(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 598 052 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
22.01.2020 Bulletin 2020/04

(21) Application number: **18767788.5**

(22) Date of filing: **12.03.2018**

(51) Int Cl.:
F28F 1/00 *(2006.01)* ***F28D 7/16*** *(2006.01)*
F28F 1/32 *(2006.01)* ***F28F 9/02*** *(2006.01)*

(86) International application number:
PCT/JP2018/009485

(87) International publication number:
WO 2018/168759 (20.09.2018 Gazette 2018/38)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **16.03.2017 JP 2017051290**
28.12.2017 JP 2017253830

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(54) HEAT EXCHANGER HAVING HEAT TRANSFER TUBE UNIT

(57) A heat exchanger (10) includes a heat-transfer-tube unit (30) and a header (21, 22). The heat-transfer-tube unit (30) includes at least one fin (32) and a plurality of heat transfer tubes (31). The heat-transfer-tube unit (30) is connected to the header (21, 22). The fin (32) and the heat transfer tubes (31) are arranged alternately side by side. The plurality of heat transfer tubes (31) each extend in a heat-transfer-tube-extending direction (z). The fin (32) has sides extending in the heat-transfer-tube-extending direction (z) and that are joined to the heat transfer tubes (31). An end (32e) of the fin (32) is positioned nearer to a center of the heat-transfer-tube unit (30) in the heat-transfer-tube-extending direction (z) than ends (31e) of the heat transfer tubes (31). The header (21, 22) has holes (24) for insertion of the ends of the heat transfer tubes (31).

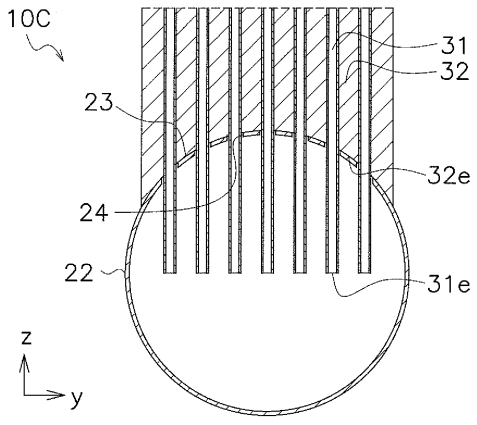

FIG. 9

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Description

TECHNICAL FIELD

[0001] The present invention relates to a heat exchanger including a heat-transfer-tube unit.

BACKGROUND ART

[0002] Some of heat exchangers intended for air conditioners and the like include heat-transfer-tube units each formed as a single member including heat transfer tubes for refrigerant to flow therein and fins for heat exchange. A heat exchanger disclosed by PTL 1 (Japanese Unexamined Patent Application Publication No. 2013-139965) includes a plurality of such heat-transfer-tube units. The plurality of heat-transfer-tube units are connected to a shared header. The connection is simplified by dividing the header into many layers. The heat exchanger is manufactured by alternately stacking the divided header layers and the heat-transfer-tube units. Then, the stack of the divided header layers and the heat-transfer-tube units is brazed in a furnace so that leakage of refrigerant from joints between the divided header layers is prevented.

SUMMARY OF THE INVENTION

<Technical Problem>

[0003] The heat exchanger configured as above with many divided header layers has an increased number of components. Therefore, the process of manufacturing the heat exchanger is complicated.

[0004] An object of the present invention is to provide a heat exchanger that is easy to manufacture.

<Solution to Problem>

[0005] A heat exchanger according to a first aspect of the present invention includes a heat-transfer-tube unit and a header. The heat-transfer-tube unit includes at least one fin and a plurality of heat transfer tubes. The heat-transfer-tube unit is connected to the header. The fin and the heat transfer tubes are arranged alternately side by side. The plurality of heat transfer tubes each extend in a heat-transfer-tube-extending direction. The fin has sides extending in the heat-transfer-tube-extending direction and that are joined to the heat transfer tubes. An end of the fin is positioned nearer to a center of the heat-transfer-tube unit in the heat-transfer-tube-extending direction than ends of the heat transfer tubes. The header has holes for insertion of the ends of the heat transfer tubes.

[0006] In such a configuration, the ends of the heat transfer tubes project from the end of the fin. Therefore, the heat exchanger can be manufactured easily by inserting the projecting portions of the heat transfer tubes into the holes in the header.

[0007] A heat exchanger according to a second aspect of the present invention is the heat exchanger according to the first aspect, in which the header includes a first header and a second header between which the heat-transfer-tube unit is held.

[0008] In such a configuration, the two ends of the heat-transfer-tube unit are fixed to the respective headers. Therefore, the heat exchanger exhibits improved durability against external forces and impacts.

[0009] A heat exchanger according to a third aspect of the present invention is the heat exchanger according to the second aspect, in which the second header is positioned below the first header. The second header has a heat-transfer-tube-unit-connecting surface inclined with respect to a heat-transfer-tube-spacing direction.

[0010] In such a configuration, the heat-transfer-tube-unit-connecting surface of the second header is inclined. Accordingly, dew condensation water running down the heat-transfer-tube unit and reaching the heat-transfer-tube-unit-connecting surface further runs down the second header because of the inclination. Therefore, the heat exchanger exhibits improved drainability.

[0011] A heat exchanger according to a fourth aspect of the present invention is the heat exchanger according to any of the first to third aspects, in which the header is a circular pipe.

[0012] In such a configuration, since the header is a circular pipe, the header is easy to manufacture. Therefore, the heat exchanger can be manufactured more easily.

[0013] A heat exchanger according to a fifth aspect of the present invention is the heat exchanger according to any of the first to fourth aspects, in which the end of the fin is shaped in conformity with a shape of the header in such a manner as to be in contact with the header with the ends of the heat transfer tubes being in the holes.

[0014] In such a configuration, the end of the fin is in contact with the header. Therefore, the heat-transfer-tube unit and the header are connected to each other with improved strength.

[0015] A heat exchanger according to a sixth aspect of the present invention is the heat exchanger according to any of the first to fourth aspects, in which the end of the fin is spaced apart from the header.

[0016] In such a configuration, the occurrence of a phenomenon in which brazing metal moves into a space between the fins by capillarity can be suppressed.

[0017] A heat exchanger according to a seventh aspect of the present invention is the heat exchanger according to the fifth aspect, in which the heat-transfer-tube unit includes stoppers. The stoppers are provided on the heat transfer tubes and between the ends of the heat transfer tubes and the end of the fin. The stoppers are each shaped in such a manner as not to be allowed to pass through the holes in the header.

[0018] In such a configuration, the occurrence of the phenomenon in which the brazing metal moves into the

space between the fins by capillarity can be suppressed further.

[0019] A heat exchanger according to an eighth aspect of the present invention is the heat exchanger according to any of the first to seventh aspects, in which the heat-transfer-tube unit is a single member.

[0020] In such a configuration, the heat-transfer-tube unit is a single member. Therefore, the heat-transfer-tube unit is easy to handle. Accordingly, the heat exchanger is easy to assemble.

[0021] A heat exchanger manufacturing method according to a ninth aspect of the present invention includes forming a heat-transfer-tube unit including a fin and heat transfer tubes; providing a cutout by removing a portion of the fin such that an end of the fin is positioned nearer to a center of the heat-transfer-tube unit in a heat-transfer-tube-extending direction than ends of the heat transfer tubes; providing holes in a header, the holes being provided for insertion of the ends of the heat transfer tubes; inserting the ends of the heat transfer tubes into the respective holes; and brazing the heat-transfer-tube unit and the header to each other.

[0022] In such a method, since the cutout is provided by removing a portion of the fin, the ends of the heat transfer tubes project from the end of the fin. Therefore, the heat exchanger can be manufactured easily by inserting the projecting portions of the heat transfer tubes into the holes in the header.

[0023] A heat exchanger manufacturing method according to a tenth aspect of the present invention is the method according to the ninth aspect, in which the forming the heat-transfer-tube unit includes integrally forming the fin and the heat transfer tubes from a metal material by extrusion molding.

[0024] In such a method, the heat-transfer-tube unit is formed as a single member from a metal material by extrusion molding. Therefore, the heat-transfer-tube unit is easy to handle. Accordingly, the heat exchanger is easy to assemble.

[0025] A heat exchanger manufacturing method according to an eleventh aspect of the present invention is the method according to the ninth or tenth aspect, in which a plurality of portions of the fin are punched off in the providing the cutout.

[0026] In such a method, the plurality of portions are removed by punching. Therefore, the heat exchanger is manufactured efficiently.

[0027] A heat exchanger manufacturing method according to a twelfth aspect of the present invention is the method according to any of the ninth to eleventh aspects, in which the holes are provided by drilling in the providing the holes.

[0028] In such a method, the holes in the header are provided simply by using a drill. Therefore, the heat exchanger is manufactured more easily.

<Advantageous Effects of Invention>

[0029] The first, fourth, and eighth aspects of the present invention each provide a heat exchanger that can be manufactured easily.

[0030] The second aspect of the present invention provides a heat exchanger that exhibits improved durability against external forces and impacts.

[0031] The third aspect of the present invention provides a heat exchanger that exhibits improved drainability.

[0032] The fifth aspect of the present invention provides a heat exchanger in which the heat-transfer-tube unit and the header are connected to each other with improved strength.

[0033] The sixth and seventh aspects of the present invention each provide a heat exchanger in which the occurrence of a phenomenon in which brazing metal moves into a space between the fins by capillarity can be suppressed.

[0034] The ninth to twelfth aspects of the present invention each provide a heat-exchanger-manufacturing method by which a heat exchanger can be manufactured easily.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035]

[Fig. 1] Fig. 1 is a diagram illustrating an outline of a heat exchanger 10 according to a first embodiment of the present invention.

[Fig. 2] Fig. 2 is a diagram illustrating an outline of a heat-transfer-tube unit 30.

[Fig. 3] Fig. 3 is a sectional view of the heat-transfer-tube unit 30.

[Fig. 4] Fig. 4 is a sectional view of part of the heat exchanger 10.

[Fig. 5] Fig. 5 is a sectional view of part of a heat exchanger 10' according to a first modification of the first embodiment of the present invention.

[Fig. 6] Fig. 6 is a sectional view of part of a heat exchanger 10" according to a second modification of the first embodiment of the present invention.

[Fig. 7] Fig. 7 is a sectional view of part of a heat exchanger 10A according to a second embodiment of the present invention.

[Fig. 8] Fig. 8 is a sectional view of part of a heat exchanger 10B according to a third embodiment of the present invention.

[Fig. 9] Fig. 9 is a sectional view of part of a heat exchanger 10C according to a fourth embodiment of the present invention.

[Fig. 10] Fig. 10 is a diagram illustrating an outline of a heat exchanger 10D according to a fifth embodiment of the present invention.

[Fig. 11] Fig. 11 is a diagram illustrating an outline of a heat-transfer-tube unit 30.

DESCRIPTION OF EMBODIMENTS

<First Embodiment>

(1) Overall Configuration

[0036] Fig. 1 illustrates a heat exchanger 10 according to a first embodiment of the present invention. The heat exchanger 10 is provided for heat exchange between refrigerant and air and is to be included in, for example, an air conditioner. The heat exchanger 10 includes a first pipe 41, a second pipe 42, a first header 21, a second header 22, and a heat-transfer-tube-unit group 39. The heat-transfer-tube-unit group 39 includes a plurality of heat-transfer-tube units 30.

(2) Configurations of Relevant Elements

(2-1) Headers and Pipes

[0037] The first pipe 41 and the second pipe 42 are provided for refrigerant to flow therethrough. The first pipe 41 and the second pipe 42 each serve as an inlet and an outlet for the refrigerant, which can be in any of different forms such as gas, liquid, and a gas-liquid two-phase form. The first pipe 41 is connected to the first header 21 so as to supply and receive the refrigerant to and from the first header 21. The second pipe 42 is connected to the second header 22 so as to supply and receive the refrigerant to and from the second header 22. The first header 21 and the second header 22 are each a hollow member and have respective heat-transfer-tube-unit-connecting surfaces 23. The first header 21 and the second header 22 are arranged such that the respective heat-transfer-tube-unit-connecting surfaces 23 face each other or substantially face each other. In the present embodiment, the second header 22 is positioned below the first header 21.

(2-2) Heat-Transfer-Tube Unit

[0038] The plurality of heat-transfer-tube units 30 included in the heat-transfer-tube-unit group 39 are arranged side by side at intervals in a heat-transfer-tube-unit-arranging direction x. Each of the heat-transfer-tube units 30 is connected to the first header 21 and to the second header at the respective heat-transfer-tube-unit-connecting surfaces 23.

[0039] Fig. 2 illustrates one of the heat-transfer-tube units 30. The heat-transfer-tube unit 30 includes a plurality of heat transfer tubes 31 and a plurality of fins 32. The number of heat transfer tubes 31 included in the heat-transfer-tube unit 30 is, for example, six or greater but is not limited thereto.

[0040] The heat transfer tubes 31 are provided for moving the refrigerant between the first header 21 and the second header 22. Two ends of each of the heat transfer tubes 31 are connected to the heat-transfer-tube-unit-connecting surfaces 23 of the first header 21 and the second header 22, respectively. The heat transfer tube 31 includes at least a portion extending in a heat-transfer-tube-extending direction z and preferably has a linear shape. The plurality of heat transfer tubes 31 are arranged side by side in a heat-transfer-tube-spacing direction y.

[0041] The fins 32 are provided for heat exchange between the refrigerant flowing in adjacent ones of the heat transfer tubes 31 and ambient air. The fins 32 are each provided between adjacent two of the heat transfer tubes 31. Additional fins 32 may be provided on the outer side of outermost ones, respectively, of the heat transfer tubes 31 included in the heat-transfer-tube unit 30. The fins 32 each have sides extending in the heat-transfer-tube-extending direction z, and the sides are joined to corresponding ones of the heat transfer tubes 31. The fins 32 and the heat transfer tubes 31 are arranged alternately side by side in the heat-transfer-tube-spacing direction y. A fan or the like, not illustrated, causes air to flow in a direction parallel to a y-z plane. The direction of the airflow may be the heat-transfer-tube-spacing direction y.

[0042] The heat-transfer-tube-unit-arranging direction x, the heat-transfer-tube-spacing direction y, and the heat-transfer-tube-extending direction z intersect one another. The heat-transfer-tube-unit-arranging direction x, the heat-transfer-tube-spacing direction y, and the heat-transfer-tube-extending direction z may be perpendicular to one another. The heat-transfer-tube-unit-arranging direction x and the heat-transfer-tube-spacing direction y may each be a horizontal direction, and the heat-transfer-tube-extending direction z may be a vertical direction.

[0043] Fig. 3 illustrates a section of the heat-transfer-tube unit 30. The heat transfer tubes 31 each have an inside diameter D of, for example, 1.5 mm or smaller, and preferably 0.8 mm or smaller. The fins 32 each have a thickness T of, for example, 0.3 mm or smaller, preferably 0.2 mm or smaller, and more preferably 0.1 mm or smaller.

(3) Connection between Heat-Transfer-Tube Unit and Header

[0044] As illustrated in Fig. 2, the heat-transfer-tube unit 30 has cutouts 33 at ends thereof in the fins 32. The presence of the cutouts 33 makes ends 32e of the fins 32 be positioned nearer to the center of the heat-transfer-tube unit 30 in the heat-transfer-tube-extending direction z than ends 31e of the heat transfer tubes 31.

[0045] Fig. 4 is a sectional view of the heat exchanger 10. The second header 22 has holes 24 for insertion of the ends 31e of the heat transfer tubes 31. The ends 32e of the fins 32 are shaped in conformity with the shape of the second header 22 in such a manner as to be in contact with at least the heat-transfer-tube-unit-connecting surface 23 of the second header 22 with the ends 31e of the heat transfer tubes 31 being in the holes 24. The points

of contact are fixed by brazing or the like, whereby the path for the refrigerant is sealed.

[0046] While Fig. 4 illustrates the second header 22 and the periphery thereof, the first header 21 and the periphery thereof are also configured as above.

(4) Method of Manufacturing Heat Exchanger 10

[0047] The heat-transfer-tube unit 30 is manufactured from a metal material such as aluminum or an aluminum alloy. Firstly, fins 32 and heat transfer tubes 31 are integrally formed from the metal material by extrusion molding with a mold corresponding to the shape of the section illustrated in Fig. 3. Subsequently, portions of the fins 32 are removed to provide cutouts 33. Thus, the ends 32e of the fins 32 are positioned nearer to the center of the heat-transfer-tube unit 30 in the heat-transfer-tube-extending direction z than the ends 31e of the heat transfer tubes 31. The cutouts 33 are desirably provided by removing a plurality of portions of the fins 32 by punching.

[0048] The first header 21 and the second header 22 are each manufactured by processing a metal material into a tubular shape. The holes 24 for insertion of the ends 31e of the heat transfer tubes 31 are formed in the first header 21 and the second header 22. The holes 24 are circular holes provided by, for example, drilling.

[0049] The heat exchanger 10 is assembled by inserting the ends 31e of the heat transfer tubes 31 of the heat-transfer-tube unit 30 into the respective holes 24 in the first header 21 and the second header 22. Thus, the ends 32e of the fins 32 come into contact with the heat-transfer-tube-unit-connecting surface 23 of the second header 22. The heat-transfer-tube unit 30 and the first header 21 or the second header 22 are brazed to each other at the points of contact. Specifically, brazing metal is applied in advance to the heat-transfer-tube-unit-connecting surfaces 23 of the first header 21 and the second header 22. After the ends 31e of the heat transfer tubes 31 of the heat-transfer-tube unit 30 are inserted into the respective holes 24 in the heat-transfer-tube-unit-connecting surfaces 23, the heat exchanger 10 is put into a furnace. Thus, the brazing metal is melted and fills the gaps between the edges of the holes 24 and the respective heat transfer tubes 31.

(5) Features

(5-1)

[0050] Since the cutouts 33 are provided by removing portions of the fins 32, the ends 31e of the heat transfer tubes 31 project from the ends 32e of the fins 32. Therefore, the heat exchanger 10 can be manufactured easily by inserting the projecting portions of the heat transfer tubes 31 into the holes 24 in the first header 21 and the second header 22.

(5-2)

[0051] The two ends of the heat-transfer-tube unit 30 are fixed to the first header 21 and the second header 22, respectively. Therefore, the heat exchanger exhibits improved durability against external forces and impacts.

(5-3)

[0052] The ends 32e of the fins 32 are in contact with the first header 21 and the second header 22. Therefore, the heat-transfer-tube unit 30 and each of the first header 21 and the second header 22 are connected to each other with improved strength.

(5-4)

[0053] The heat-transfer-tube unit 30 is formed as a single member from a metal material by extrusion molding. Therefore, the heat-transfer-tube unit 30 is easy to handle. Accordingly, the heat exchanger 10 is easy to assemble.

(5-5)

[0054] The plurality of cutouts 33 are provided at a time by punching. Therefore, the heat exchanger 10 is manufactured efficiently.

(5-6)

[0055] The holes in the first header 21 and the second header 22 may be provided simply by using a drill. In that case, the heat exchanger 10 is manufactured more easily.

(6) Modifications

[0056] Modifications of the present embodiment will now be described.

(6-1) First Modification

[0057] Fig. 5 illustrates a heat exchanger 10' according to a first modification of the first embodiment of the present invention. The heat exchanger 10' is different from the heat exchanger 10 according to the first embodiment in that the ends 32e of the fins 32 are spaced apart from the heat-transfer-tube-unit-connecting surfaces 23 of the first header 21 and the second header 22. Such a configuration is realized with stoppers 35 provided on the heat transfer tubes 31. The stoppers 35 are provided between the ends 31e of the heat transfer tubes 31 and the ends 32e of the fins 32. The stoppers 35 are shaped in such a manner as not to be allowed to pass through the holes 24 in the first header 21 and the second header 22. A gap 36 is provided between each of the stoppers 35 and a corresponding one of the fins 32, whereby the

stoppers 35 are spaced apart from the ends 32e of the fins 32. In the first modification, the stoppers 35 are provided to all of the heat transfer tubes 31 of the heat-transfer-tube unit 30, respectively.

[0058] The stoppers 35 are formed as fins 32 at the beginning of the manufacturing process. Then, in a step of punching off portions of the fins 32 for providing cutouts 33, stoppers 35 are obtained as portions that are not punched off, and remain on the heat transfer tubes 31.

[0059] Such a configuration in which the stoppers 35 are spaced apart from the ends 32e of the fins 32 suppresses the occurrence of a phenomenon in which the brazing metal melted in the furnace moves into spaces between the fins 32 by capillarity. Therefore, concentration of the brazing metal is suppressed, and the occurrence of erosion of the brazing metal or the fins 32 is reduced.

(6-2) Second Modification

[0060] Fig. 6 illustrates a heat exchanger 10" according to a first modification of the first embodiment of the present invention. The heat exchanger 10" is different from the heat exchanger 10' according to the first modification of the first embodiment in that the stoppers 35 are provided on only some of the heat transfer tubes 31 of the heat-transfer-tube unit 30.

[0061] Such a configuration further suppresses the occurrence of the phenomenon in which the brazing metal moves into spaces between the fins 32 by capillarity.

<Second Embodiment>

(1) Configuration

[0062] Fig. 7 illustrates a heat exchanger 10A according to a second embodiment of the present invention. The heat exchanger 10A is configured such that at least the second header 22 has a trapezoidal sectional shape. Therefore, the heat-transfer-tube-unit-connecting surface 23 of the second header 22 is inclined with respect to the heat-transfer-tube-spacing direction y. The ends 32e of the fins 32 are shaped in conformity with the shape of the second header 22 in such a manner as to be in contact with at least the heat-transfer-tube-unit-connecting surface 23 of the second header 22 with the ends 31e of the heat transfer tubes 31 being in the holes 24.

[0063] Such a configuration causes dew condensation water running down the heat-transfer-tube unit 30 and reaching the heat-transfer-tube-unit-connecting surface 23 to further run down the second header 22 because of the inclination. Therefore, the heat exchanger 10A exhibits improved drainability.

(2) Modifications

[0064] The modifications of the first embodiment may be applied to the present embodiment.

<Third Embodiment>

(1) Configuration

[0065] Fig. 8 illustrates a heat exchanger 10B according to a third embodiment of the present invention. The heat exchanger 10B is configured such that at least the second header 22 has a sectional shape pointed upward. Therefore, the heat-transfer-tube-unit-connecting surface 23 of the second header 22 includes two inclined surfaces inclining with respect to the heat-transfer-tube-spacing direction y. The ends 32e of the fins 32 are shaped in conformity with the shape of the second header 22 in such a manner as to be in contact with at least the heat-transfer-tube-unit-connecting surface 23 of the second header 22 with the ends 31e of the heat transfer tubes 31 being in the holes 24.

[0066] Such a configuration also causes dew condensation water running down the heat-transfer-tube unit 30 and reaching the heat-transfer-tube-unit-connecting surface 23 to further run down the second header 22 because of the inclination. Therefore, the heat exchanger 10B exhibits improved drainability.

(2) Modifications

[0067] The modifications of the first embodiment may be applied to the present embodiment.

<Fourth Embodiment>

(1) Configuration

[0068] Fig. 9 illustrates a heat exchanger 10C according to a fourth embodiment of the present invention. The heat exchanger 10C is configured such that at least the second header 22 is a circular pipe. Therefore, most part of the heat-transfer-tube-unit-connecting surface 23 of the second header 22 is inclined with respect to the heat-transfer-tube-spacing direction y. The ends 32e of the fins 32 are shaped in conformity with the shape of the second header 22 in such a manner as to be in contact with at least the heat-transfer-tube-unit-connecting surface 23 of the second header 22 with the ends 31e of the heat transfer tubes 31 being in the holes 24.

[0069] In such a configuration, since at least the second header 22 is a circular pipe, the second header 22 is easy to manufacture. Therefore, the heat exchanger 10 can be manufactured more easily.

[0070] In addition, since the heat-transfer-tube-unit-connecting surface 23 of the second header 22 is inclined, dew condensation water running down the heat-transfer-tube unit 30 and reaching the heat-transfer-tube-unit-connecting surface 23 further runs down the second header 22. Therefore, the heat exchanger 10C exhibits improved drainability.

(2) Modifications

[0071] The modifications of the first embodiment may be applied to the present embodiment.

<Fifth Embodiment>

(1) Configuration

[0072] Fig. 10 illustrates a heat exchanger 10D according to the above embodiment of the present invention. The heat exchanger 10D is configured such that the first header 21 and the second header 22 are provided on the same side of the heat-transfer-tube-unit group 39. The first header 21 and the second header 22 are connected to the first pipe 41 and the second pipe 42, respectively.

[0073] Fig. 11 illustrates one of a plurality of heat-transfer-tube units 30 included in the heat-transfer-tube-unit group 39 of the heat exchanger 10D. The heat-transfer-tube unit 30 includes a plurality of heat transfer tubes 31 and at least one fin 32. The heat transfer tubes 31 each include at least a portion extending in the heat-transfer-tube-extending direction z and each preferably have a linear shape. The plurality of heat transfer tubes 31 are arranged side by side in the heat-transfer-tube-spacing direction y. Furthermore, adjacent ones of the heat transfer tubes 31 are coupled to each other with a curved coupling pipe 31c. That is, the heat-transfer-tube unit 30 has a single refrigerant path formed of the heat transfer tubes 31 and the coupling pipes 31c. The refrigerant path allows the refrigerant to move between the first header 21 and the second header 22. The ends 31e of the heat transfer tubes 31 are connected to the heat-transfer-tube-unit-connecting surfaces 23 of both the first header 21 and the second header 22.

[0074] The heat-transfer-tube unit 30 includes the fin 32 that is present between adjacent ones of the heat transfer tubes 31. Additional fins 32 may be provided on the outer side of outermost ones, respectively, of the heat transfer tubes 31 of the heat-transfer-tube unit 30. Such a plurality of fins 32 may be connected to one another at the upper end or the lower end of the heat-transfer-tube unit 30. The fins 32 each have sides extending in the heat-transfer-tube-extending direction z, and the sides are joined to corresponding ones of the heat transfer tubes 31. The fins 32 and the heat transfer tubes 31 are arranged alternately side by side in the heat-transfer-tube-spacing direction y. A fan or the like, not illustrated, causes air to flow in a direction parallel to the y-z plane. The direction of the airflow may be the heat-transfer-tube-spacing direction y. The heat-transfer-tube unit 30 may be manufactured by a method other than extrusion molding of a metal material.

[0075] The heat-transfer-tube unit 30 has cutouts 33 at ends thereof in the fins 32. The presence of the cutouts 33 makes ends 32e of the fins 32 be positioned nearer to the center of the heat-transfer-tube unit 30 in the heat-transfer-tube-extending direction z than ends 31e of the heat transfer tubes 31. The ends 32e of the fins 32 are shaped in conformity with the shapes of the first header 21 and the second header 22 in such a manner as to be in contact with the heat-transfer-tube-unit-connecting surfaces 23 with the ends 31e of the heat transfer tubes 31 being in the holes 24 in the first header 21 and the second header 22. The points of contact are fixed by brazing or the like, whereby the refrigerant path is sealed.

[0076] Such a configuration allows three of the four sides of the heat-transfer-tube unit 30 to be open to a peripheral space. Therefore, dew condensation water is drained more easily.

(2) Modifications

[0077] The modifications of the first embodiment may be applied to the present embodiment.

<Sixth Embodiment>

[0078] The embodiments described above concern an exemplary arrangement in which the heat-transfer-tube-unit-arranging direction x and the heat-transfer-tube-spacing direction y are each a horizontal direction, and the heat-transfer-tube-extending direction z is a vertical direction. Alternatively, the heat exchanger 10 may be oriented in another way. For example, the heat-transfer-tube-spacing direction y and the heat-transfer-tube-extending direction z may each be a horizontal direction, and the heat-transfer-tube-unit-arranging direction x may be a vertical direction.

REFERENCE SIGNS LIST

[0079]

10	heat exchanger
21	first header
22	second header
23	heat-transfer-tube-unit-connecting surface
24	hole
30	heat-transfer-tube unit
31	heat transfer tube
31e	end of heat transfer tube
32	fin
32e	end of fin
33	cutout
35	stopper
36	gap
41	first pipe
42	second pipe

CITATION LIST

PATENT LITERATURE

[0080] [PTL 1] Japanese Unexamined Patent Applica-

tion Publication No. 2013-139965

Claims

1. A heat exchanger (10) comprising:

   a heat-transfer-tube unit (30) including at least one fin (32) and a plurality of heat transfer tubes (31); and
   a header (21, 22) to which the heat-transfer-tube unit is connected,
   wherein the fin and the heat transfer tubes are arranged alternately side by side,
   wherein the plurality of heat transfer tubes each extend in a heat-transfer-tube-extending direction (z),
   wherein the fin has sides extending in the heat-transfer-tube-extending direction (z) and that are joined to the heat transfer tubes,
   wherein an end (32e) of the fin is positioned nearer to a center of the heat-transfer-tube unit in the heat-transfer-tube-extending direction (z) than ends (31e) of the heat transfer tubes, and
   wherein the header has holes (24) for insertion of the ends of the heat transfer tubes.

2. The heat exchanger according to claim 1,
   wherein the header includes a first header (21) and a second header (22) between which the heat-transfer-tube unit is held.

3. The heat exchanger according to claim 2,

   wherein the second header is positioned below the first header, and
   wherein the second header has a heat-transfer-tube-unit-connecting surface (23) inclined with respect to a heat-transfer-tube-spacing direction.

4. The heat exchanger according to any of claims 1 to 3, wherein the header is a circular pipe.

5. The heat exchanger according to any of claims 1 to 4, wherein the end of the fin is shaped in conformity with a shape of the header in such a manner as to be in contact with the header with the ends of the heat transfer tubes being in the holes.

6. The heat exchanger according to any of claims 1 to 4, wherein the end (32e) of the fin is spaced apart from the header (21, 22).

7. The heat exchanger according to claim 6,

   wherein the heat-transfer-tube unit further includes stoppers (35) provided on the heat transfer tubes (31) and between the ends (31e) of the heat transfer tubes and the end (32e) of the fin, and
   wherein the stoppers are each shaped in such a manner as not to be allowed to pass through the holes in the header.

8. The heat exchanger according to any of claims 1 to 7, wherein the heat-transfer-tube unit is a single member.

9. A heat exchanger manufacturing method, comprising:

   forming a heat-transfer-tube unit (30) including a fin (32) and heat transfer tubes (31);
   providing a cutout (33) by removing a portion of the fin such that an end (32e) of the fin is positioned nearer to a center of the heat-transfer-tube unit in a heat-transfer-tube-extending direction (z) than ends (31e) of the heat transfer tubes;
   providing holes (24) in a header (21, 22), the holes being provided for insertion of the ends of the heat transfer tubes;
   inserting the ends of the heat transfer tubes into the respective holes; and
   brazing the heat-transfer-tube unit and the header to each other.

10. The heat exchanger manufacturing method according to claim 9,
    wherein the forming the heat-transfer-tube unit includes integrally forming the fin and the heat transfer tubes from a metal material by extrusion molding.

11. The heat exchanger manufacturing method according to claim 9 or 10,
    wherein a plurality of portions of the fin are punched off in the providing the cutout.

12. The heat exchanger manufacturing method according to any of claims 9 to 11,
    wherein the holes are provided by drilling in the providing the holes.

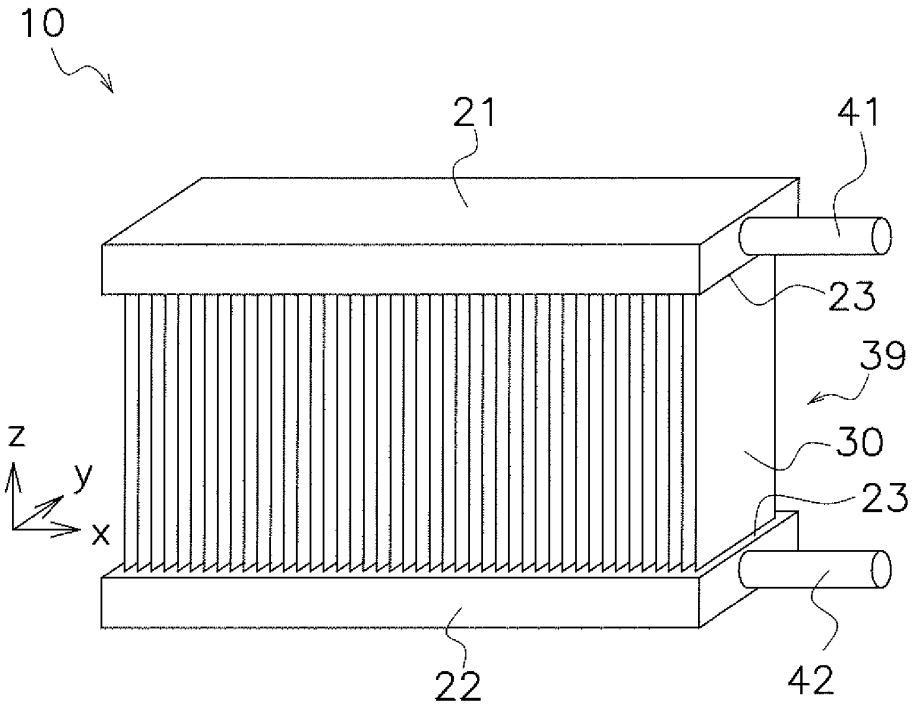
10
21
41
23
39
30
23
z
y
x
22
42

FIG. 1

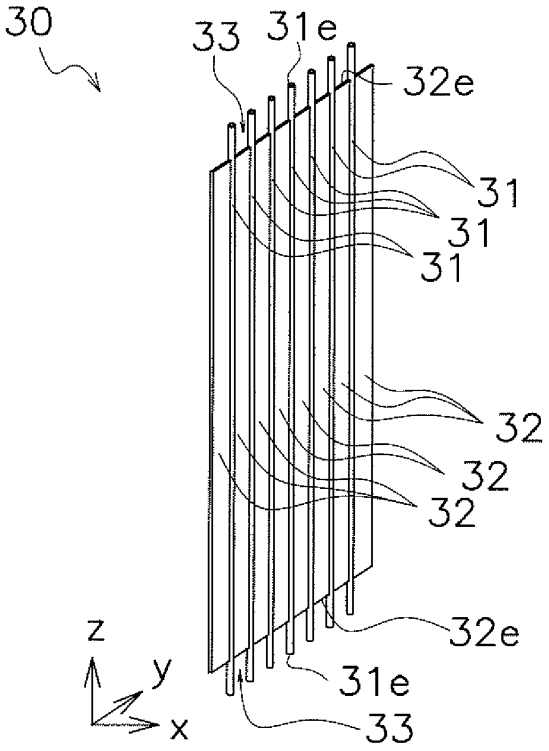
30
33
31e
32e
31
31
31
32
32
32
32e
31e
33
z
y
x

FIG. 2

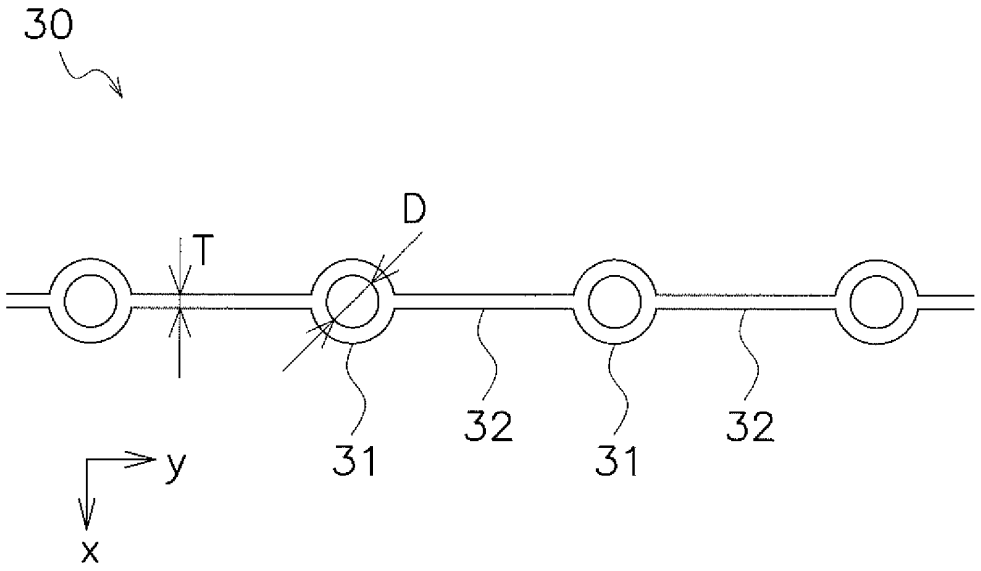

FIG. 3

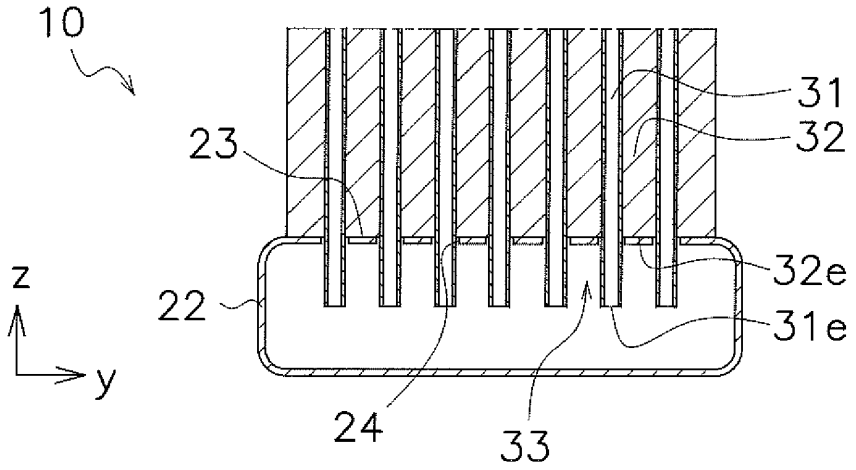

FIG. 4

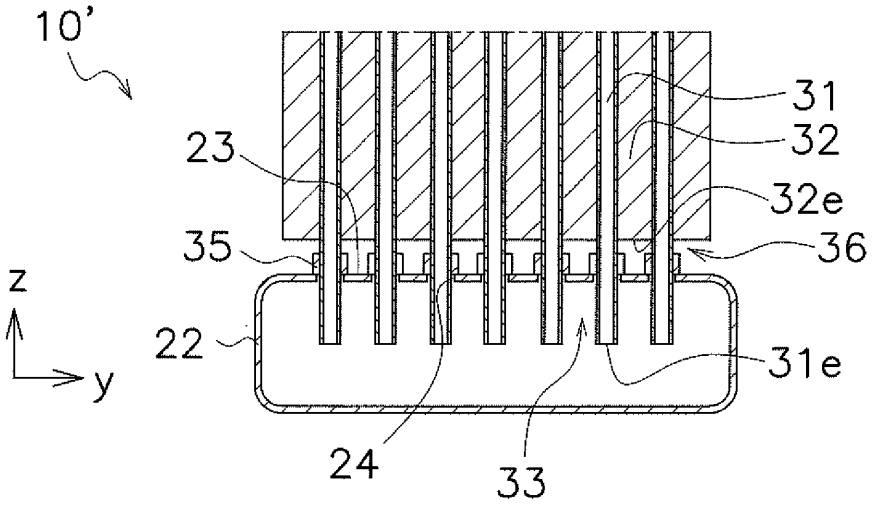
10'
31
32
23
32e
35
36
z
22
31e
y
24
33

FIG. 5

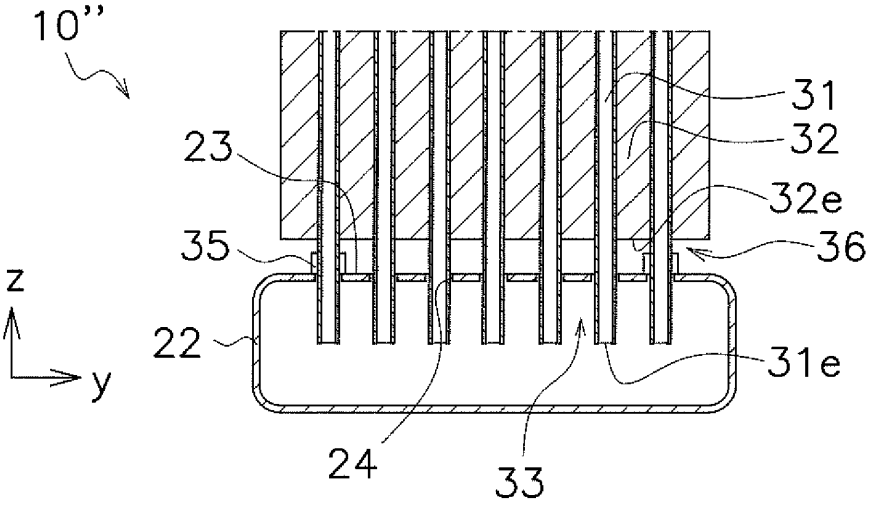
10''
31
32
23
32e
35
36
z
22
31e
y
24
33

FIG. 6

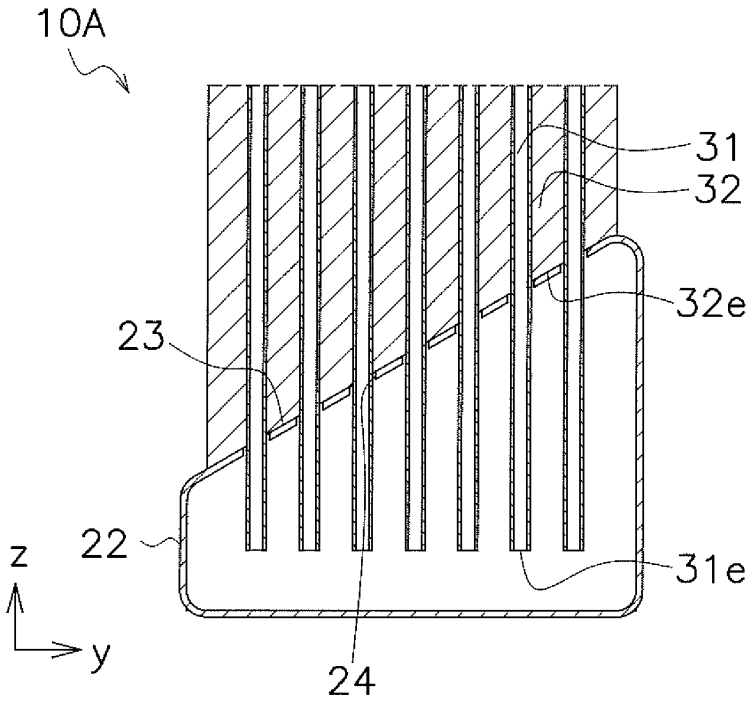

FIG. 7

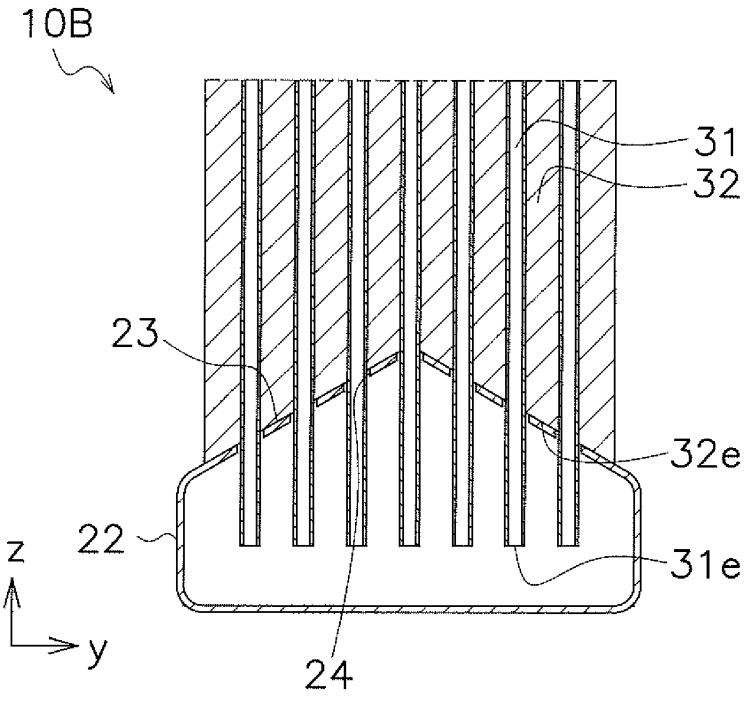

FIG. 8

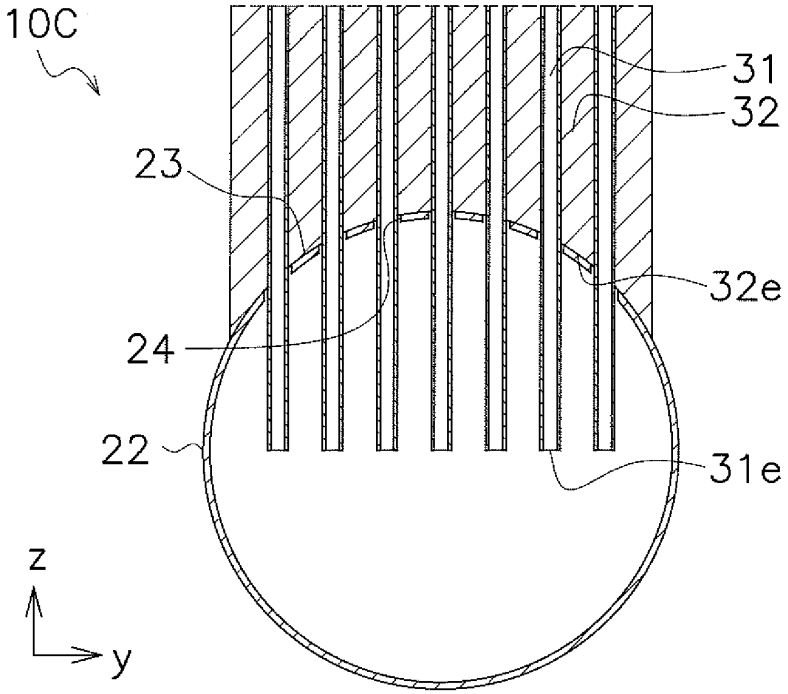

FIG. 9

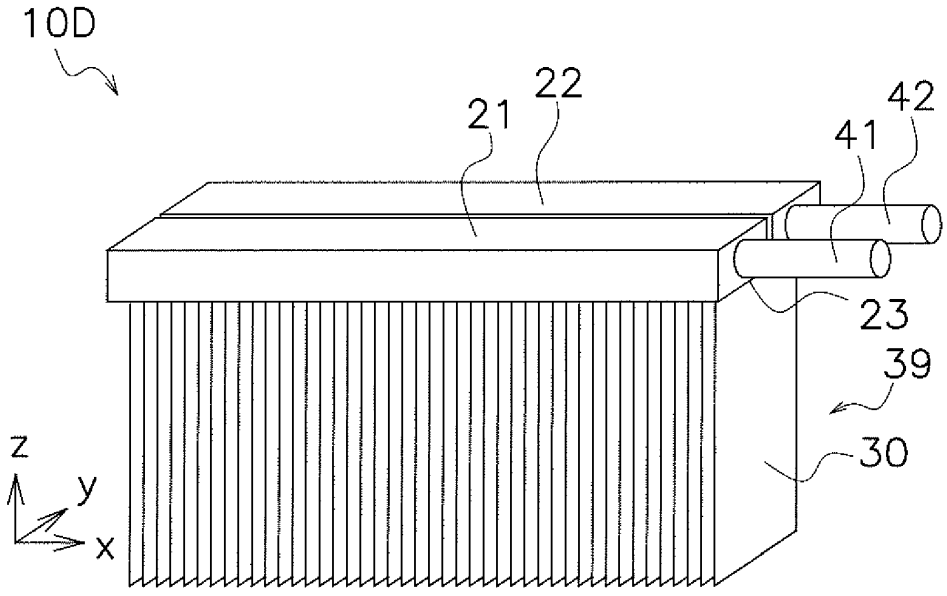

FIG. 10

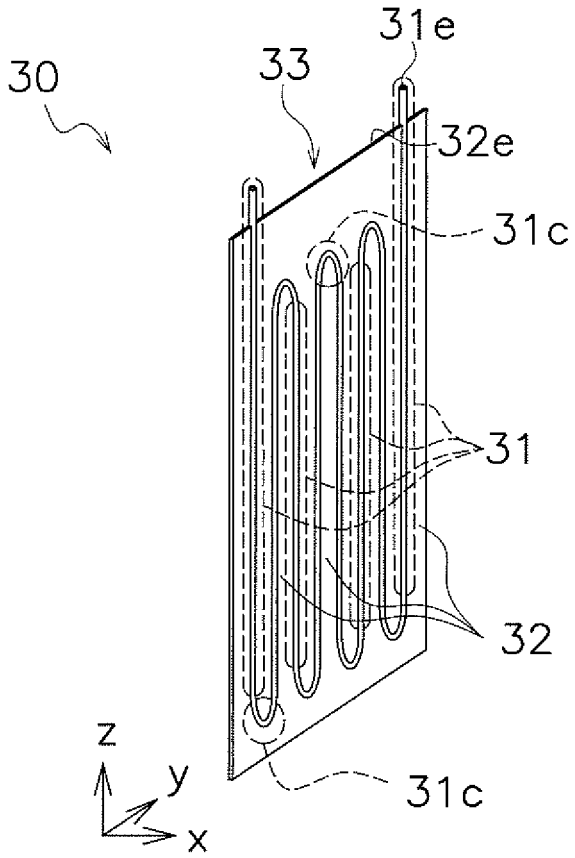

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/009485

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F28F1/00(2006.01)i, F28D7/16(2006.01)i, F28F1/32(2006.01)i, F28F9/02(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)
Int.Cl. F28F1/00, F28D7/16, F28F1/32, F28F9/02

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 07-218172 A (SANDEN CORP.) 18 August 1995, claims, paragraphs [0026]-[0035], fig. 7-23 & US 5647433 A: claims, column 5, line 60 to column 8, line 32, fig. 7-23 & EP 657711 A1 & CN 1107566 A	1-2, 8-12
X Y	JP 07-318275 A (SANDEN CORP.) 08 December 1995, claims, fig. 1-3 (Family: none)	1-2, 5 3-4, 6-7

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

* Special categories of cited documents:
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"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
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 May 2018 (22.05.2018)	05 June 2018 (05.06.2018)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/009485

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2015/189990 A1 (MITSUBISHI ELECTRIC CORP.) 17 December 2015, claims, fig. 3, 6-9 & EP 3156752 A1: claims, fig. 3, 6-9	3
Y	WO 2005/073655 A1 (CALSONIC KANSEI CORPORATION) 11 August 2005, paragraphs [0034]-[0042], fig. 5-8 (Family: none)	4
Y	JP 08-327276 A (SANDEN CORP.) 13 December 1996, claims, paragraphs [0008]-[0009], fig. 1, 3 & US 5782291 A: column 7, line 13 to column 7, line 59, fig. 5, 7	6-7
X	JP 2006-112732 A (DAIKIN INDUSTRIES, LTD.) 27 April 2006, paragraphs [0050]-[0083], fig. 1-6 (Family: none)	1, 8
A	JP 09-159386 A (SANDEN CORP.) 20 June 1997, entire text, all drawings (Family: none)	1-12
A	JP 2013-122369 A (HYUNDAI MOTOR COMPANY) 20 June 2013, entire text, all drawings & US 2013/0146255 A1 & DE 102012105523 A & KR 10-2013-0064936 A & CN 103162560 A	1-12
A	CN 101963418 A (JHONSON CONTROLS BUILDING EQUIPMENT TECHNOLOGY WUXI CO., LTD.) 02 February 2011, entire text, all drawings (Family: none)	1-12

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 2013139965 A **[0002] [0080]**