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(71) Applicant: **Mitsubishi Electric Corporation**
Chiyoda-ku
Tokyo 100-8310 (JP)

(72) Inventor: **BABA Toshimichi**
Tokyo 100-8310 (JP)

(74) Representative: **Sajda, Wolf E.**
Meissner Bolte Patentanwälte
Rechtsanwälte Partnerschaft mbB
Postfach 86 06 24
81633 München (DE)

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(54) **HEAT EXCHANGER**

(57) A fin (2) has a U-form cutaway portion (21a) into which a flat tube (1) is fitted and a fin collar (22) standing inclined from an edge portion of the cutaway portion (21a), and an opened end width W2 of the cutaway portion (21a) is formed to be larger than an outer width W1 of the flat tube (1).

Also, the fin collar (22) has a fin collar inclined face portion (22a) standing inclined with respect to a fin flat face from the edge portion of the cutaway portion (21a), and a fin collar end face portion (22b) bent from an end portion of the fin collar inclined face portion (22a) and in surface contact with an outer face of the flat tube (1).

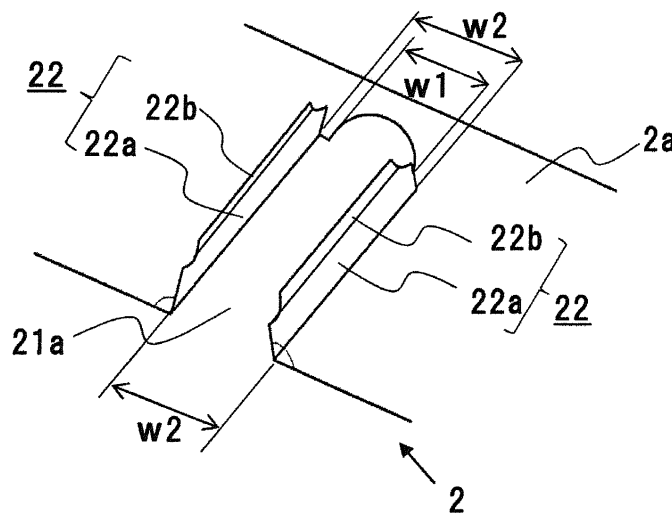


FIG.2

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Description

Technical Field

[0001] The present invention relates to a fin-and-tube heat exchanger in which a flat tube is used.

Background Art

[0002] An existing fin-and-tube heat exchanger in which a flat tube is used is manufactured using a manufacturing device such that a position of a flat tube is regulated by the flat tube being fitted between restraining pins, fins are held in a mounting drum that carries out a rotary movement, and the fins are sequentially mounted in the flat tube while the mounting drum is rotated (for example, refer to Patent Document 1).

Citation List

Patent Literature

[0003] Patent Document 1: JP-A-2013-59847

Summary of the Invention

Technical Problem

[0004] The heat exchanger disclosed in Patent Document 1 is such that a force is exerted whereby the flat tube attempts to push apart a closed end portion of a U-form cutaway portion for fitting the fin into the flat tube. Because of this, there is a problem in that when the restraining pins regulating the position of the flat tube are removed, the fin becomes deformed, and warping occurs in a step direction of the flat tube, of which a multiple are disposed.

[0005] Further, when warping in the step direction of the flat tube increases at a manufacturing stage of mounting the fin in the flat tube, there is a case in which the fin can no longer be inserted into the flat tube. When the heat exchanger manufacturing device is operated in a state in which the fin cannot be inserted into the flat tube, there is concern that a problem such as a fin mounting plate and the flat tube colliding will occur, and the manufacturing device will stop due to damage.

[0006] The invention, having been contrived in order to resolve the heretofore described kind of problem, has an object of employing a cutaway portion form such that a force that attempts to push apart a closed end of a fin cutaway portion when fitting the fin into a flat tube can be restricted, reducing warping in a step direction of the flat tube, and preventing damage to the flat tube and a fin mounting plate.

Solution to the Problem

[0007] A heat exchanger according to the invention in-

cludes a multiple of a flat tube that forms a passage of a heat conducting medium and whose cross-section is of a flat form, and a multiple of a fin, fixed to the flat tube, whose main flat face is perpendicular to a passage direction of the flat tube, and which is disposed at intervals in the passage direction, wherein the fin has a cutaway portion into which the flat tube is fitted and a fin collar standing erect from an edge portion of the cutaway portion, an opened end of the cutaway portion is larger than an outer width of the flat tube, and the fin collar has a fin collar inclined face portion standing inclined with respect to a fin flat face from the edge portion of the cutaway portion, and a fin collar end face portion bent from an end portion of the fin collar inclined face portion and in surface contact with an outer face of the flat tube.

Advantageous Effects of the Invention

[0008] According to the heat exchanger of the invention, an opened end of a cutaway portion is larger than an outer width of a flat tube, because of which deformation of a fin when fitting the fin on the flat tube can be restricted, and as a fin collar end face portion of a fin collar is in surface contact with an outer face of the flat tube, the fin and the flat tube can be fixed, and thermal conductivity between the two can be secured.

Brief Description of the Drawings

[0009]

FIG. 1 is a perspective view of a heat exchanger of the invention.

FIG. 2 is a perspective view showing a form of a cutaway portion of a fin of a heat exchanger of a first embodiment of the invention.

FIG. 3 is a schematic configuration diagram of a manufacturing device of the heat exchanger of the invention.

FIG. 4 is a perspective view showing a flat tube restraining portion used in manufacturing the heat exchanger of the invention.

FIG. 5 is a side sectional view showing assembly of the fin on the flat tube of the heat exchanger of the first embodiment of the invention.

FIG. 6A and FIG. 6B are sectional views showing a form of a cutaway portion of the fin of the heat exchanger of the first embodiment of the invention.

FIG. 7A and FIG. 7B are diagrams showing a form of a cutaway portion of the fin of the heat exchanger according to a second embodiment of the invention, wherein FIG. 7A is a perspective view, and FIG. 7B is a side sectional view showing assembly of the fin on the flat tube.

FIG. 8 is a side sectional view showing assembly of the fin on the flat tube of the heat exchanger of a third embodiment of the invention.

FIG. 9 is a reference perspective view showing a fin

cutaway portion form necessary for a description of the invention.

FIG. 10 is a reference perspective view showing fin warping necessary for a description of the invention. FIG. 11A, FIG. 11B, and FIG. 11C are perspective views showing a form of a cutaway portion of the fin of the heat exchanger according to a fourth embodiment of the invention.

Description of Embodiments

First Embodiment

[0010] A heat exchanger of a first embodiment of the invention will be described, using FIG. 1 to FIG. 6.

[0011] FIG. 1 is a perspective view showing a heat exchanger 100, manufactured using a manufacturing method and a manufacturing device to which the invention is applied, and in which a flat tube 1 whose cross-section is formed to be flat is used. In FIG. 1, the heat exchanger 100 is a fin-and-tube heat exchanger in which the flat tube 1 is used, is formed of the flat tube 1 and a fin 2, and is in a state wherein the flat tube 1 is fitted into a cutaway portion 21a provided in the fin 2, and the flat tube 1 and the fin 2 are joined together in this fitting portion.

[0012] The fin 2 is of a flat plate form, and a multiple thereof are mounted in parallel at constant intervals in a longitudinal direction of the flat tube 1, that is, a passage direction of a heat conducting medium. The flat tube 1 is such that a cross-section perpendicular to the passage direction is of a flat form, a multiple thereof are disposed in parallel with outer peripheral planes (outer faces) of neighboring flat tubes 1 opposing each other, and a fluid forming a heat conducting medium, such as water or a refrigerant, flows through an interior of each flat tube 1.

[0013] FIG. 2 is a perspective view showing a form of the cutaway portion 21a of the fin 2 configuring the heat exchanger 100 of the invention. A multiple of the cutaway portion 21a are provided at predetermined intervals along an edge in a longitudinal direction of the fin 2, but one cutaway portion 21a is formed so as to form a slit of a width (an opened end width W2) greater than a width (an outer width W1) of the flat tube 1, as shown in FIG. 2.

[0014] An opened form of the cutaway portion 21a is a U-form, and in a state in which the fin 2 and the flat tube 1 are fitted, one semi-circular end portion of the flat tube 1 is fitted into a semi-circular portion (an R portion) forming a closed end of the cutaway portion 21a.

[0015] Also, a slit (not shown) is formed in each of flat portions 2a segregated by the cutaway portion 21a.

[0016] Further, a fin collar 22 for joining the flat tube 1 and the fin 2 closely is formed standing erect along an edge portion of each cutaway portion 21a on the same surface side of the fin 2.

[0017] The fin collar 22 and the slit (not shown) are formed protruding in the same direction with respect to the surface of the fin 2.

[0018] In this way, the fin 2 of the first embodiment of the invention has the cutaway portion 21a in which the flat tube 1 is fitted, and the fin collar 22 standing erect from the edge portion of the cutaway portion 21a toward the outer face of the flat tube 1, and the opened end width W2 of the cutaway portion 21a is offset so as to extend from the semi-circular portion of the closed end of the cutaway portion 21a, in order to be greater than the outer width W1 of the flat tube 1.

[0019] The fin collar 22 has a fin collar inclined face portion 22a standing inclined with respect to a fin plane from the edge portion of the cutaway portion 21a, and a fin collar end face portion 22b bending from an end portion of the fin collar inclined face portion 22a and in surface contact with the outer face of the flat tube 1.

[0020] Because of this, an edge portion of the fin collar 22 of the fin 2 is not in a state of being in contact with the outer face of the flat tube 1, even when in a state of being fitted with the flat tube 1.

[0021] Fixing of the flat tube 1 and the fin 2 is carried out by joining the outer face of the flat tube 1 and the fin collar end face portion 22b of the fin 2, and thermal conductivity can be secured by the two being in surface contact.

[0022] Herein, the fin collar inclined face portion 22a of the fin 2 is formed in a state extending from two parallel linear edge portions extending from the opened end to the closed end of the U-form cutaway portion 21a, and standing erect opposing the outer face of the flat tube 1 at an angle of less than 90° with respect to the flat portion 2a of the fin 2. At this time, as shown in FIG. 2, an angle formed by an extended face of the flat portion 2a of the fin 2 and a lower face of the fin collar inclined face portion 22a is less than 90°. From another point of view, an angle formed by an upper face of the flat portion 2a of the fin 2 and an upper face of the fin collar inclined face portion 22a is an angle greater than 90° (an obtuse angle).

[0023] Also, as previously described, a fluid such as water or a refrigerant is caused to flow through the interior of the flat tube 1, but owing to the cross-section being of a flat form, an amount of the fluid such as water or a refrigerant can be increased without causing an increase in ventilation resistance in comparison with a circular tube. Because of this, performance as the heat exchanger 100 can be improved. That is, when compared as having the same performance, the heat exchanger 100 in which the flat tube 1 is used has an advantage in that size can be reduced in comparison with an existing heat exchanger in which a circular tube is used.

[0024] As shown in FIG. 1, the fin 2 is disposed straddling the multiple of flat tubes 1 disposed in parallel, with a main flat face perpendicular to the passage direction of the flat tube 1, at intervals in the passage direction, and by the flat tube 1 being individually mounted in each cutaway portion 21a, the fin 2 is mounted on the outer peripheral faces and the outer faces of the multiple of flat tubes 1. A direction in which the flat tubes 1 are arrayed, perpendicular to the passage direction of the flat tube 1,

is taken to be a step direction of the flat tube 1.

[0025] As shown in FIG. 1, the step direction in which the multiple of flat tubes 1 are disposed in parallel and the direction in which the multiple of cutaway portions 21a of the fin 2 are disposed are the same, and it goes without saying that pitches at which the flat tubes 1 and the cutaway portions 21a are disposed in the heretofore described direction are the same.

[0026] Further, as shown in FIG. 1, a multiple of fins 2 formed in the same form are mounted at predetermined intervals on the outer peripheral faces of the multiple of flat tubes 1, and in a state in which the heat exchanger 100 is operating, the atmosphere is cooled by the fluid flowing inside each flat tube 1 absorbing heat from the atmosphere via the flat tube 1 and the multiple of fins 2, and conversely, the atmosphere is warmed by the fluid radiating heat.

[0027] FIG. 3 is a schematic view showing the manufacturing device of the heat exchanger 100 to which the invention is applied. A method of manufacturing the heat exchanger 100 using the manufacturing device of FIG. 3 is a method whereby the multiple of fins 2 are mounted at predetermined intervals in the passage direction (length direction) of the flat tube 1 on the outer peripheral face of the flat tube 1, through whose interior the fluid forming the heat conducting medium is caused to flow, and includes a movement function of relatively moving the fin 2 to be mounted on the flat tube 1 and the flat tube 1 in the length direction of the flat tube 1, a fin mounting function of mounting the fins 2 one-by-one on the flat tube 1, and a flat tube restraining function for fixing the position in a width direction of the flat tube 1 when executing fin mounting using the fin mounting function.

[0028] Manufacture of the heat exchanger 100 is such that before assembling the fin 2, a number of the flat tubes 1 set in accordance with a required cooling and heating performance are disposed in parallel at predetermined intervals. Further, the fin-and-tube is manufactured by all of the multiple of flat tubes 1 disposed in parallel being restrained using the flat tube restraining function, and a necessary number of fins 2 being mounted at predetermined intervals on the restrained flat tubes 1 using the fin mounting function.

[0029] The fin mounting function will be described in detail using FIG. 3. A drum 122 configuring the manufacturing device rotates at a predetermined speed around an axis center X in a direction of an arrow A, that is, in a clockwise direction in FIG. 3. A most appropriate source, such as a servo motor, is selected as a rotational drive source. A multiple (eight in FIG. 3) of fin mounting plates 121 disposed at predetermined intervals in a circumferential direction of the drum 122 are provided in a peripheral edge portion of the drum 122. Each of the fin mounting plates 121 carries out a circular movement centered on the axis X in accompaniment to the rotation of the drum 122.

[0030] The drum 122 repeatedly pauses operation every one-eighth of a rotation, that is, at a pitch of 45°.

At this time, a most appropriate value is selected as the rotation speed. The fin mounting plate 121 that, for example, reaches an uppermost portion forming an apex portion of the drum 122 in accompaniment to the rotation of the drum 122 receives and holds one fin 2 supplied from a separate mechanism (not shown). For example, vacuum suctioning that suctions the fin 2 utilizing an intake of air is employed for the holding of the fin 2 by the fin mounting plate 121.

[0031] The fin mounting plate 121 holding the fin 2 rotates in the direction of the arrow A around the axis X, and stops in a position perpendicular with respect to the flat tube 1 in a lower portion of (directly below) the drum 122, owing to the drum 122 performing one-half of a rotation.

[0032] Subsequently, by the fin 2 held by vacuum suctioning being released from the fin mounting plate 121 by vacuum breaking, the fin 2 can be mounted on the outer peripheral face of the flat tube 1.

[0033] Next, the fin mounting plate 121 that releases the fin 2 rotates owing to the drum 122 rotating further, but it is necessary here that the fin mounting plate 121 operates so as not to interfere with the fin 2 mounted on the flat tube 1. For the purpose of this operation, a cam follower 124 is attached to the fin mounting plate 121. Furthermore, a cam (not shown) is disposed in a rotational center portion of the drum 122. By the cam follower 124 following the cam in accompaniment to the drum 122 rotating, the position of the fin mounting plate 121 is controlled, and a configuration such that the fin mounting plate 121 does not interfere with the fin 2 can be adopted.

[0034] Next, the movement function of the flat tube 1 will be described in detail. A kind of flat tube restraining portion 300 shown in FIG. 4 is used to hold the multiple of flat tubes 1. FIG. 4 is a perspective view showing the flat tube restraining portion 300 having the flat tube restraining function, which is one portion of the manufacturing device of the heat exchanger 100 to which the invention is applied. A base plate 302 forms a base of the flat tube restraining portion 300, and the flat tube 1 is held between restraining pins 301 erected on the base plate 302 so that a major axial direction of the cross-section of the flat tube 1 is vertical.

[0035] Further, the flat tube restraining portion 300 is moved a predetermined distance in a direction of an arrow B at a predetermined speed in order to move a position on the flat tube 1 in which the fin 2 is to be mounted with respect to a fin mounting position directly below the direction of rotation of the drum 122 as shown in FIG. 3.

[0036] A most appropriate source, such as a servo motor, is selected as a drive source of the flat tube restraining portion 300. Further, as the distance of movement in the B direction changes depending on product specifications, a most appropriate value is selected together with movement speed, and can easily be changed on an operating panel with which the device is operated. It goes without saying that the flat tube 1 may be fixed, and the drum 122 moved in a direction opposite to that of the

arrow B.

[0037] In FIG. 4, the flat tube restraining portion 300 is configured of a multiple of the restraining pins 301, and the base plate 302, in which are provided holes (not shown in the drawing) for fixing the restraining pins 301 at equal pitches. The multiple of restraining pins 301 are fixed by one portion thereof being mounted in holes provided in rows in each of one side portion and another side portion of a surface of the base plate 302. Two each of the restraining pins 301 neighboring in the one side portion and the other side portion of the surface of the base plate 302 regulate a horizontal direction position of the flat tube 1 on the surface of the base plate 302.

[0038] Because of this, the multiple of flat tubes 1 are arranged at equal pitches in the width direction of the flat tube 1. The flat tube restraining function is such that, while the heretofore described kind of fin mounting operation is being carried out, movement is carried out by the movement function while the flat tube 1 is constantly restrained (in contact). That is, the restraining pin 301 and the flat tube 1 are in a state of being in contact. Therefore, a material with excellent abrasion resistance is selected for the restraining pin 301.

[0039] The flat tube restraining portion 300 shown in FIG. 4 is such that an interval between restraining pins 301 positioned on either side of one flat tube 1 is set to be slightly wider than the width of the flat tube 1, and attachment to and detachment from the multiple of flat tubes 1 of the flat tube restraining portion 300, and movement thereof, is easily carried out.

[0040] Herein, a case in which the restraining pins 301 are disposed in two rows, and the pins positioned on either side of the multiple of flat tubes 1 are set so as to be in the same row, is shown in the example of FIG. 4, but the restraining pins 301 may also be arrayed in three or more rows so as to lock three or more places in the passage direction of the flat tube 1. Also, rather than the restraining pins positioned on either side of the multiple of flat tubes 1 forming one row, the restraining pins can also be arrayed in, for example, a zigzag so as to form a staggered form. Also, an article such as a bearing, which rotates in the direction in which the flat tube 1 operates owing to the movement function, may be chosen and used instead of the restraining pin 301.

[0041] After the fin 2 has been mounted on the flat tube 1 by the manufacturing device of FIG. 3, the flat tube 1 moves a predetermined distance owing to the movement function, and the next fin 2 is mounted on the flat tube 1 using the fin mounting function again. By this cycle (the cycle of the fin 2 being mounted on the flat tube 1 and the flat tube 1 being moved) being carried out continuously a predetermined number of times, the heat exchanger 100 wherein the multiple of fins 2 are mounted at, for example, equal intervals on the flat tube 1 can be manufactured.

[0042] Next, FIG. 5 shows a side sectional view of the heat exchanger 100 before the fin 2 is mounted on the flat tube 1, and after mounting the fin 2. FIG. 5 is a diagram

showing the assembly of the fin 2 on the flat tube 1 of the heat exchanger 100. Before the fin mounting, the fin 2 is such that the edge portion of the cutaway portion 21a is not of a structure to be pressed against the outer face of the flat tube 1, as shown in an upper view of FIG. 5.

[0043] Because of this, even when the fin 2 is mounted on the flat tube 1, a force that attempts to push apart the closed end of the cutaway portion 21a of the fin 2, as shown in a lower view of FIG. 5, is unlikely to be exerted. Because of this, warping in the longitudinal direction of the fin 2, and inclination of the flat tube 1 caused by the warping, are unlikely to occur in the heat exchanger 100.

[0044] Consequently, even when retracting the flat tube restraining portion 300, and removing the flat tube restraining portion 300 from the heat exchanger 100 being manufactured, in a step of sequentially mounting the fins 2 on the flat tube 1 in the manufacturing process of the heat exchanger 100, the fin mounting plate 121 and the flat tube 1 no longer interfere, because of which the fin 2 can be mounted as far as a fin mounting terminus portion of the flat tube 1, thereby completing the heat exchanger 100.

[0045] Next, using FIG. 6A and FIG. 6B, a modified example of the cutaway portion 21a of the fin 2 will be described. FIG. 6A and FIG. 6B are sectional views of the fin 2 in the passage direction of the flat tube 1 and a width direction of the opened end of the cutaway portion 21a.

[0046] As heretofore described, the fin collar 22 includes the fin collar inclined face portion 22a, but the fin collar inclined face portion 22a can be a fin collar inclined face portion 22aa formed of a flat face, as shown in FIG. 6A, and other than this, can also be a fin collar inclined face portion 22ab formed of a curved face, as shown in FIG. 6B. The fin collar inclined face portion 22ab of the curved face form of FIG. 6B is such that a direction of protrusion is the cutaway portion 21a side, but it goes without saying that the form can be changed and used, such as by adopting a curved face form that protrudes on the opposite side.

[0047] As shown in FIG. 6A and FIG. 6B, the fin collar inclined face portions 22aa and 22ab are formed bent at an angle of less than 90° with respect to the extended face of the flat portion 2a of the fin 2 from the edge portion of the cutaway portion 21a, and end portions of the fin collar inclined face portions 22aa and 22ab are in surface contact with the outer face of the flat tube 1.

[0048] Further, the fin collar end face portion 22b is formed, bent further, in the end portions of the fin collar inclined face portions 22aa and 22ab, and a flat face of the fin collar end face portion 22b is in a state of being in surface contact with the outer face of the flat tube 1. Therefore, a state wherein the fin collar end face portion 22b is joined with the flat tube 1 over a sufficient area can be obtained, whereby a heat exchanging performance of the heat exchanger 100 can be improved.

[0049] Herein, a perspective view of a fin 200 that forms a comparative example is shown in FIG. 9 for a compar-

ison with the first embodiment of the invention. As shown in FIG. 9, a narrow cutaway portion 210 whose opened end is of a width smaller than an outer width of the flat tube 1 is provided in the fin 200 that forms the comparative example.

[0050] The fin 200 is such that a width W3 of the opened end of the narrow cutaway portion 210 is formed to be slightly smaller than the width W1 of the flat tube 1, and furthermore, a fin collar 220 is formed so as to stand erect perpendicular to a flat face portion 200a from an edge portion of the narrow cutaway portion 210, because of which positional deviation when the fin 2 is assembled on the flat tube 1 can be restricted.

[0051] Next, FIG. 10 shows a sectional view of a case in which the fin 200 of FIG. 9 is mounted on the flat tube 1. As shown in an upper view of FIG. 10, no deformation such as warping is apparent at a stage before the fin 200 is mounted on the flat tube 1.

[0052] As shown in a middle view of FIG. 10, when the fin 200 is fitted on the flat tube 1, the edge portion of the narrow cutaway portion 210 presses the outer face of the flat tube 1, and a force that attempts to push apart a closed end of the narrow cutaway portion 210 is exerted, but as a state is such that the flat tube 1 is held in the unshown flat tube restraining portion 300, the force is restricted by the restraining pin 301, and no deformation is apparent in the fin 200 at this stage.

[0053] However, at a stage at which the flat tube 1 is removed from the flat tube restraining portion 300, the width of the opened end of the narrow cutaway portion 210 increases, and warping occurs in a longitudinal direction of the fin 200, as shown in a lower view of FIG. 10.

[0054] The force that attempts to push apart the narrow cutaway portion 210 acts more strongly the nearer the outer side of the heat exchanger 100, as there is nothing to counteract the force, the nearer the flat tube 1 is to the outer side, the more the flat tube 1 inclines, and a change occurs in the parallel disposition of the flat tubes 1.

[0055] The comparative example shown in FIG. 9 and FIG. 10 is such that after the fin mounting, unnecessary stress caused by the form of the narrow cutaway portion 210 is generated between the fitted flat tube 1 and fin 200, but the heat exchanger 100 according to the first embodiment of the invention is such that the opened end width W2 of the form of the cutaway portion 21a is set to be greater than the width W1 of the flat tube 1, whereby a generation of unnecessary stress is restricted, and manufacturing performance can be improved.

[0056] Furthermore, the heat exchanger 100 according to the first embodiment of the invention is of a configuration such that the flat face of the fin collar end face portion 22b and the outer face of the flat tube 1 are provided so as to be parallel, and these faces are in surface contact with each other, because of which the two can be fixed and thermal conductivity can be secured.

Second Embodiment

[0057] FIG. 7A and FIG. 7B are schematic views showing the heat exchanger 100 according to a second embodiment of the invention, wherein FIG. 7A is a perspective view showing a form of a cutaway portion 21b of the fin 2, and FIG. 7B is a side sectional view showing a state of assembling the fin 2 on the flat tube 1.

[0058] A case in which the width W2 of the opened end of the cutaway portion 21a is greater than the width W1 of the closed end, and the two linear edge portions of the cutaway portion 21a, which is of a U-form, are parallel, is shown as an example in the first embodiment, but the cutaway portion 21b of the fin 2 according to the second embodiment, as shown in FIG. 7A, is such that the width W2 of an opened end of the cutaway portion 21b is greater than the width W1 of a closed end equivalent to a diameter of a U-form semi-circular form, and two linear edge portions of the cutaway portion 21b are positioned one each on non-parallel lines that connect the opened end and the closed end. An aperture width of the cutaway portion 21b is in a state of being formed to be greater the nearer to the opened end, and smaller the nearer to the closed end.

[0059] Also, as the aperture of the cutaway portion 21b is formed to be greater the nearer to the opened end, as shown in FIG. 7A, a distance between the edge portion of the cutaway portion 21b and the outer face of the flat tube 1 is also greater the nearer to the opened end. Because of this, a form of a fin collar 23 also changes in accompaniment to this, and is such that an upright width of a fin collar inclined face portion 23a is greater the nearer to the opened end of the cutaway portion 21b, and the upright width of the fin collar inclined face portion 23a is smaller the nearer to the closed end of the cutaway portion 21b.

[0060] Forming a fin collar end face portion 23b bent from an end portion of the fin collar inclined face portion 23a is the same as forming the fin collar end face portion 22b of the first embodiment.

[0061] With regard to the size of the upright width of the fin collar inclined face portion 23a, however, an example such that the upright width is greater the nearer to the opened end of the cutaway portion 21b, and smaller the nearer to the closed end, is shown in FIG. 7A, but an upright dimension (width) of the fin collar end face portion 23b can be regulated so as to be the same dimension, regardless of the depth of the cutaway portion 21b, at a stage of manufacturing the fin 2 using press molding. Also, as a modified example of the fin collar end face portion 23b, it goes without saying that joint area can be earned by the dimension (width) nearer the closed end of the cutaway portion 21b being increased.

[0062] As heretofore described, the form of the cutaway portion 21b of the fin 2 need not necessarily be of the kind of constant width (W2) shown in FIG. 2, but may be the kind of form shown in FIG. 7A wherein the opened end width W2 is greater than the width W1 of the flat tube

1, and by adopting this kind of form, a generation of a force that attempts to push apart the closed end side of the cutaway portion 21b when mounting the fin 2 can be restricted, and the same advantages as in the first embodiment can be obtained. Also, a load exerted when the fin 2 is mounted on the flat tube 1 can be reduced.

[0063] Further, a state wherein the flat tube 1 and the fin 2 are joined with no gap is obtained in a position near the closed end of the cutaway portion 21b, whereby good contact between the flat tube 1 and the fin collar 23 after the fin 2 is mounted on the flat tube 1 can be secured.

Third Embodiment

[0064] FIG. 8 is a schematic view showing the heat exchanger 100 according to a third embodiment of the invention, and is a side sectional view showing a state of assembling the fin 2 on the flat tube 1 when cutaway portions of a multiple of forms are used in combination in one fin 2.

[0065] An example wherein the multiple of cutaway portions 21a or 21b formed in the fin 2 are all of the same form is shown in the first embodiment or the second embodiment. However, a multiple of cutaway portions formed in one fin 2 need not all be of the same form. Cutaway portions of differing forms can be used in combination.

[0066] For example, the fin 2 formed employing two kinds of cutaway portion of differing aperture widths, wherein the narrow cutaway portion 210 shown as a comparative example of the first embodiment and the cutaway portion 21b shown in the second embodiment are disposed alternately, can be used, as shown in FIG. 8. It goes without saying that by the narrow cutaway portion 210 and the cutaway portion 21b being disposed alternately, the advantages of both can be included.

[0067] Not being limited to this, three or more kinds of cutaway portion may be provided in the fin 2, and the most appropriate kinds may be selected and employed. Furthermore, with regard to the distribution of cutaway portions in one fin 2, the distribution need not necessarily be of a form such that differing kinds of cutaway portion are disposed alternately. For example, it goes without saying that the cutaway portion form can be changed every two cutaway portions, or cutaway portion forms can be distinguished between depending on a mounting region.

[0068] The cutaway portions 21a and 21b of the fin 2 shown in the first embodiment and the second embodiment are such that although a force that attempts to push apart the closed end side of the fin 2 is no longer generated, there is a tendency for contact force between the flat tube 1 and the fin 2 to decrease.

[0069] Therefore, in order to supplement the contact force between the flat tube 1 and the fin 2, one portion of the multiple of cutaway portions are replaced in the fin 2 with the narrow cutaway portion 210 of the width W3 slightly smaller than the width W1 of the flat tube 1, as

shown in FIG. 8, whereby the contact force with the flat tube 1 is increased, and positional deviation of the flat tube 1 and the fin 2 can be restricted.

[0070] Also, as shown in FIG. 1, the heat exchanger 100 is such that a large number of fins 2 are mounted on the flat tube 1. In the first and second embodiments, it is envisaged that the necessary number of fins 2 of the same form are prepared and sequentially assembled on the flat tube 1, but the fins 2 mounted in one heat exchanger 100 can also be such that a multiple of kinds of fin 2 of differing cutaway portion forms are used in combination.

[0071] For example, the heat exchanger 100 can also be formed by a necessary number of the fin 2 in which only the cutaway portion 21a is provided shown in FIG. 2 of the first embodiment, the fin 2 in which only the cutaway portion 21b is provided shown in FIG. 7A of the second embodiment, and the fin 2 in which the two forms of the narrow cutaway portion 210 and 21b are alternately disposed, shown in the side sectional view of FIG. 8, being sequentially assembled on the flat tube 1. The kind of fin 2 and the order of assembly on the flat tube 1 can be variously changed by varying the order of supplying the fin 2 to the manufacturing device.

Fourth Embodiment

[0072] FIG. 11A, FIG. 11B, and FIG. 11C are each perspective views of the fin 2 according to a fourth embodiment of the invention, and are diagrams showing forms of cutaway portions 21c, 21d, and 21e.

[0073] An example wherein the fin collars 22 and 23 are provided with line symmetry across a central line passing through a closed end apex of the cutaway portion 21a or the cutaway portion 21b, and left and right fin collar forms are the same, is shown in the first embodiment and the second embodiment. In the fourth embodiment, a case in which fin collars standing erect from left and right edge portions of the cutaway portions 21c, 21d, and 21e are of differing forms will be described.

[0074] As shown in FIG. 11A, the fin collar 22 is formed on a left side edge portion of the cutaway portion 21c of the fin 2, and the fin collar 23 is formed on a right side edge portion.

[0075] The cutaway portion 21c of the fin 2 shown in FIG. 11A is such that an opened end is larger than a closed end (a semi-circular portion), and of the two linear edge portions of the cutaway portion 21c to be fitted with a main flat face of the flat tube 1, the edge portion on the side on which the fin collar 22 is formed is positioned on a line parallel to the main flat face of the flat tube 1, and the edge portion on the side on which the other fin collar 23 is formed is positioned on a line connecting the opened end and the closed end of the cutaway portion 21c.

[0076] A broken line extending from a point at which the opened end of the cutaway portion 21c and the fin collar 23 come into contact indicates a line parallel to the edge portion of the fin collar 22. An aperture width W4

of the closed end side is offset in a direction spreading from the semicircular portion (width W1) end portion of the closed end of the cutaway portion 21c, and is formed to be greater than the outer width W1 of the flat tube 1 by the offset amount. Further, the opened end width W2 of the cutaway portion 21c is such that the aperture width is greater still than the aperture width W4 of the closed end side by an amount equivalent to the spread of the fin collar 23.

[0077] The structure of the fin 2 shown in FIG. 11A is such that the fin collars 22 and 23 including the fin collar inclined face portions 22a and 23a and the fin collar end face portions 22b and 23b are disposed on the left and right of the cutaway portion 21c, because of which deformation of the fin 2 on the left and right of the cutaway portion 21c when assembling on the flat tube 1 is restricted, and the fin 2 and the flat tube 1 can be stably fixed.

[0078] Of two linear edge portions of a cutaway portion of the fin 2 in which the flat tube 1 is to be fitted, the fin collar 22 of the first embodiment is formed on a left side edge portion, and a fin collar 220 of an existing structure is formed on a right side edge portion, as shown in FIG. 11B.

[0079] The fin 2 including the fin collar 22 is such that an opened end of the cutaway portion 21d is larger than a closed end, the fin collars 22 and 220 standing erect one from each of the two linear edge portions of the cutaway portion 21d are of differing forms, the edge portion on the side on which the fin collar 22 is formed is positioned on a line connecting a position offset in a direction in which the cutaway portion 21d spreads from a closed end semi-circular portion and the opened end, the edge portion on the side on which the fin collar 220 is formed is positioned on a line connecting the opened end and the closed end, and the two are disposed in parallel.

[0080] The cutaway portion 21d is such that an opened end width and the aperture width W4 on the closed end side are of the same dimension, which is greater than the width W1 of the closed end (the semi-circular portion).

[0081] Furthermore, a structure such that the fin collar 23 of the second embodiment is formed on a left side edge portion of the cutaway portion 21e of the fin 2, and the fin collar 220 is formed on a right side edge portion, can also be adopted, as shown in FIG. 11C. The opened end width W4 of the cutaway portion 21e is greater than the closed end width W1 by an amount equivalent to a spread of the fin collar 23.

[0082] It goes without saying that the cutaway portions 21c, 21d, and 21e of the fin 2 shown in FIG. 11A, FIG. 11B, and FIG. 11C are such that the fin collars can be interchanged left and right without problem.

[0083] By the forms of the cutaway portions 21c, 21d, and 21e of the fin 2 shown in FIG. 11A, FIG. 11B, and FIG. 11C being employed, generation of a force that attempts to push apart the closed end sides of the cutaway portions 21c, 21d, and 21e can be restricted, and the fin 2 can be stably fixed to the flat tube 1, in the same way as in the first embodiment and the second embodiment.

[0084] Also, it goes without saying that the cutaway portions 21c, 21d, and 21e shown in FIG. 11A, FIG. 11B, and FIG. 11C can be formed in an arbitrary order in the fin 2, in the same way as in the third embodiment.

[0085] The embodiments of the invention can be freely combined, and each embodiment can be modified or abbreviated as appropriate, without departing from the scope of the invention.

Claims

1. A heat exchanger, comprising:

- a multiple of a flat tube that forms a passage of a heat conducting medium and whose cross-section is of a flat form; and
- a multiple of a fin, fixed to the flat tube, whose main flat face is perpendicular to a passage direction of the flat tube, and which is disposed at intervals in the passage direction,
- wherein the fin has a cutaway portion into which the flat tube is fitted and a fin collar standing erect from an edge portion of the cutaway portion, an opened end of the cutaway portion is larger than an outer width of the flat tube, and
- wherein the fin collar has a fin collar inclined face portion standing inclined with respect to a fin flat face from the edge portion of the cutaway portion, and a fin collar end face portion bent from an end portion of the fin collar inclined face portion and in surface contact with an outer face of the flat tube.

2. The heat exchanger according to claim 1, wherein an aperture form of the cutaway portion is U-form, one semi-circular end portion of the flat tube is fitted into a semi-circular portion forming a closed end of the cutaway portion, and wherein the fin collar inclined face portion extends from two linear edge portions reaching from the opened end to the closed end of the cutaway portion, and stands erect facing the outer face of the flat tube at an angle of less than 90° with respect to the fin flat face.

3. The heat exchanger according to claim 2, wherein the opened end of the cutaway portion is larger than the closed end, and the two linear edge portions of the cutaway portion are parallel.

4. The heat exchanger according to claim 2, wherein the opened end of the cutaway portion is larger than the closed end, and each of the two linear edge portions of the cutaway portion is positioned on a line connecting the opened end and the closed end.

5. The heat exchanger according to any one of claim 1 to 4,
wherein the fin collar inclined face portion and the fin collar end face portion are both flat faces. 5
6. The heat exchanger according to any one of claim 1 to 4,
wherein the fin collar inclined face portion is a curved face, and the fin collar end face portion is a flat face. 10
7. The heat exchanger according to any one of claim 1 to 6,
wherein the fin has a narrow cutaway portion whose opened end is smaller than the outer width of the flat tube in addition to the cutaway portion. 15
8. The heat exchanger according to claim 7,
wherein the cutaway portion and the narrow cutaway portion are alternately disposed in an end portion of the fin. 20
9. The heat exchanger according to claim 2,
wherein the opened end of the cutaway portion is larger than the closed end, fin collars standing erect from each of the two linear edge portions of the cutaway portion are of differing forms, one of the edge portions is positioned on a line parallel to the main flat face of the flat tube, and the other of the edge portions is positioned on a line connecting the opened end and the closed end. 25
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10. The heat exchanger according to claim 2,
wherein the opened end of the cutaway portion is larger than the closed end, fin collars standing erect from each of the two linear edge portions of the cutaway portion are of differing forms, one of the edge portions is positioned on a line connecting a position offset in a direction in which the cutaway portion spreads from the closed end and the opened end, and the other of the edge portions is positioned on a line connecting the opened end and the closed end. 35
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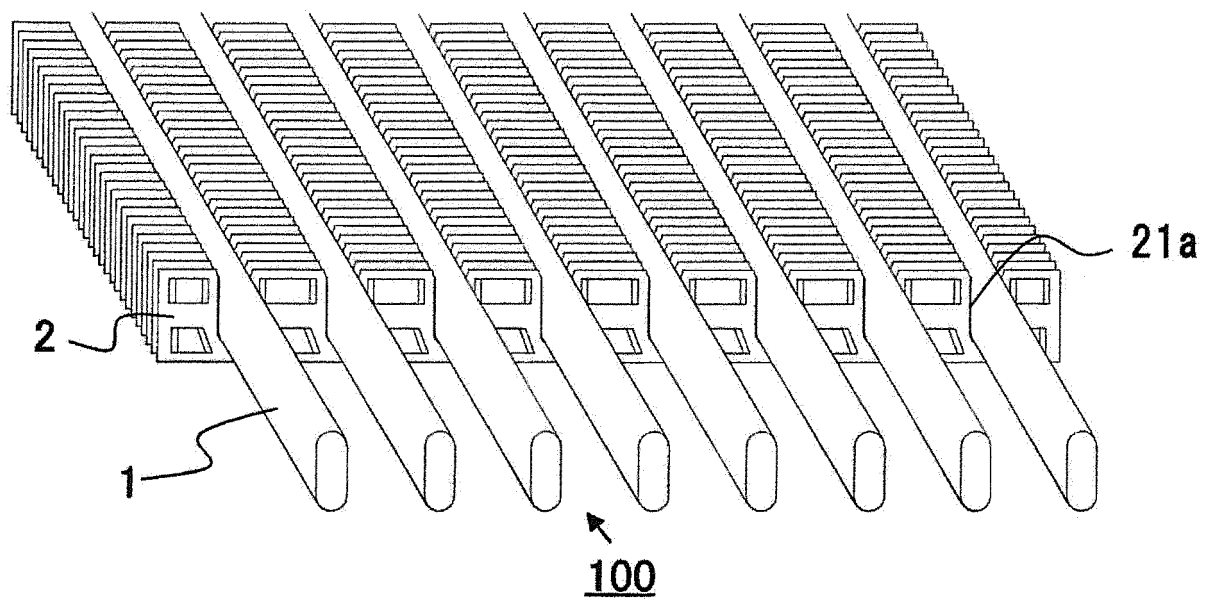


FIG. 1

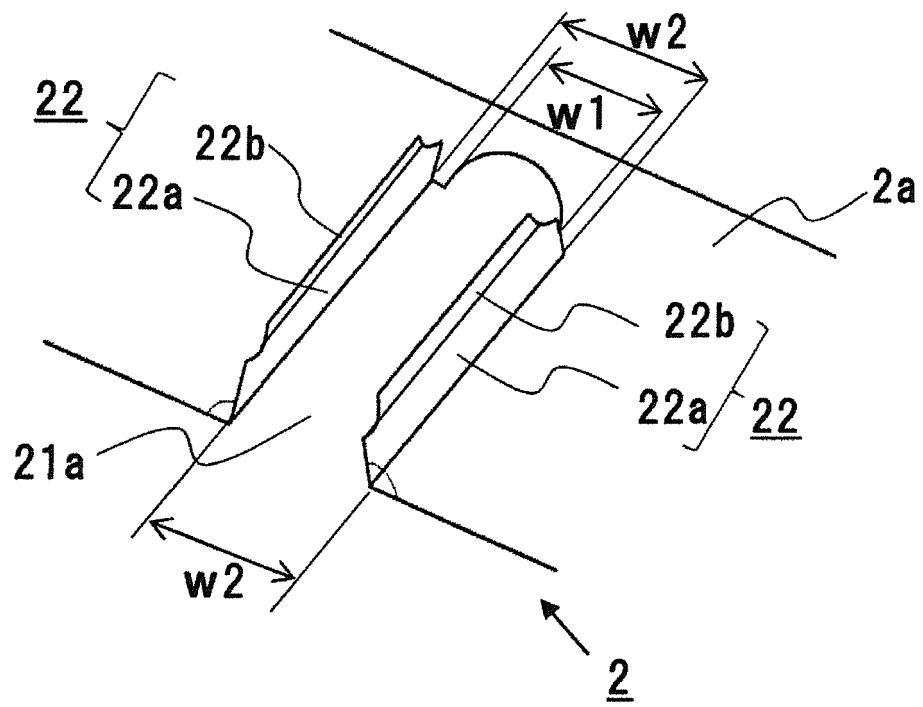


FIG.2

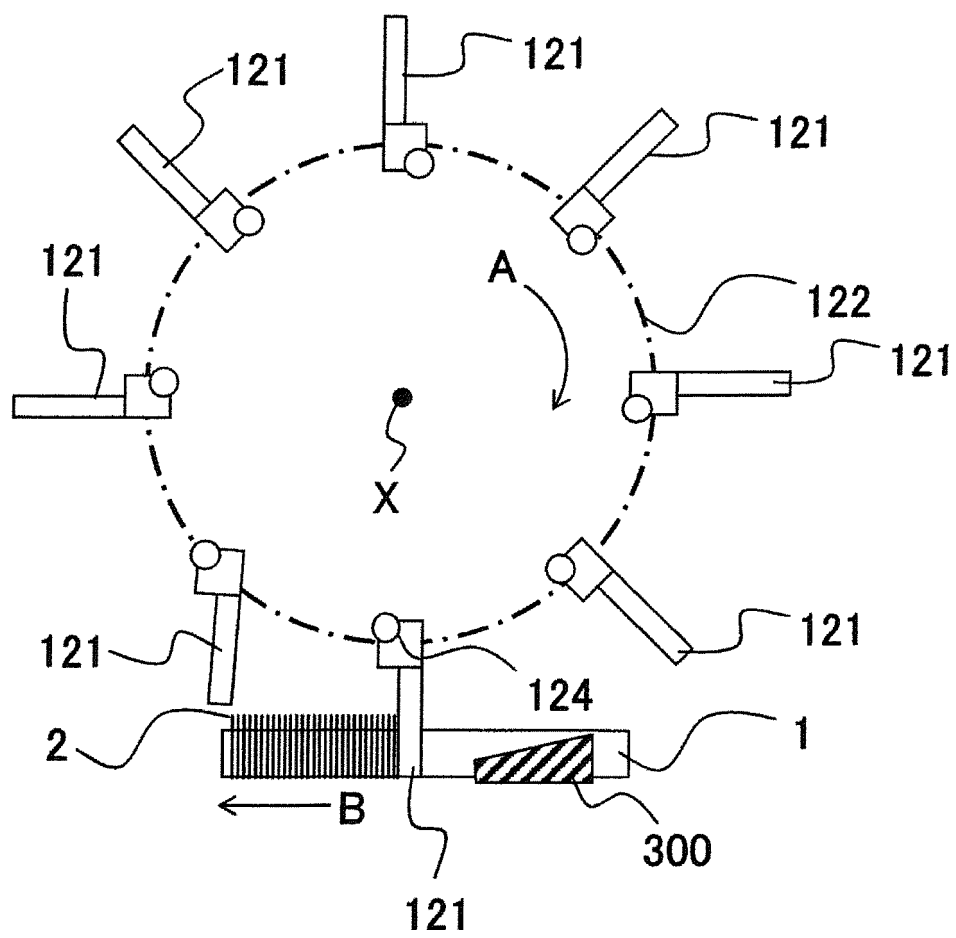


FIG.3

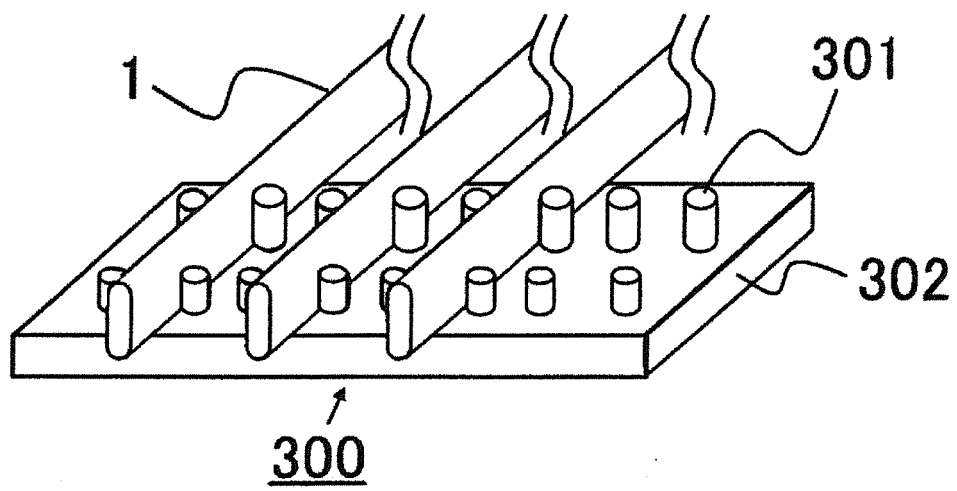


FIG. 4

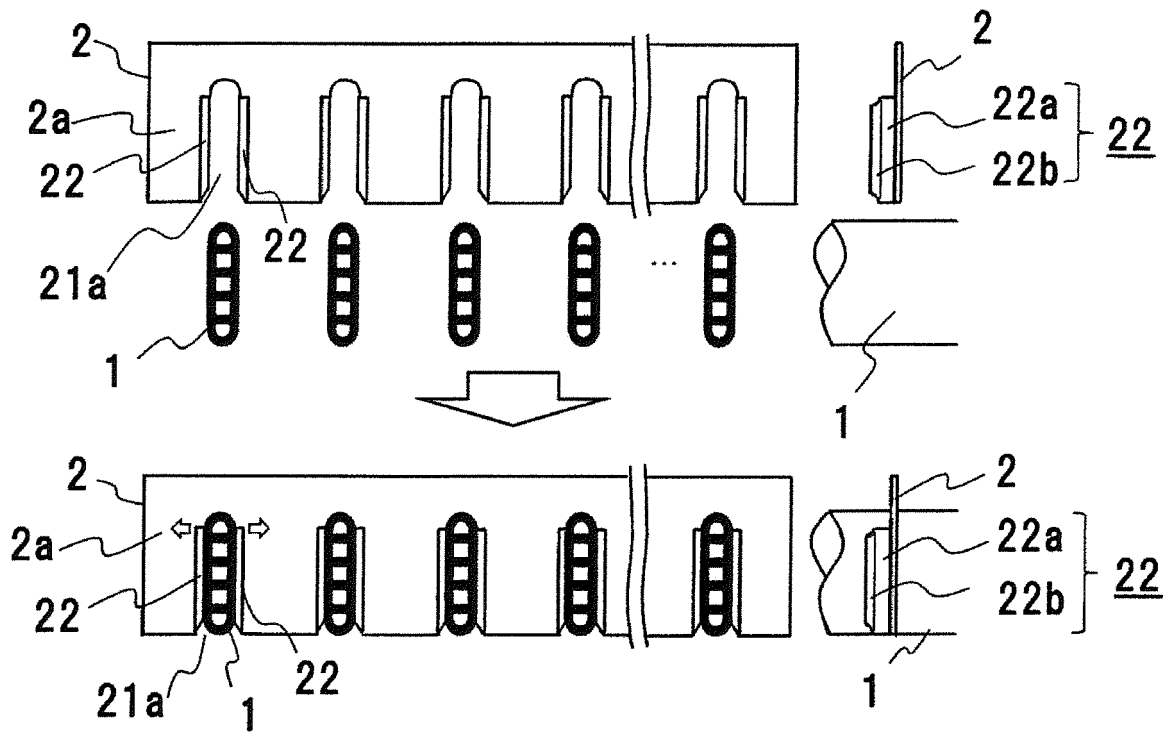


FIG.5

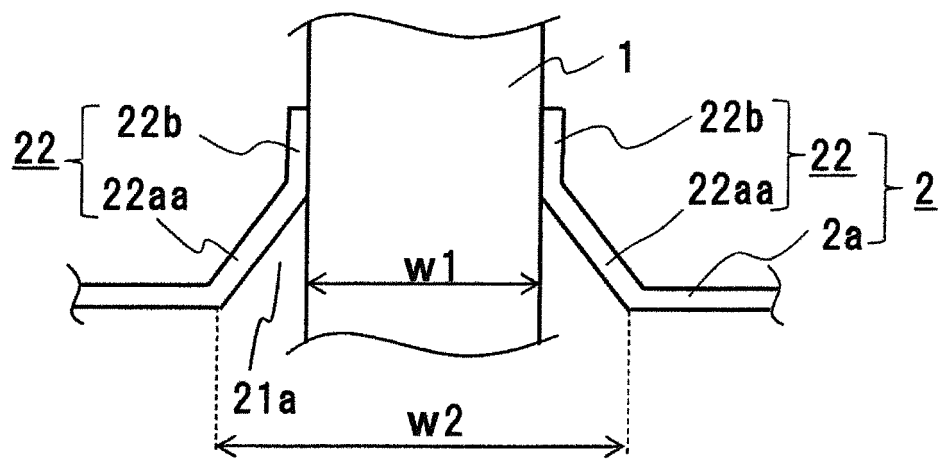


FIG.6A

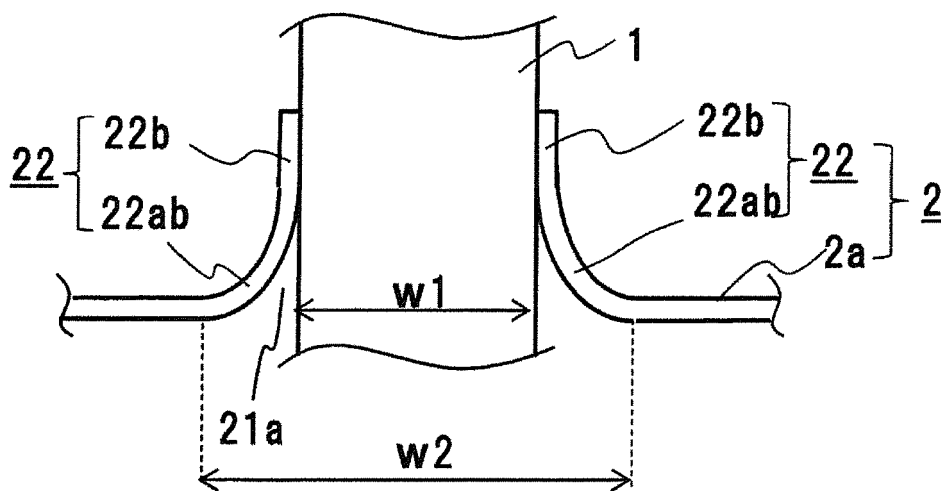


FIG.6B

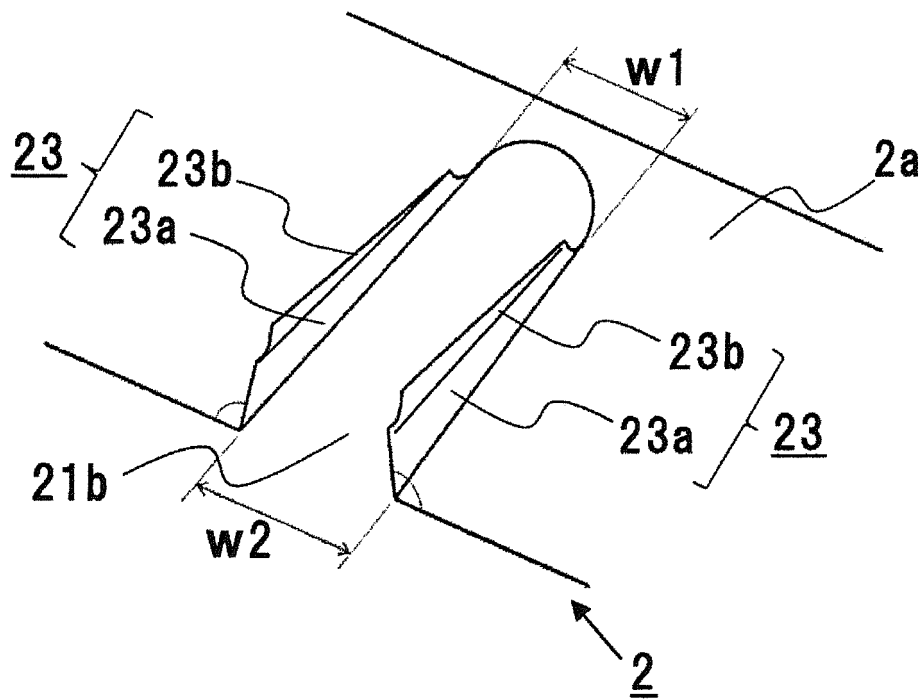


FIG.7A

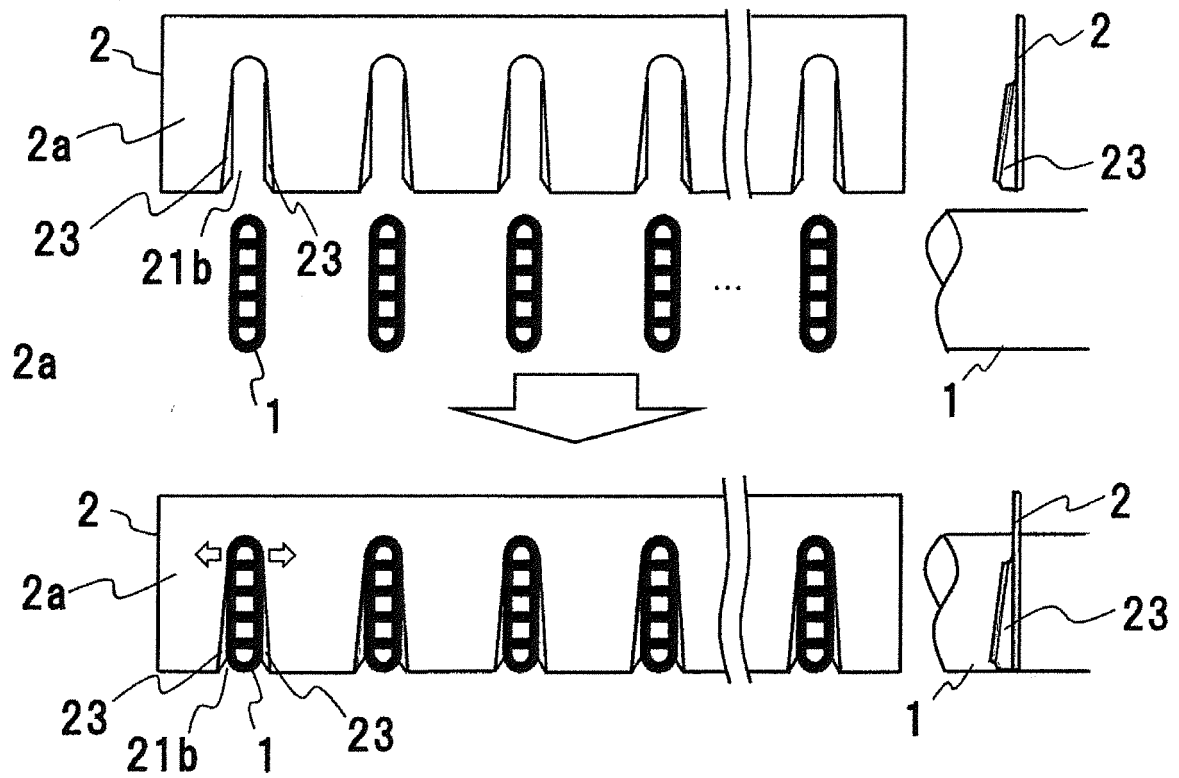


FIG.7B

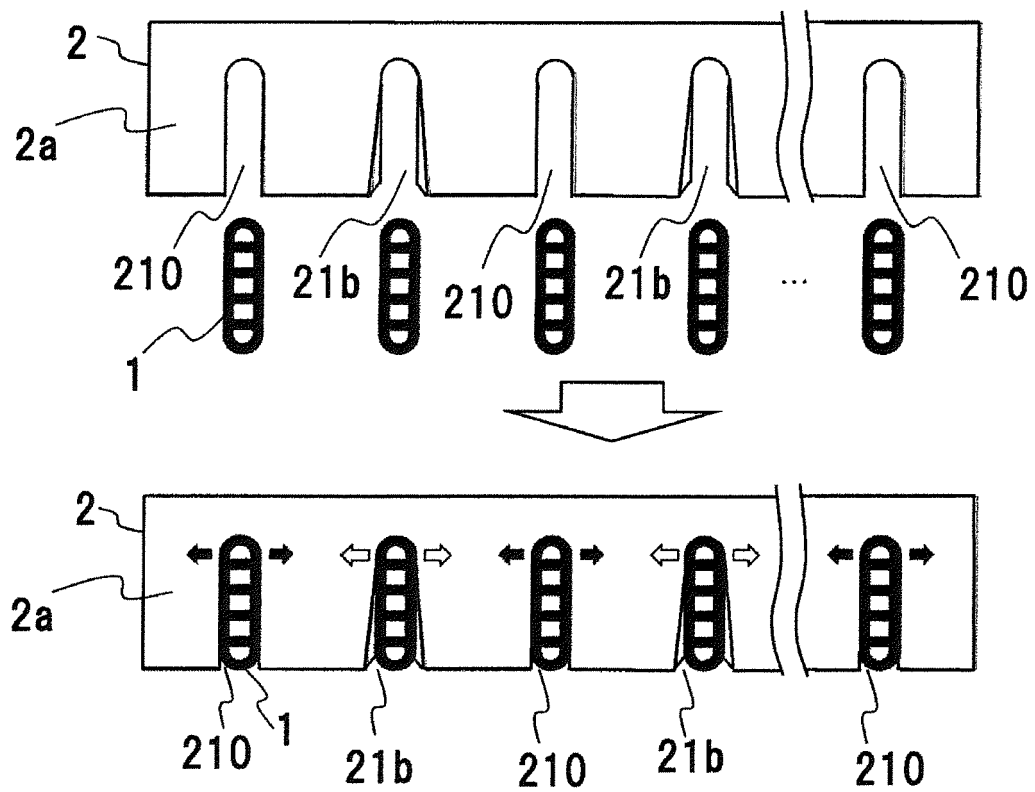


FIG.8

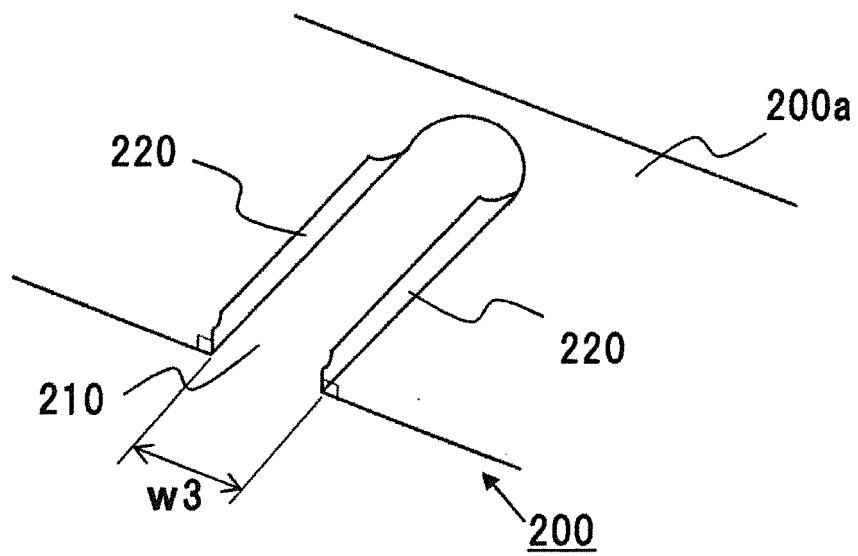


FIG.9

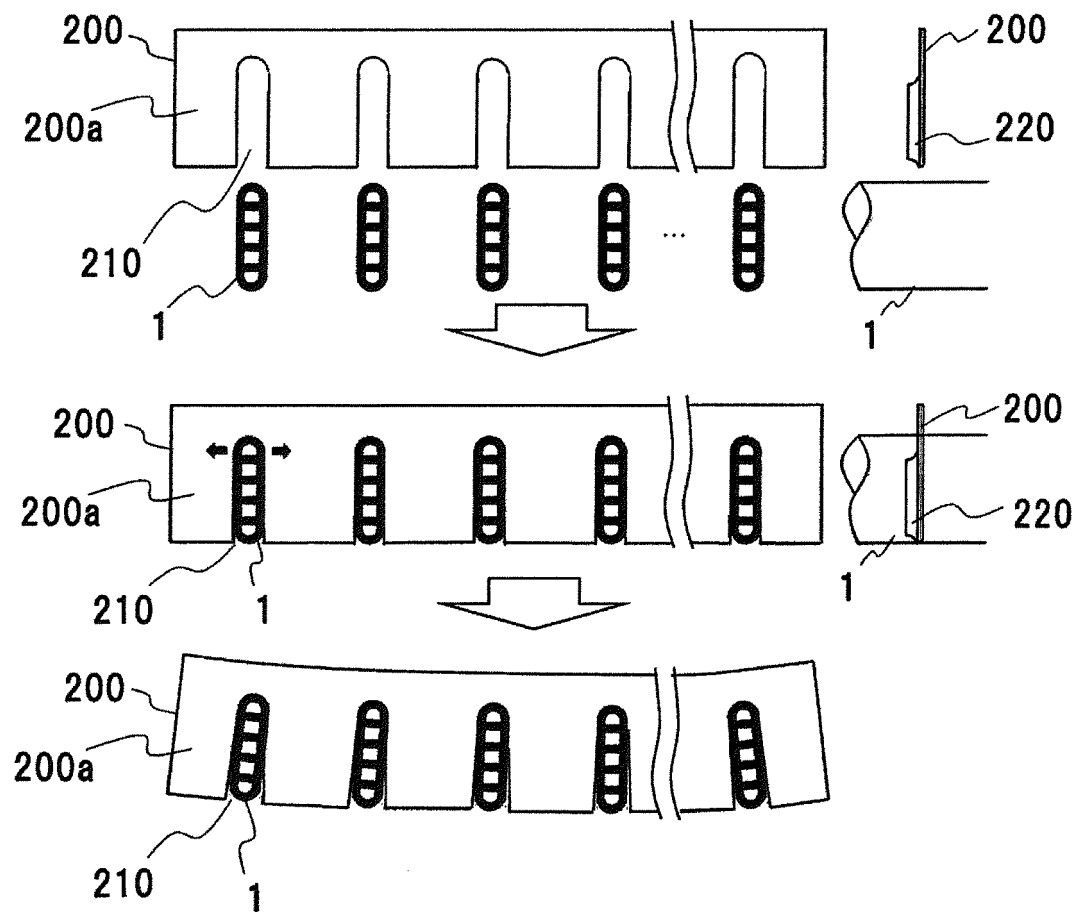


FIG.10

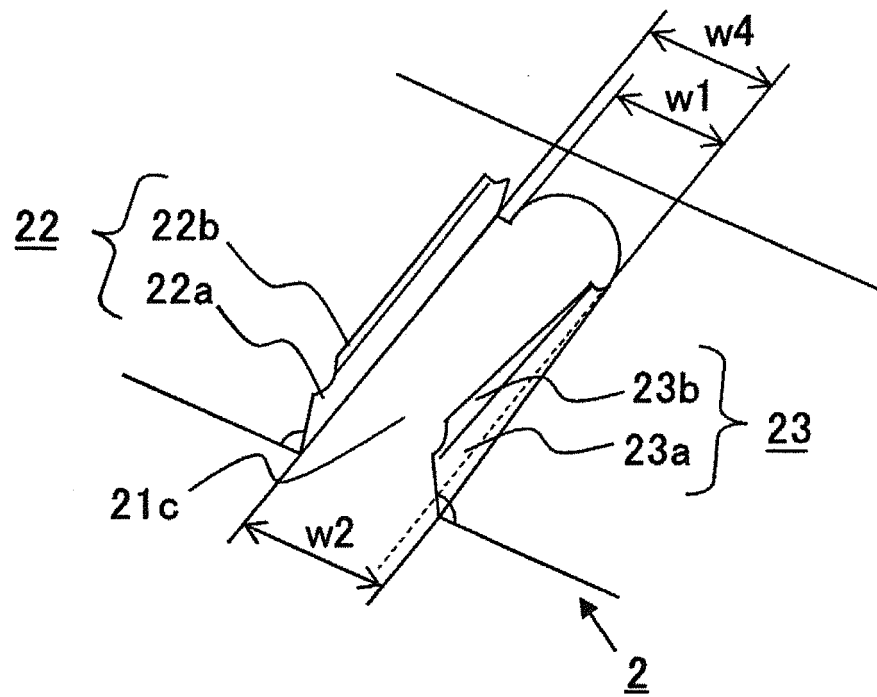


FIG.11A

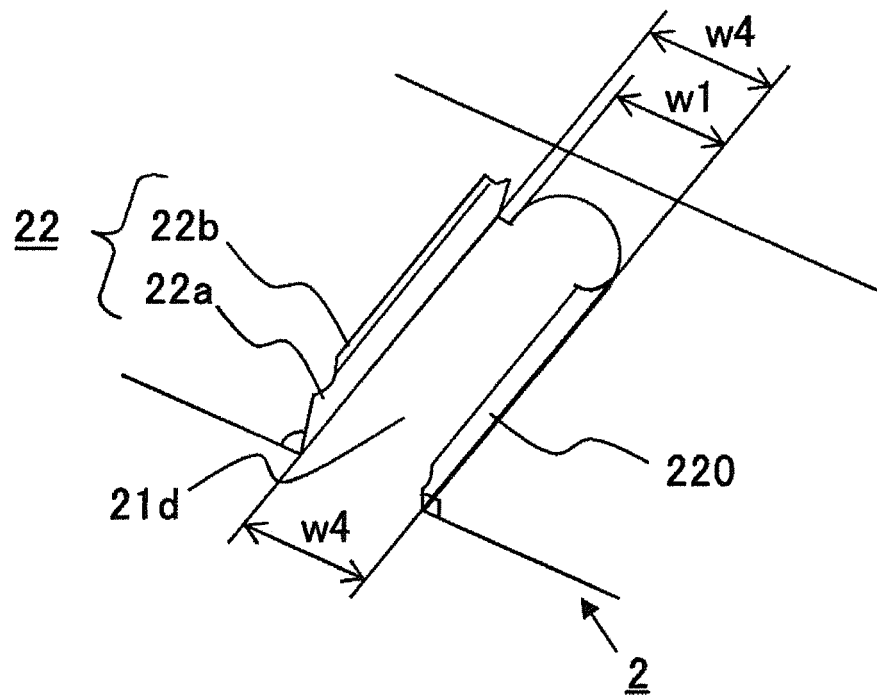


FIG.11B

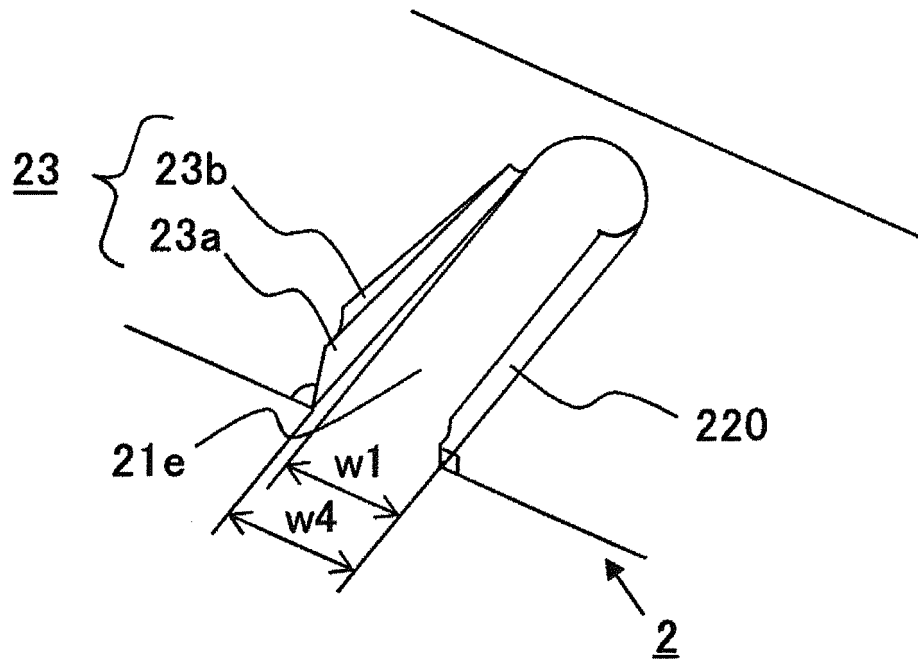


FIG.11C

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/003941

A. CLASSIFICATION OF SUBJECT MATTER

F28F1/32(2006.01)i, F28F1/02(2006.01)i

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)

F28F1/32, F28F1/02

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

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 A	JP 2011-127867 A (Mitsubishi Electric Corp.), 30 June 2011 (30.06.2011), paragraphs [0012], [0048], [0061] to [0067]; fig. 9 to 12 (Family: none)	1, 5-6 2-4, 7-10
A	JP 53-96556 A (Hitachi, Ltd.), 23 August 1978 (23.08.1978), fig. 4 (Family: none)	1-10
A	JP 2014-238204 A (Mitsubishi Electric Corp.), 18 December 2014 (18.12.2014), entire text; all drawings (Family: none)	1-10

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

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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
12 April 2017 (12.04.17)Date of mailing of the international search report
25 April 2017 (25.04.17)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/003941

C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2012-154498 A (Daikin Industries, Ltd.), 16 August 2012 (16.08.2012), entire text; all drawings (Family: none)	1-10
A	JP 2-169177 A (Matsushita Refrigeration Co.), 29 June 1990 (29.06.1990), entire text; all drawings (Family: none)	1-10
P, A	JP 2016-102619 A (Fujitsu General Ltd.), 02 June 2016 (02.06.2016), entire text; all drawings (Family: none)	1-10

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2013059847 A [0003]