joining two plates are also known. Further, flat tubes obtained by an extrusion molding of an aluminum material or an aluminum alloy material is known. Such a molded tube has internal passages divided by laterally arranged partitions. The outer surface of such a molded flat tube is provided with grooves each having a concave cross section for the purposes of increasing a surface area, weight reduction, discharge of dew drops and the like.

Problems to be resolved by the Invention

In the case of the conventional tube for heat exchanger as described above, as shown in Fig. 8, a recess resulting from the bead 21A located on the upstream side of the air flow tends to heavily collect the dust x and the like carried by the air flow, causing the problems such as the corrosion of the tube or the degradation of corrosion resistance of the tube and resultant shorter lives of the parts.

Not only the recesses resulting from the formation of the beads but also the grooves on the tubes formed by the extrusion molding for the purposes of increasing the surface area, decreasing weight or saving of material to be used have been giving rise to a problem that the dust collected in such recesses and grooves causes the corrosion of the tubes.

More particularly, in general, in the case of conventional heat exchanger, the air is made to flow in the lateral direction of the tube located between the radiating fins which are disposed at upper and lower surfaces of the tube. As a result, the surface of the tube, that is, the surface of the portion of the tube extending from its front to the portion located on the upstream side of the air flow, is apt to collect the dust contained in the air flow, while the surface of the portion of the tube on the downstream side of the air flow is less apt to be contaminated with the dust. Thus, when the recesses as described previously are located on the upstream side of the air flow, the aforementioned tendency is promoted, causing the concentrative accumulation of the dust in such recesses. Further, in contrast with that the dust collected in the recesses facing downwardly on the outer surface of the lower tube wall can be removed easily by falling, but the dust accumulated heavily in the recesses facing upwardly cannot be removed easily, causing the corrosion of the tubes.

Further, there are chances that the rainwater is directly drawn into the inside of the heat exchanger and that, depending on the conditions under which the heat exchange takes place, condensation of moisture occurs in the vicinity of tubes and flows into the recesses facing upwardly, thereby causing the dust accumulated in other places to be carried into such recesses together

with such condensed moisture.

Further, since the wall thickness of the tube itself is reduced for the purposes such as cost reduction, weight reduction and higher efficiency of heat exchange with outside medium, even minor corrosion can cause various troubles such as the degradation of the pressure resistance or leakage of heat exchange medium.

Especially, in the case of the heat exchanger to be mounted on vehicles, the air for cooling is introduced from outside, and thus the quantity of the dust contained in the air is relatively greater, adding to the aforementioned adverse effect on the tubes leading to the shorter life of the tube.

On the other hand, a type of tube in which the recess resulting from the bead facing upwardly from the outer surface of the tube is depressed in advance to be joined integrally with the tube wall has been proposed, for example, in the Japanese Patent Laid-Open Publication No. 4-86489.

Such a type of tube, however, requires complex manufacturing steps that result in high manufacturing cost.

Thus, it is an object of the present invention to provide tubes for a heat exchanger, wherein each tube is provided with recesses made by beads or grooves on the upper and lower outer surfaces of the tube, and such recesses or grooves are formed to face upwardly on the outer surface of the tube wall so that the dust is less apt to accumulate therein, thereby to provide tubes for the heat exchanger having a higher corrosion resistance, which, in turn, leads to a longer life.

Means for Solving the Problems

The invention recited in Claim 1 of the present application relates to tubes for a heat exchanger, each tube being formed by bending a single sheet of plate or by joining two sheets of plates, wherein the tube is formed with a plurality of beads each having a concave cross section, the tops of beads are joined with the surface of an opposite tube wall to form a plurality of divided passages in the tube, and at least one bead located on the most upstream side of an air flow projects upwardly from the lower tube wall.

As described above, the portion of the tube located on the most upstream side of the air flow is provided with the recesses of the beads disposed on the lower tube wall, so that dust is prevented from remaining in the recesses. Thus, even when the recesses of the beads are formed on the upper tube wall on the downstream side of the air flow, the dust in the air flow is caught by the radiating fins and the like interposed between adjacent laminated tubes to enable relatively clean air to circulate, so that the dust is less apt to remain in the recesses. As a result, the corrosion resistance of the tube can be improved for longer life of the heat exchanger. Further, the portion of the tube located on the most upstream side of the air flow is apt to collect

the dust, but the recesses are facing downwardly, so that, even when the dust enters into the recesses, the dust falls easily, thereby preventing the dust from remaining on the surface of the tube.

The invention recited in Claim 2 of the present application relates to tubes for a heat exchanger according to Claim 1, wherein the tops of said beads are joined with the opposite flat surface of the tube wall or the tops of the beads formed on the opposite tube wall, the bead located on the most upstream side of the air flow is formed on the lower tube wall, and the beads located on the downstream side of the air flow are formed projecting inwardly and alternately from the upper and lower tube walls.

As described above, when the beads formed with the tube are made to project alternately from the upper tube wall and lower tube wall along the direction of the air flow to be circulated, the cross section of the molded tube becomes substantially symmetric with respect to its upper tube wall and lower tube wall, whereby not only molding process of the tube becomes easy but also the tops of the beads on the upper tube wall and the lower tube wall are arranged symmetrically. As a result, the residual stress of the tube material in the upper tube wall and the lower tube wall is made uniform, thereby contributing to the increase in the pressure resistance of the tube itself and resultant increase in durability and longer life of the heat exchanger.

The invention recited in Claim 3 of the present application relates to tubes for a heat exchanger, each tube being formed from an aluminum or an aluminum alloy material by an extrusion molding, wherein the outer surface of each tube is formed with a plurality of grooves each having a concave cross section, each tube is provided with partitions to laterally divide the inside of the tube into a plurality of internal passages, and at least one groove located on the most upstream side of an air flow is formed underside the lower tube wall.

As described above, when the tube is formed with the grooves by the extrusion molding, not only its surface area is increased for a higher heat exchange efficiency but also the quantity of aluminum or aluminum alloy material to be used can be reduced for lower manufacturing cost and for light weight of the tube. Further, since the recess resulting from the groove located on the most upstream side of the air flow is formed on the outer surface of the lower tube wall, not only the dust and the like in the air is less apt to enter the opening of the recess but also the dust collected in the opening can be removed by falling, thereby preventing the dust or moisture from remaining on the surface of the tube. As a result, the corrosion resistance of the tube is improved for longer life.

Effects of the Invention

As described above, the invention recited in Claim 1

of the present application relates to tubes for a heat exchanger, each tube being formed by bending a single sheet of plate or by joining two sheets of plates, wherein the tube is formed with a plurality of beads each having a concave cross section, the tops of beads are joined with the surface of an opposite tube wall to form a plurality of divided passages in the tube, and at least one bead located on the most upstream side of an air flow projects upwardly from the lower tube wall.

Thus, the recesses resulting from the beads on the most upstream side of the air flow face downwardly, thereby preventing the dust from remaining in the recesses. Therefore, even when the recesses facing upwardly resulting from the beads are formed on the outer surface of the upper tube wall on the downstream side of the air flow, the dust is less apt to remain in the recesses of the beads, since the dust and the like in the air are caught by the radiating fins and the like interposed between the adjacent tubes, and thus relatively clean air flows. As a result, the corrosion resistance of the tubes will be increased for longer life of the heat exchanger. Further, the portion of the tube on the most upstream side of the air flow is apt to collect the dust and the like contained in the air flow, but the dust and the like passing the recesses resulting from the beads are less apt to accumulate therein by falling easily, since the recesses face downwardly, thereby preventing the accumulation of the dust on the surface of the tube.

The invention recited in Claim 2 of the present application relates to tubes for a heat exchanger according to Claim 1, wherein the tops of said beads are joined with the opposite flat surface of the tube wall or the tops of the beads formed on the opposite tube wall, the bead located on the most upstream side of the air flow is formed on the lower tube wall, and the beads located on the downstream side of the air flow are formed projecting inwardly and alternately from the upper and lower tube walls.

In this fashion, when the beads of the tube are formed projecting alternately from the upper and lower tube walls in the direction of air flow, the formed tube has a substantially symmetrical cross section with respect to its upper half and lower half, thereby making the formation easier. Further, the beads are formed symmetrically on the upper wall and lower wall, and, as a result, the residual stress occurring in the tube material is distributed evenly to equalize the strength of the upper wall of the tube and that of the lower wall of the tube, thereby contributing to the increase in pressure resistance of the tube. This further contributes to the maintenance of the necessary durability and longer life of the heat exchanger.

The invention recited in Claim 3 of the present application relates to tubes for a heat exchanger, each tube being formed from an aluminum or an aluminum alloy material by an extrusion molding, wherein the outer surface of each tube is formed with a plurality of grooves each having a concave cross section, each

tube is provided with partitions to laterally divide the inside of the tube into a plurality of internal passages, and at least one groove located on the most upstream side of an air flow is formed underside the lower tube wall.

As described above, when the grooves are provided on the tubes formed by the extrusion, not only the surface area of each tube can be increased for the higher heat exchange efficiency but also the quantity of the material such as the aluminum material or aluminum alloy material can be reduced for reduction of manufacturing cost and weight of the tube. Further, the recess resulting from the groove located on the upstream side of the air flow faces downwardly from the lower tube wall, so that not only the dust and the like in the air are less apt to accumulate in the opening of the recesses but also the dust and the like accumulated in the recess fall easily, thereby preventing the dust or the moisture from remaining on the surface of the tube and contributing to the increase in the corrosion resistance and longer life of the tube.

As described above, the present invention provides tubes for a heat exchanger, each tube is provided with recesses made by beads or grooves on the upper and lower outer surfaces of the tube, and such recesses or grooves are formed to face upwardly on the outer surface of the tube wall so that the dust is less apt to accumulate therein, thereby to provide tubes for the heat exchanger having a higher corrosion resistance, which, in turn, leads to a longer life.

Brief Description of the Drawings

- FIG. 1 A front view of a laminated type heat exchanger of a first embodiment of the present invention.
- FIG. 2 A perspective view taking along the line A-A in FIG. 1 and showing a cross section of a flat tube.
- FIG. 3 A cross-sectional view of the flat tube of the first embodiment of the invention.
- FIG. 4 A cross-sectional view of the flat tube of the first embodiment of the invention.
- FIG. 5 A cross-sectional view of the flat tube of a second embodiment of the invention.
- FIG. 6 A cross-sectional view of the flat tube of a third embodiment of the invention.
- FIG. 7 A cross-sectional view of the flat tube of a fourth embodiment of the invention.
- FIG. 8 A cross-sectional view of a conventional flat tube for the heat exchanger.

Embodiments of the Invention

A first embodiment of the present invention will be described referring to Fig. 1 and Fig. 2. In the embodiments which will be described hereafter, the basic construction of the heat exchanger comprising the flat tubes

as described in this embodiment is common and thus the description thereof will be omitted by assigning same reference numerals.

In Fig. 1, a laminated type heat exchanger 1 comprises two units of vertically installed header pipes 3, 4, a plurality of flat tubes 2 of equal length parallelly laminated one another with thin corrugated fins 5 interposed between the tubes, the tubes being disposed between the two header pipes, the opposite ends of these flat tubes being communicatively connected to the header pipes. Further, as shown in Fig. 2, the top of each corrugated fins 5 is in contact with the flat surface of the flat tube 2.

The top and bottom openings of each of the header pipes 3 and 4 are closed with blank caps 6. The header pipe 3 provided with an inlet joint 3a at its predetermined location for introducing a heat exchange medium from outside, while the header pipe 4 is provided with an outlet joint 4a at its predetermined location for discharging the medium, which has undergone heat exchange process, maintaining the communication between the header pipes. Further, the inside of the header pipe 3 and that of the header pipe 4 are respectively divided by partitions 7. Further, in Fig. 1, reference numeral 8 denotes side plates disposed on the top and bottom of the laminated flat tubes 2, the side plates 8, 8 being designed to protect the corrugated fins 5 and to reinforce the structural strength of the heat exchanger 1.

The heat exchange medium introduced through the inlet joint 3a circulates, or flows through the tubes 2 arranged in zigzag, between the header pipe 3 on the left and the header pipe 4 on the right by making a plurality of turns, bringing about the heat exchange effect during the circulation, and is discharged through the outlet joint 4a. That is, the medium introduced into the heat exchanger 1 is made to meander downwardly through each of the group units of flat tubes, each group unit comprising a predetermined number of the flat tubes.

As shown in Fig. 3 and Fig. 4, each of the tubes 2 is formed by bending, a sheet of plate, and joining the opposite ends 2b and 2a of the material. A plurality of beads 11A and 11B, projecting alternately from both the outer surfaces 2A and 2B of the flat tube wall, are integrally formed with each flat tube. The beads 11A and 11B, making four rows in total, projects inwardly alternately from predetermined places on the opposite walls of the flat tube 2, thereby providing five passages 12 having substantially equal cross-sectional areas. By forming the tube in this way, not only the contact area of the tube with the circulating medium can be increased to obtain a higher heat exchange efficiency but also the pressure resistance of the tube 2 can be increased by letting the beads 11A and 11B function as reinforcing members.

By properly determining the locations of these beads 11A and 11B, the dust carried by the air flowing through the tubes 2 can be prevented to a greatest pos-

sible extent from accumulating in the recesses 11a and 11b formed on the outer surfaces the tubes.

Further, since a flat-sheet type brazing sheet is formed into a flat tube, it is easier for manufacturing that the cross section of the tube has a substantially vertically symmetric form of upper and lower portions, because the portions of the flat-sheet type material where the beads 11A and 11B are formed tend to have a small residual stress or the strength differing from the other portions, which may adversely affect the moldability of the material or cause deformation of the tube. Thus, it is not desirable to form the beads 11A and 11B only on one of the tube walls but desirable to form the beads symmetrically on opposite tube walls. Thus, in the case of this embodiment, although the opposite walls of the tube 2 are not symmetrical, the above-described desirable condition is satisfied to a practically problem-free level by providing the equal number of beads 11A, 11B on the opposite walls.

More particularly, four rows of beads are formed alternately on the opposite tube walls along the width of each tube, that is, the direction of the air to be circulated. A first bead 11B (1) is projected upwardly from the lower wall; a second bead 11A (2), downwardly from the upper wall; a third bead 11B (3), upwardly from the lower wall; and a fourth bead 11A (4), downwardly from the upper wall.

Thus, as shown in Fig. 4, a recess 11b resulting from the bead 11B facing downwardly from the lower wall of the tube 2 is located in the vicinity of the portion of the tube facing the flow of the air passing the heat exchanger 1, so that the dust x is prevented from easily accumulating in the recess 11b. Since the dust is apt to accumulate on the most upstream side of the circulating air flow, it is impossible to completely prevent the dust x from being accumulated in the recess 11b resulting from the bead 11B; however, even in this case, the dust easily falls from the recess 11b to be removed, so that the dust x is prevented from remaining in the recess 11b. Furthermore, on the downstream side of the air flow, the recesses 11b and 11a resulting from the bead 11A and bead 11B are alternately located on the upper wall and lower wall of the tube 2, and so the dust and the like in the flowing air is caught by the radiating fins 5 located on the top and bottom of the tube 2, thereby allowing relatively clean air to circulate, so that the dust is less apt to accumulate in the recesses 11a and 11b resulting from the beads.

Presumably, the dust and the like removed from the flowing air and the dust removed from the bead 11B of the tube 2 and the like may be caught by the corrugated fins 5, will cause the corrosion of the corrugated fins. However, the damage to the heat exchanger is smaller when caused by the corrosion of the corrugated fins 5, since the fin is passed by only the flow of the air, than the damage caused by the corrosion of the tubes, since tubes are passed by the flow of the heat exchange medium, and so the damage caused by the corrosion of

the entire heat exchanger can be minimized.

Further, in Fig. 3 and Fig. 4, arrow marks directing rightward indicates the direction of circulating air, and an arrow directing downward indicates the direction of falling dust x.

As described above, on the most upstream side facing the flow of the air, the recess resulting from the bead faces downwardly on the outer surface of the lower tube wall, so that the accumulation of the dust and the like can be prevented. Even when the recess resulting from the bead is formed on the outer surface of the upper tube wall on the downstream side of the air flow, the dust and the like are less apt to accumulate in the recess resulting from the bead, since the recess is passed by relatively clean flow of the air. Further, the upstream side of the tube facing the flow of the air is apt to collect the dust and the like contained in the flowing air; however, the recess is located on the outer surface of the lower tube wall, so that, even when the dust or the like is caught by the recess resulting from the bead, the dust and the like are easily removed by falling therefrom, thereby preventing the dust or moisture from remaining therein and contributing to the maintenance of a higher corrosion resistance and resultant longer life of the tube.

Next, the flat tubes for the heat exchanger according to a second embodiment of the present invention will be described by referring to Fig. 5. In Fig. 5, arrow marks indicate the direction of circulating air.

The flat tube 2 for the heat exchanger according to this embodiment is provided with four rows of the beads like the case of the preceding embodiment but differs in the arrangement of the beads. That is, the recesses resulting from the beads are located away from the upstream side of the air flowing upper and lower surfaces of the tube, so that the chances of accumulation of the dust and the like in the recesses can be reduced further.

More particularly, of the four rows of the beads formed in the direction of the width of the tube, i.e., in the direction of air flow, a first and a second beads are made to project upwardly from the lower tube wall, while a third and a fourth beads are made to project downwardly from the upper tube wall. The dust and the like in the air flow are gradually caught by the radiating fins and the like while the air flows along the direction of the width of the tube, so that the accumulation of the dust in the recesses can be prevented by collectively locating the recesses projecting from the lower tube wall as remote as possible from the portion of the tube first facing the air flow. On the other hand, the first and second beads 11B (1) and 11B (2), projecting upwardly from the lower tube wall, and the third and fourth beads 11A (3) and 11A (4), projecting downwardly from the upper tube wall, are formed symmetrically with respect to the right and left respectively along the direction of the width of the tube in order for the tube to avoid the adverse effect on moldability of the tube and deformation of the tube.

Next, the flat tube for the heat exchanger according to a third embodiment of the present invention is described by referring to Fig. 6. In Fig. 6, arrow marks indicate the direction of air flow.

In the case of the flat tube 2 for the heat exchanger according to this embodiment, except the first bead located on the most upstream side of air flow, the second, third and fourth beads respectively constitute beads 13A and beads 13B, respectively projecting inwardly from the outer surface 2A of the upper tube wall and the outer surface 2B of the lower tube wall. The beads 13A and 13B respectively project to substantially a half of the inner height of the flat tube 2. The tops of the beads 13A and the tops of the beads 13B are made to join with one another, thereby forming a plurality of divided passages 12 in the flat tube 2. These beads 13A and 13B serve not only to enhance the heat exchange efficiency by increasing the area of the tube in contact with the medium passing these passages 12 but also to function as reinforcing members to increase the pressure resistance of the tube.

Further, the first bead 11B (1) located on the most upstream side in the direction of the width of the tube projects upwardly from the lower wall of the tube. The amount of projection of this bead 11B (1) is set to be substantially equal to the inner height of the flat tube 2, and the portion of the wall of the flat tube 2 confronting the bead 11B (1) is left flat, but the top of the bead 11B (1) is joined with the inner surface of the opposite wall of the flat tube 2.

In this fashion, the recess resulting from the bead is made to open downwardly on the most upstream side of the air flow, so that the dust can be prevented from accumulating in the recess resulting from the bead 11B (1).

Next, the flat tube for the heat exchanger according to the present invention is described based on a fourth embodiment shown in Fig. 7. The flat tube 2 for the heat exchanger according to this embodiment differs from the preceding embodiment in that the tube is formed by extruding an aluminum material. The inside of the tube is provided with partitions 15 to divide the passage in the direction of width of the tube, forming a plurality of divided passages 12. The flat tube 2 obtained by such an extrusion molding is provided with recesses on its outer surface not only for increasing its surface area but also for reducing its weight, which eventually result in the decrease in the quantity of material to be used and resulting reduction of manufacturing cost.

More particularly, the flat tube 2 obtained by the extrusion molding is provided with grooves 14A and 14B, each having a concave cross section, on the outer surface 2A of the upper wall and the outer surface 2B of the lower wall. These grooves 14A and 14B, similar to the case of the preceding embodiment, are not only provided alternately on the surfaces 2A and 2B of the upper wall and lower the tube walls but also arranged so that the accumulation of the dust can be reduced. Further, in

the case of this embodiment, four rows of grooves 14A, 14B are provided alternately on the outer surface 2A of the upper wall and the outer surface 2B of the lower tube wall, a first groove 14B (1) being formed on the outer surface 2B of the lower tube wall and a second groove 14A (2) being formed on the outer surface 2A of the upper tube wall, a third groove 14B (3) being formed on the outer surface 2B of the lower tube wall, and a fourth groove 14A (4) being formed on the outer surface 2A of the upper tube wall.

As described above, the first groove 14B (1) is formed on the outer surface 2B of the lower wall in the vicinity of the portion of the tube facing the air flow, so that the accumulation of the dust in a concave 14b resulting from the groove 14B (1) can be prevented. Thus, even in the case of such flat tube obtained by the extrusion molding and provided with the grooves for reducing the manufacturing cost and weight too, it is possible to improve the corrosion resistance for longer life of the heat exchanger 1.

Further, in this embodiment, the present invention is applied to the flat tube provided with four rows of beads or grooves and five passages for the heat exchange medium provided within the tube, but the application of the present invention is not limited to the case of this embodiment and thus applicable to any other cases where any number of beads or grooves are formed.

Further, in this embodiment, the intervals between the rows of the beads or grooves arranged in the direction of the width of the tube are equalized, but such intervals may be partially differentiated to any degree. Further, all the beads may be made to project upwardly from the lower wall of the tube, as long as such arrangement will not adversely affect the strength of the tube.

Further, in this embodiment, the beads are formed in succession in the direction of the width of the tube, but the beads may be formed intermittently or irregularly, or each of the beads may be formed with a gap provided at predetermined places for communicating with the adjacent passages within the tube.

Further, in this embodiment, the flat tube is formed by bending a sheet of plate, but this embodiment is not limited to the method of this embodiment. The tube may be formed by joining two sheets of plates, and the tube may be provided with the beads at predetermined locations in the manner similar to the case of the tube formed from the single plate.

Description of the Reference Numerals

- 1 Laminated type heat exchanger
- 2 Flat tube
- 2A Upper surface of tube
- 2B Lower surface of tube
- 2a Joined portion
- 2b Joined portion
- 3 Inlet-side header pipe

- 3a Inlet joint
- 4 Outlet-side header pipe
- 4a Outlet joint
- 5 Corrugated fin
- 6 Blank cap
- 7 Partition
- 8 Side plate
- 9 Tube insertion hole
- 11A Bead of upper tube wall
- 11a Recess of upper tube wall resulting from the bead of upper tube wall
- 11B Bead of lower tube wall
- 11b Recess of lower tube wall resulting from the bead of lower tube wall
- 12 Divided inside passages of tube
- 13A Bead of upper tube wall
- 13B Bead of lower tube wall
- 14A Outside groove of the upper tube wall
- 14a Outside recess resulting from the groove of upper tube wall
- 14B Outside groove of lower tube wall
- 14b Outside recess resulting from the groove of lower tube wall
- 15 Partition
- 20 Flat tube
- 20a Joined portion
- 20b Joined portion
- 21 Bead
- 21A Bead of upper tube wall
- 21B Bead of lower tube wall
- 22 Divided inside passages of tube
- x Dust

Claims

1. Tubes for a heat exchanger, each tube being formed by bending a single sheet of plate or by joining two sheets of plates, characterized in that
 - the tube is formed with a plurality of beads each having a concave cross section, the tops of beads are joined with the surface of an opposite tube wall to form a plurality of divided passages in the tube, and
 - at least one bead located on the most upstream side of an air flow projects upwardly from the lower tube wall.
2. Tubes for a heat exchanger according to Claim 1, wherein the tops of said beads are joined with the opposite flat surface of the tube wall or the tops of the beads formed on the opposite tube wall, the bead located on the most upstream side of the air flow is formed on the lower tube wall, and the beads located on the downstream side of the air flow are formed projecting inwardly and alternately from the upper and lower tube walls.

3. Tubes for a heat exchanger, each tube being formed from an aluminum or an aluminum alloy material by an extrusion molding, characterized in that

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the outer surface of each tube is formed with a plurality of grooves each having a concave cross section, each tube is provided with partitions to laterally divide the inside of the tube into a plurality of internal passages, and at least one groove located on the most upstream side of an air flow is formed underside the lower tube wall.

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FIG. 2

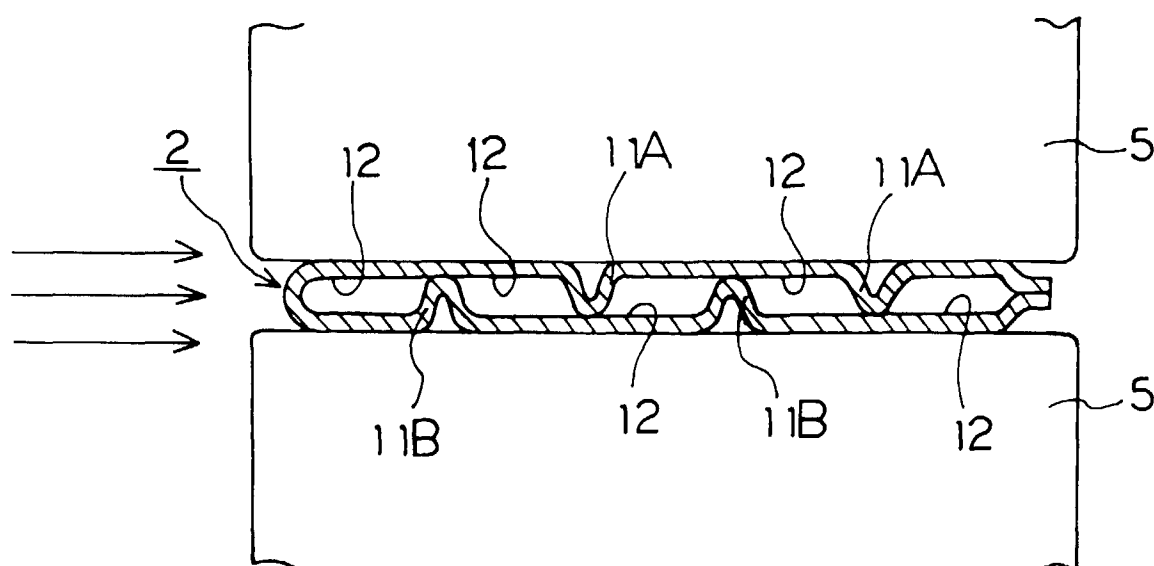


FIG. 3

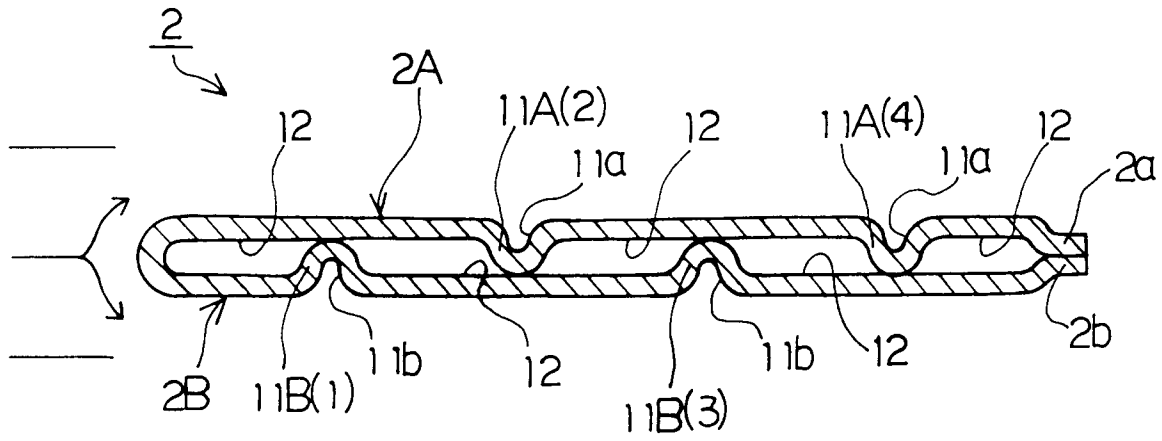


FIG. 4

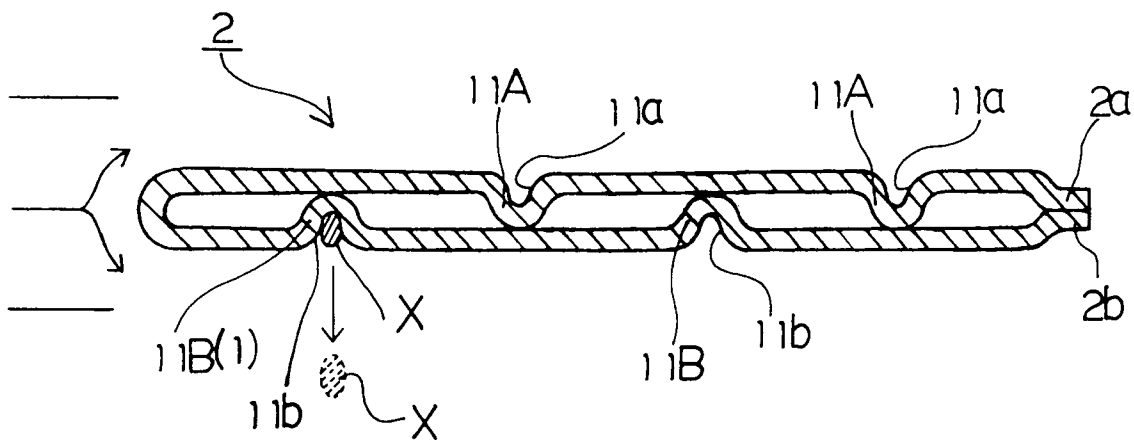


FIG. 5

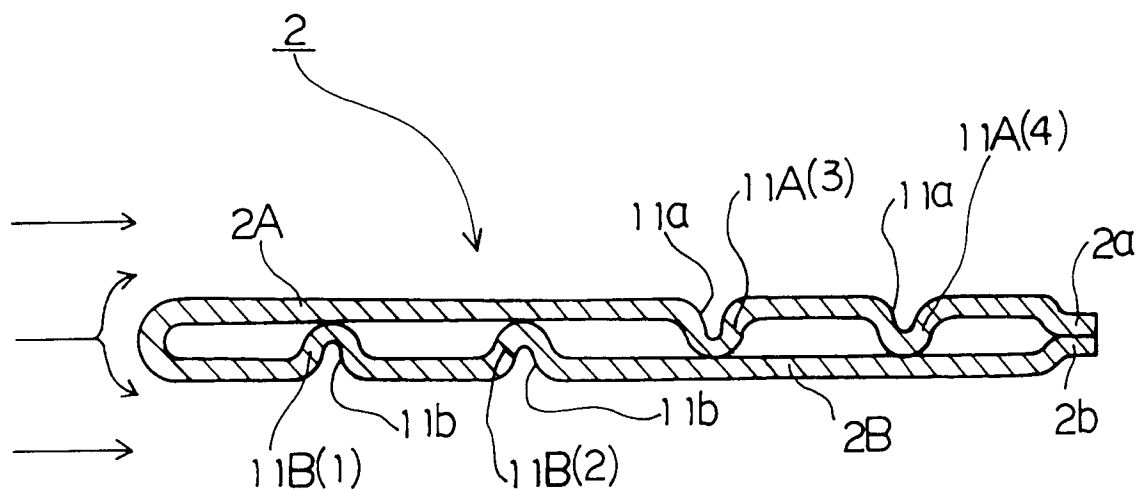


FIG. 6

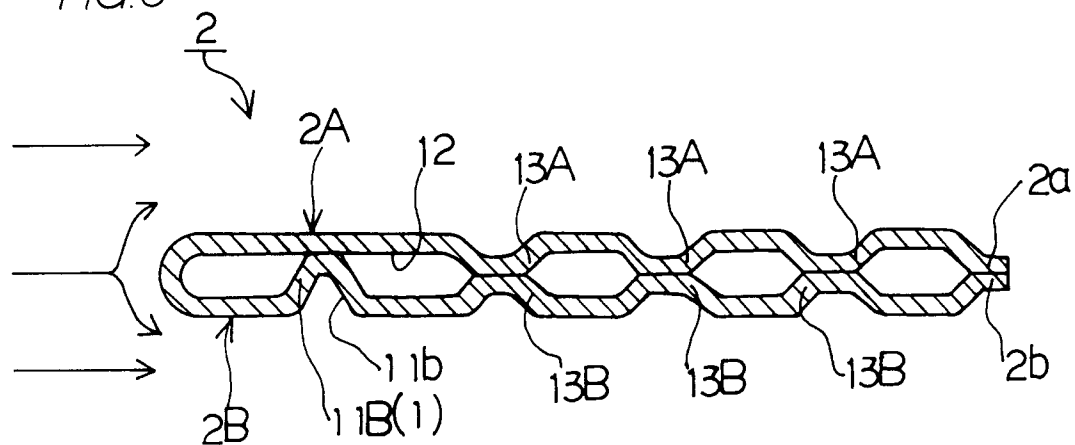


FIG. 7

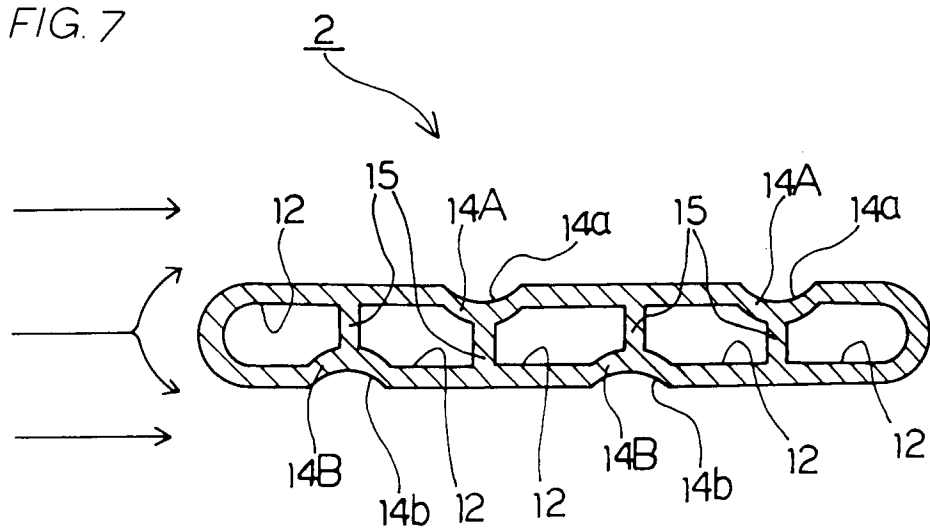


FIG. 8

