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(54) **COOLING DEVICE, REFRIGERATION CYCLE DEVICE, AND METHOD FOR PRODUCING COOLING DEVICE**

(57) The present invention includes a metallic member (45) comprising: a metallic member main body (51); a pair of opening sections (52, 54) provided in the metallic member main body (51) in a state exposed from an outer surface (51a) of the metallic member main body (51) and functioning as the entrance and exit for a refrigerant; and a refrigerant flow path (56) which is provided in the metallic member main body (51) so as to be connected to the pair of opening sections (52, 54), and through which the refrigerant flows in a state of being in contact with the metallic member main body (51).

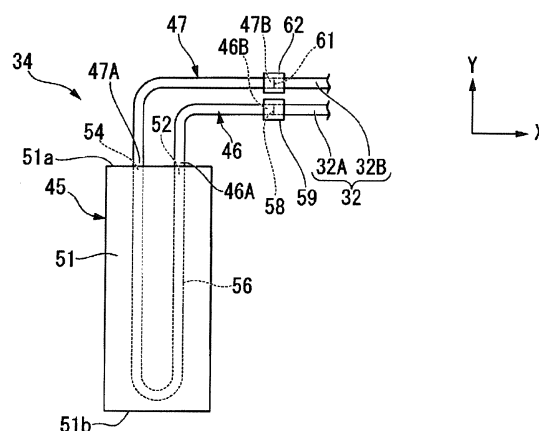


FIG. 2

Description

Technical Field

[0001] The present invention relates to a cooling device, a refrigeration cycle device including the cooling device, and a method of manufacturing the cooling device.

Background Art

[0002] In an air-conditioning device as a conventional refrigeration cycle device, a power element that generates heat is generally used as an electrical circuit for controlling operation of an electric motor of a compressor. The electrical circuit is housed in a control box. In the control box, there is a component that generates heat other than the power element.

[0003] Some conventional refrigeration cycle devices include a cooling mechanism for preventing the power element from reaching a high temperature higher than a temperature at which the power element can operate (for example, refer to Patent Document 1).

[0004] Patent Document 1 discloses a refrigerant jacket that cools a power element. The refrigerant jacket disclosed in Patent Document 1 is configured to partially cover refrigerant piping that connects an outdoor heat exchanger to an expansion valve. A refrigerant flowing through the part of the refrigerant piping cools the power element via the refrigerant jacket.

Citation List

Patent Document

[0005] Patent Document 1: JP 4488093 B

Summary of Invention

Technical Problem

[0006] It is important for the refrigerant jacket disclosed in Patent Document 1 that an outer peripheral surface of the refrigerant piping closely contact to the refrigerant jacket without a gap therebetween in order to efficiently cool the power element.

[0007] However, Patent Document 1 does not disclose any means for eliminating a gap between the outer peripheral surface of the refrigerant piping and the refrigerant jacket and increasing contactness between the outer peripheral surface of the refrigerant piping and the refrigerant jacket.

[0008] Thus, it is difficult to efficiently cool a member that is housed in the control box and generates heat to be cooled (hereinafter referred to as a "cooling subject") in the refrigerant jacket disclosed in Patent Document 1.

[0009] Thus, the present invention provides a cooling device capable of efficiently cooling a cooling subject in

a control box, a refrigeration cycle device, and a method of manufacturing a cooling device.

Solution to Problem

[0010] A cooling device according to one aspect of the present invention is a cooling device for causing a cooling subject that is housed in a control box and generates heat and a refrigerant circulated in a refrigeration cycle device to exchange heat and thus cools the cooling subject. The cooling device includes a metallic member. The metallic member includes a metallic member main body, a pair of openings provided in the metallic member main body while being exposed from an outer surface of the metallic member main body and functioning as an entrance and an exit of the refrigerant, and a refrigerant flow path provided in the metallic member main body while being connected to the pair of openings and through which the refrigerant flows. A portion of the metallic member main body that defines the refrigerant flow path contacts the refrigerant.

[0011] According to the present invention, the refrigerant flow path through which the refrigerant flows while contacting with the metallic member main body is provided in the metallic member main body. Thus, the refrigerant can directly cool the metallic member main body. As a result, the cooling subject that is housed in the control box and generates heat can be efficiently cooled by the cold of the refrigerant via the metallic member main body.

[0012] In the cooling device according to one aspect of the present invention, the pair of openings may include a first opening and a second opening. The cooling device may include a first connect tube formed of a metallic material that is the same as that for the metallic member main body and different from that for a first refrigerant tube forming the refrigeration cycle device, and a second connect tube formed of a metallic material that is the same as that for the metallic member main body and different from that for a second refrigerant tube forming the refrigeration cycle device. A first end of the first connect tube may be connected to the first opening, and a second end of the first connect tube may be connected to the first refrigerant tube. A first end of the second connect tube may be connected to the second opening, and a second end of the second connect tube may be connected to the second refrigerant tube.

[0013] In this way, the first connect tube formed of the metallic material that is the same as that for the metallic member main body and different from that for the first refrigerant tube is connected to the first opening provided in the metallic member main body. Thus, the same metallic material is joined together. This can easily join the first connect tube and the first opening together in an excellent state.

[0014] Further, the second connect tube formed of the metallic material that is the same as that for the metallic member main body and different from that for the second

refrigerant tube is connected to the second opening provided in the metallic member main body. Thus, the same metallic material is joined together. This can easily join the second connect tube and the second opening together in an excellent state.

[0015] In the cooling device according to one aspect of the present invention, the refrigerant flow path may include a plurality of penetrating flow paths that penetrate the metallic member main body in a predetermined direction. The plurality of penetrating flow paths may be provided in the metallic member main body and include third openings each disposed at an end to be exposed from an outer surface of the metallic member main body. The cooling device may further include a U-shaped tube connected to two of the third openings provided in adjacent positions.

[0016] In this way, even in a case where the refrigerant flow path includes the plurality of penetrating flow paths penetrating the metallic member main body in the predetermined direction, the cooling subject housed in the control box can be efficiently cooled by the cold of the refrigerant via the metallic member main body.

[0017] For example, in a case where the refrigerant flow path includes only the plurality of penetrating flow paths, the refrigerant flow path can be easily processed in comparison with a case where winding refrigerant flow paths are processed.

[0018] In the cooling device according to one aspect of the present invention, the U-shaped tube may be formed of the same metallic material as that for the metallic member main body.

[0019] In this way, the U-shaped tube is formed of the same metallic material as that for the metallic member main body. Thus, the same metallic material is joined together when the metallic member main body is joined to the U-shaped tube. This eliminates occurrence of contact corrosion between dissimilar metals, and thus the U-shaped tube and the metallic member main body can be joined together in an excellent state.

[0020] The cooling device according to one aspect of the present invention may further include: a first moisture suppressing member covering a connection portion between the first connect tube and the first refrigerant tube; and a second moisture suppressing member covering a connection portion between the second connect tube and the second refrigerant tube.

[0021] In this way, the first moisture suppressing member covering the connection portion between the first connect tube and the first refrigerant tube is provided, so that the first moisture suppressing member can suppress adhesion of moisture to the connection portion at which different metallic materials are connected. This can suppress occurrence of contact corrosion between dissimilar metals at the connection portion.

[0022] The second moisture suppressing member covering the connection portion between the second connect tube and the second refrigerant tube is provided, so that the second moisture suppressing member can suppress

adhesion of moisture to the connection portion at which different metallic materials are connected. This can suppress occurrence of contact corrosion between dissimilar metals at the connection portion.

[0023] To solve the above-described problem, a refrigeration cycle device according to one aspect of the present invention may include: an outdoor unit including the above-described cooling device; and an indoor unit connected to the outdoor unit while the refrigerant flowing through the outdoor unit can be introduced into or led out from the indoor unit.

[0024] According to the present invention, the refrigerant flow path through which the refrigerant flows while contacting with the metallic member main body is provided in the metallic member main body. Thus, the refrigerant can directly cool the metallic member main body. As a result, the cooling subject that is housed in the control box and generates heat can be efficiently cooled by the cold of the refrigerant via the metallic member main body.

[0025] To solve the above-described problem, a method of manufacturing a cooling device according to one aspect of the present invention is a method of manufacturing a cooling device including a metallic member that causes a cooling subject that is housed in a control box and generates heat and a refrigerant to exchange heat and thus cools the cooling subject. The method of manufacturing a cooling device may include the steps of: forming a first opening and a second opening functioning as an entrance and an exit of the refrigerant in a metallic member main body and a refrigerant flow path provided in the metallic member main body so as to be connected to the first opening and the second opening to obtain the metallic member; joining a first connect tube formed of the same metallic material as that for the metallic member main body to the first opening; and joining a second connect tube formed of the same metallic material as that for the metallic member main body to the second opening.

[0026] According to the present invention, the refrigerant flows through the refrigerant flow path while contacting the portion of the metallic member main body that defines the refrigerant flow path. Thus, the refrigerant can directly cool the metallic member main body. As a result, the cooling subject that is housed in the control box and generates heat can be efficiently cooled by the cold of the refrigerant via the metallic member main body.

[0027] The first connect tube is joined to the first opening, and the second connect tube is joined to the second opening. Thus, the pair of piping that supply and collect the refrigerant to and from the refrigerant flow path via the first opening or the second opening can be joined in a position away from the metallic member main body.

[0028] Thus, for example, in a case where the pair of piping are formed of a metallic material different from that for the metallic member main body, the moisture suppressing members can be easily provided to the connection portions (joint portions). This can suppress contact

corrosion between dissimilar metals at the connection portions (joint portions).

Advantageous Effects of Invention

[0029] According to the present invention, a cooling subject in a control box can be efficiently cooled.

Brief Description of Drawings

[0030]

FIG. 1 is a system diagram illustrating a schematic configuration of a refrigeration cycle device according to a first embodiment of the present invention. FIG. 2 is an enlarged view of a portion surrounded as a region A of the refrigeration cycle device illustrated in FIG. 1.

FIG. 3 is a diagram schematically illustrating a state where a first connect tube and a second connect tube are located away from a metallic member with the exclusion of a first moisture suppressing member and a second moisture suppressing member from a structural body illustrated in FIG. 2.

FIG. 4 is a diagram when the metallic member illustrated in FIG. 3 is seen from a B view.

FIG. 5 is a system diagram illustrating a schematic configuration of a refrigeration cycle device according to a first modification of the first embodiment of the present invention.

FIG. 6 is a system diagram illustrating a schematic configuration of a refrigeration cycle device according to a second modification of the first embodiment of the present invention.

FIG. 7 is a diagram illustrating a cooling device according to a second embodiment of the present invention.

FIG. 8 is a diagram illustrating a cooling device according to a third embodiment of the present invention.

FIG. 9 is a diagram illustrating a cooling device according to a fourth embodiment of the present invention.

FIG. 10 is a diagram schematically illustrating a state where a metallic member and a U-shaped tube illustrated in FIG. 9 are located away from each other.

FIG. 11 is a diagram when the metallic member illustrated in FIG. 10 is seen from a C view.

FIG. 12 is a diagram illustrating a cooling device according to a fifth embodiment of the present invention.

FIG. 13 is a diagram illustrating a cooling device according to a sixth embodiment of the present invention.

FIG. 14 is a diagram illustrating a cooling device according to a seventh embodiment of the present invention.

FIG. 15 is a diagram schematically illustrating a state

where a U-shaped tube and a metallic member illustrated in FIG. 14 are located away from each other.

FIG. 16 is a diagram schematically illustrating a stage before U-shaped piping illustrated in FIG. 15 has a diameter expanded.

Description of Embodiments

[0031] Embodiments to which the present invention is applied will be described below in detail with reference to the drawings. Note that the drawings used in the following description are for illustrating the configurations of the embodiments of the present invention, and in terms of the size, thickness, dimensions, and the like of each illustrated part, the actual dimensional relationships thereof in a cooling device and a refrigeration cycle device may be different.

First Embodiment

[0032] FIG. 1 is a system diagram illustrating a schematic configuration of a refrigeration cycle device according to a first embodiment of the present invention. FIG. 1 illustrates a configuration of a multi-type air-conditioning device as an example of a refrigeration cycle device 10.

[0033] With reference to FIG. 1, the refrigeration cycle device 10 according to the first embodiment includes one outdoor unit 11, gas-side piping 12, a branching device 14A, a branching device 14B, a branching device 17A, a branching device 17B, liquid-side piping 16, an indoor unit 18, and an indoor unit 19.

[0034] The outdoor unit 11 includes a compressor 21, discharge piping 22, a four-way selector valve 23, gas piping 24, 26, and 36, an outdoor heat exchanger 25, an outdoor expansion valve 27 for heating (EEVH), a receiver 28, liquid piping 29, intake piping 31, liquid piping 32, a control box (not illustrated), a cooling device 34, an accumulator 35, a gas-side operation valve 37, a liquid-side operation valve 39, and an outdoor fan 41.

[0035] The compressor 21 is connected to a first end of the discharge piping 22 and a second end of the intake piping 31. The compressor 21 compresses a refrigerant to generate a high-temperature, high-pressure refrigerant gas. The high-temperature, high-pressure refrigerant gas is supplied to the four-way selector valve 23 via the discharge piping 22. A second end of the discharge piping 22 is connected to the four-way selector valve 23.

[0036] The four-way selector valve 23 is connected to the gas piping 24, the intake piping 31, and a second end of the gas piping 36. The four-way selector valve 23 is a valve for switching piping that supplies the high-temperature, high-pressure refrigerant gas supplied via the discharge piping 22 (in other words, for switching a circulation path of the refrigerant).

[0037] The outdoor heat exchanger 25 is connected to a second end of the gas piping 24 and a first end of the gas piping 26. The outdoor heat exchanger 25 causes

the refrigerant supplied from the gas piping 24 or the gas piping 26 and outside air supplied from the outdoor fan 41 to exchange heat.

[0038] A part of the gas piping 26 penetrates the receiver 28 such that a second end of the gas piping 26 is disposed in the receiver 28.

[0039] The outdoor expansion valve 27 is provided in the gas piping 26 located between the outdoor heat exchanger 25 and the receiver 28.

[0040] The receiver 28 is a tank that stores a refrigerant in a fluid state (hereinafter simply referred to as a "liquid refrigerant").

[0041] A part of the liquid piping 29 penetrates the receiver 28 such that a first end of the liquid piping 29 is disposed in the receiver 28. A second end of the liquid piping 29 is connected to the liquid-side operation valve 39.

[0042] The second end of the intake piping 31 is connected to the compressor 21.

[0043] The liquid piping 32 includes a first refrigerant tube 32A and a second refrigerant tube 32B. The first refrigerant tube 32A is branched from the intake piping 31 located between the four-way selector valve 23 and the accumulator 35. The first refrigerant tube 32A is connected to the cooling device 34. Some of the liquid refrigerant flowing through the intake piping 31 flows into the first refrigerant tube 32A. In other words, the liquid refrigerant is introduced into the cooling device 34 via the first refrigerant tube 32A.

[0044] The second refrigerant tube 32B is branched from the liquid piping 29 located between the receiver 28 and the liquid-side operation valve 39. The second refrigerant tube 32B is connected to the cooling device 34. A liquid refrigerant passing through the cooling device 34 and contributing to heat exchange is led into the second refrigerant tube 32B. The liquid refrigerant led into the second refrigerant tube 32B flows into the intake piping 31.

[0045] The first and second refrigerant tubes 32A and 32B are formed of a metallic material having a high coefficient of thermal conductivity. For example, copper can be used as the metallic material forming the first and second refrigerant tubes 32A and 32B.

[0046] The control box (not illustrated) houses a cooling subject 33 that generates heat and the cooling device 34. The cooling subject 33 is disposed so as to contact a metallic member 45 forming the cooling device 34. For example, a power element, a diode module, a reactor, and the like can be exemplified as the cooling subject 33.

[0047] FIG. 2 is an enlarged view of a portion surrounded as a region A of the refrigeration cycle device illustrated in FIG. 1. In FIG. 2, the same reference signs are used for constituent components that are the same as those illustrated in FIG. 1. In FIG. 2, an X direction indicates a width direction of a metallic member main body 51 while a Y direction indicates a length direction of the metallic member main body 51.

[0048] FIG. 3 is a diagram schematically illustrating s

state where a first connect tube and a second connect tube are located away from the metallic member with the exclusion of a first moisture suppressing member and a second moisture suppressing member from a structural body illustrated in FIG. 2. In FIG. 3, the same reference signs are used for constituent components that are the same as those illustrated in FIG. 2.

[0049] FIG. 4 is a diagram when the metallic member illustrated in FIG. 3 is seen from a B view. In FIG. 4, the same reference signs are used for constituent components that are the same as those illustrated in FIG. 3. A Z direction illustrated in FIG. 4 indicates a thickness direction of the metallic member main body 51 orthogonal to the X direction.

[0050] With reference to FIGS. 1 to 4, the cooling device 34 includes the metallic member 45, a first connect tube 46, a second connect tube 47, a first moisture suppressing member 59, and a second moisture suppressing member 62.

[0051] The metallic member 45 includes the metallic member main body 51, a first opening 52, a second opening 54, and a refrigerant flow path 56.

[0052] The metallic member main body 51 is a metal block having a predetermined thickness. The metallic member main body 51 includes a pair of outer surfaces 51a and 51b orthogonal to the Y direction.

[0053] A metallic material forming the metallic member main body 51 is preferably a metallic material having a high coefficient of thermal conductivity (for example, aluminum, copper, and the like). For example, lightweight and inexpensive aluminum is more preferable as the metallic material forming the metallic member main body 51.

[0054] Note that FIGS. 2 and 3 exemplify a rectangle as an example of a shape of the metallic member main body 51 in plan view, but the shape of the metallic member main body 51 is not limited to this.

[0055] The first opening 52 is provided in the metallic member main body 51 while being exposed from the outer surface 51a of the metallic member main body 51. The first opening 52 is connected to a first end portion 46A of the first connect tube 46. The refrigerant in the fluid state flowing through the first refrigerant tube 32A is introduced into the first opening 52 via the first connect tube 46.

[0056] The second opening 54 is provided in the metallic member main body 51 while being exposed from the outer surface 51a of the metallic member main body 51. The second opening 54 is disposed on the same outer surface 51a side as the first opening 52. The second opening 54 is located away from the first opening 52 in the X direction.

[0057] The second opening 54 is connected to a first end portion 47A of the second connect tube 47. The liquid refrigerant flowing through the refrigerant flow path 56 to contribute to cooling of the cooling subject 33 and having a temperature increased is led out from the second opening 54 into the second connect tube 47.

[0058] The refrigerant flow path 56 is provided in the

metallic member main body 51 so as to be connected to the first opening 52 and the second opening 54. The refrigerant flow path 56 has a U shape. The refrigerant flow path 56 is a flow path defined by the metallic member main body 51. The liquid refrigerant is introduced into the refrigerant flow path 56 via the first opening 52. The refrigerant flows through the refrigerant flow path 56 while directly contacting a portion of the metallic member main body 51 that defines the refrigerant flow path 56 (a part of the metallic member main body 51).

[0059] The metallic member 45 having the above-described configuration causes the cooling subject 33 generating heat and the refrigerant flowing through the refrigerant flow path 56 to exchange heat and thus cools the cooling subject 33.

[0060] In this way, the refrigerant flow path 56 through which the refrigerant flows while contacting with the metallic member main body 51 is provided in the metallic member main body 51. Thus, the refrigerant can directly cool the metallic member main body 51. As a result, the cooling subject 33 that is housed in the control box and generates heat can be efficiently cooled by the cold of the refrigerant via the metallic member main body 51.

[0061] The first connect tube 46 is piping having an L shape. The first connect tube 46 is formed of a metallic material that is the same as that for the metallic member main body 51 and different from that for the first refrigerant tube 32A. For example, in a case where a metallic material for the metallic member main body 51 is aluminum and a metallic material for the first refrigerant tube 32A is copper, aluminum can be used as a metallic material for the first connect tube 46.

[0062] The first end portion 46A of the first connect tube 46 is connected to the first opening 52. The first end portion 46A is affixed to the first opening 52 by welding or brazing.

[0063] In a case where the first end portion 46A is joined to the first opening 52 by welding, a welded portion (not illustrated) is formed at a connection portion between the first end portion 46A and the first opening 52. The welded portion is formed by solidifying the first end portion 46A and the first opening 52 after melting.

[0064] In a case where the first end portion 46A is joined to the first opening 52 by brazing, a brazed portion (not illustrated) is formed at the connection portion between the first end portion 46A and the first opening 52. The brazed portion is formed by solidifying an alloy (solder) having a melting point lower than that of a metallic material forming the metallic member main body 51 and the first connect tube 46 after melting.

[0065] In this way, the first connect tube 46 formed of the metallic material that is the same as that for the metallic member main body 51 and different from that for the first refrigerant tube 32A is connected to the first opening 52 provided in the metallic member main body 51. Thus, the same metallic material is joined together. This can easily join the first connect tube 46 and the first opening 52 together in an excellent state.

[0066] Note that in the case where the first end portion 46A of the first connect tube 46 is joined to the first opening 52, the first end portion 46A and the first opening 52 may be joined together while the first end portion 46A is partially inserted in the first opening 52.

[0067] A second end portion 46B is connected to the first refrigerant tube 32A. As described above, the first connect tube 46 is formed of the same metallic material as that for the metallic member main body 51. Thus, different kinds of metal are joined together between the second end portion 46B and the first refrigerant tube 32A. Therefore, moisture adhering to a connection portion 58 between the second end portion 46B and the first refrigerant tube 32A may cause contact corrosion between dissimilar metals.

[0068] The second end portion 46B is affixed to the first refrigerant tube 32A by welding or brazing.

[0069] In a case where the second end portion 46B is joined to the first refrigerant tube 32A by welding, a welded portion (not illustrated) is formed at the connection portion 58 between the second end portion 46B and the first refrigerant tube 32A.

[0070] In a case where the second end portion 46B is joined to the first refrigerant tube 32A by brazing, a brazed portion (not illustrated) is formed at the connection portion 58 between the second end portion 46B and the first refrigerant tube 32A.

[0071] The second connect tube 47 is piping having an L shape. The second connect tube 47 is formed of a metallic material that is the same as that for the metallic member main body 51 and different from that for the second refrigerant tube 32B. For example, in a case where a metallic material for the metallic member main body 51 is aluminum and a metallic material for the second refrigerant tube 32B is copper, aluminum can be used as a metallic material for the second connect tube 47.

[0072] The first end portion 47A of the second connect tube 47 is connected to the first opening 52. The first end portion 47A is affixed to the second opening 54 by welding or brazing.

[0073] In a case where the first end portion 47A is joined to the second opening 54 by welding, a welded portion (not illustrated) is formed at a connection portion between the first end portion 47A and the second opening 54. The welded portion is formed by solidifying the first end portion 47A and the second opening 54 after melting.

[0074] In a case where the first end portion 47A is joined to the second opening 54 by brazing, a brazed portion (not illustrated) is formed at the connection portion between the first end portion 47A and the second opening 54. The brazed portion is formed by solidifying an alloy (solder) having a melting point lower than that of a metallic material forming the metallic member main body 51 and the second connect tube 47 after melting.

[0075] In this way, the second connect tube 47 formed of the metallic material that is the same as that for the metallic member main body 51 and different from that for the first refrigerant tube 32A is connected to the second

opening 54 provided in the metallic member main body 51. Thus, the same metallic material is joined together. This can easily join the second connect tube 47 and the second opening 54 together in an excellent state.

[0076] Note that in the case where the first end portion 47A of the second connect tube 47 is joined to the second opening 54, the first end portion 47A and the second opening 54 may be joined together while the first end portion 47A is partially inserted in the second opening 54.

[0077] A second end portion 47B is connected to the second refrigerant tube 32B. As described above, the second connect tube 47 is formed of the same metallic material as that for the metallic member main body 51. Thus, different kinds of metal are joined together between the second end portion 47B and the second refrigerant tube 32B. Therefore, moisture adhering to a connection portion 61 between the second end portion 47B and the second refrigerant tube 32B may cause contact corrosion between dissimilar metals.

[0078] The second end portion 47B is affixed to the second refrigerant tube 32B by welding or brazing.

[0079] In a case where the second end portion 47B is joined to the second refrigerant tube 32B by welding, a welded portion (not illustrated) is formed at the connection portion 61 between the second end portion 47B and the second refrigerant tube 32B.

[0080] In a case where the second end portion 47B is joined to the second refrigerant tube 32B by brazing, a brazed portion (not illustrated) is formed at the connection portion 61 between the second end portion 47B and the second refrigerant tube 32B.

[0081] The first moisture suppressing member 59 is provided so as to cover the connection portion 58. The first moisture suppressing member 59 is a member for suppressing adhesion of moisture from the outside to a portion at which different kinds of metallic materials are connected. For example, a tube capable of suppressing transmission of moisture can be used as the first moisture suppressing member 59.

[0082] Specifically, for example, a heat-shrinkable tube can be used as the first moisture suppressing member 59.

[0083] In this way, the first moisture suppressing member 59 is disposed so as to cover the connection portion between the first connect tube 46 and the first refrigerant tube 32A, so that the first moisture suppressing member 59 can suppress adhesion of moisture to the connection portion 58 at which different metallic materials are connected. This can suppress occurrence of contact corrosion between dissimilar metals at the connection portion 58.

[0084] The second moisture suppressing member 62 is provided so as to cover the connection portion 61. The second moisture suppressing member 62 is a member for suppressing adhesion of moisture from the outside to a portion at which different kinds of metallic materials are connected. Specifically, for example, the same member as the first moisture suppressing member 59 described

above can be used as the second moisture suppressing member 62.

[0085] In this way, the second moisture suppressing member 62 covering the connection portion 61 between the second connect tube 47 and the second refrigerant tube 32B is provided, so that the second moisture suppressing member 62 can suppress adhesion of moisture to the connection portion 61 at which different metallic materials are connected. This can suppress occurrence of contact corrosion between dissimilar metals at the connection portion 61.

[0086] With reference to FIG. 1, the accumulator 35 is provided in the intake piping 31 located between the branched position of the second refrigerant tube 32B and the compressor 21.

[0087] The accumulator 35 separates a liquid portion of a component contained in the refrigerant suctioned into the compressor 21 and causes the compressor 21 to suction only a gas portion.

[0088] A second end of the gas piping 36 is connected to the gas-side operation valve 37. The liquid-side operation valve 39 is connected to a second end of the liquid piping 29.

[0089] The outdoor fan 41 is located at a position so as to face the outdoor heat exchanger 25.

[0090] A first end of the gas-side piping 12 is connected to the gas-side operation valve 37 while a second end of the gas-side piping 12 is connected to the branching device 14A.

[0091] The branching device 14A divides branched gas-side piping 12A and is connected to a first end of the branched gas-side piping 12A. The branching device 14B divides branched gas-side piping 12B and is connected to a first end of the branched gas-side piping 12B.

[0092] The branched gas-side piping 12A is connected to the indoor unit 18. The branched gas-side piping 12B is connected to the indoor unit 19.

[0093] A first end of the liquid-side piping 16 is connected to the liquid-side operation valve 39 while a second end of the liquid-side piping 16 is connected to the branching device 17A.

[0094] The branching device 17A divides branched liquid-side piping 16A and is connected to a first end of the branched liquid-side piping 16A. The branching device 17B divides branched liquid-side piping 16B and is connected to a first end of the branched liquid-side piping 16B.

[0095] The branched liquid-side piping 16A is connected to the indoor unit 18. The branched liquid-side piping 16B is connected to the indoor unit 19.

[0096] The indoor unit 18 includes an indoor heat exchanger 71 that causes the refrigerant and inside air to exchange heat and thus performs indoor air conditioning, an indoor expansion valve for cooling 72 (EEVC), and an indoor fan 74 that circulates the inside air via the indoor heat exchanger 71.

[0097] The indoor heat exchanger 71 is connected to the branched gas-side piping 12A. The indoor expansion

valve 72 is connected to the branched liquid-side piping 16A.

[0098] The indoor unit 19 has the same configuration as that of the above-described indoor unit 18. The indoor heat exchanger 71 forming the indoor unit 19 is connected to the branched gas-side piping 12B. The indoor expansion valve 72 forming the indoor unit 19 is connected to the branched liquid-side piping 16B.

[0099] In the refrigeration cycle device 10 having the above-described configuration, heating operation is performed by the following technique. The high-temperature, high-pressure refrigerant gas that has been compressed by the compressor 21 is discharged to the discharge piping 22, and is then circulated to the gas piping 36 side by the four-way selector valve 23. This refrigerant is led out from the outdoor unit 11 via the gas-side operation valve 37 and the gas-side piping 12, and is further introduced into the indoor units 18 and 19 via the branching devices 14A and 14B and the branched gas-side piping 12A and 12B on the indoor side.

[0100] The high-temperature, high-pressure refrigerant gas introduced into the indoor units 18 and 19 is subjected to heat exchange with the inside air circulated by the indoor fan 74. The inside air is thus heated by the heat exchange and provided for indoor heating.

[0101] On the other hand, the refrigerant is condensed, flows to the branching devices 17A and 17B via the indoor expansion valve 72 and the branched liquid-side piping 16A and 16B, and merges with the refrigerant from other indoor units. The refrigerant then returns to the outdoor unit 11 via the liquid-side piping 16.

[0102] The refrigerant that has returned to the outdoor unit 11 is introduced into the receiver 28 via the liquid-side operation valve 39 and the liquid piping 29. The refrigerant is then stored temporarily, and a circulation amount of the liquid refrigerant is adjusted.

[0103] This liquid refrigerant is supplied to the outdoor expansion valve 27 via the liquid piping 29, is then adiabatically expanded, and subsequently introduced into the outdoor heat exchanger 25.

[0104] In the outdoor heat exchanger 25, heat is exchanged between the refrigerant and the outside air blown from the outdoor fan 41, and the refrigerant absorbs the heat from the outside air and is evaporated and gasified. The gasified refrigerant flows from the outdoor heat exchanger 25 via the gas piping 24, the four-way selector valve 23, and the intake piping 31, merges with the liquid refrigerant led out from the second refrigerant tube 32B, and is then introduced into the accumulator 35.

[0105] In the accumulator 35, the liquid portion contained in the refrigerant is separated, and only the gas portion is suctioned into the compressor 21 and once again compressed in the compressor 21.

[0106] The heating operation is performed by repeating the above-described cycle.

[0107] On the other hand, cooling operation is performed by the following technique.

[0108] The high-temperature, high-pressure refriger-

ant gas compressed in the compressor 21 is discharged to the discharge piping 22. Subsequently, the refrigerant gas is circulated toward the gas piping 24 side by the four-way selector valve 23, and subjected to heat exchange with the outside air blown by the outdoor fan 41 to be condensed and liquefied in the outdoor heat exchanger 25. This liquid refrigerant passes through the outdoor expansion valve 27 and is stored temporarily in the receiver 28.

[0109] The liquid refrigerant having a circulation amount adjusted by the receiver 28 is led out from the outdoor unit 11 to the liquid-side piping 16 via the liquid-side operation valve 39. Then, the liquid refrigerant introduced into the liquid-side piping 16 is diverted to the branched liquid-side piping 16A and 16B of the respective indoor units 18 and 19 by the branching devices 14A and 14B.

[0110] The liquid refrigerant diverted to the branched liquid-side piping 16A and 16B flows into each of the indoor units 18 and 19, is adiabatically expanded by the indoor expansion valve 72 to form a gas-liquid two-phase flow, and is introduced into the indoor heat exchanger 71.

[0111] In the indoor heat exchanger 71, heat is exchanged between the refrigerant forming the gas-liquid two-phase flow and the inside air circulated by the indoor fan 74.

[0112] The inside air is thus cooled by the heat exchange and provided for indoor cooling. On the other hand, the refrigerant is gasified, flows to the branching devices 14A and 14B via the branched gas-side piping 12A and 12B, and merges with the refrigerant gas from other indoor units in the gas-side piping 12.

[0113] The refrigerant gas merged in the gas-side piping 12 returns to the outdoor unit 11 once again, and flows to the intake piping 31 via the gas-side operation valve 37, the gas piping 36, and the four-way selector valve 23.

[0114] In the accumulator 35, the liquid portion contained in the refrigerant is separated, and only the gas portion is suctioned into the compressor 21. This refrigerant is once again compressed in the compressor 21.

[0115] The cooling operation is performed by repeating the cycle described above.

[0116] According to the cooling device 34 in the first embodiment, the refrigerant flow path 56 through which the refrigerant flows while contacting with the metallic member main body 51 is provided in the metallic member main body 51. Thus, the refrigerant can directly cool the metallic member main body 51. As a result, the cooling subject 33 that is housed in the control box and generates heat can be efficiently cooled by the cold of the refrigerant via the metallic member main body 51.

[0117] The refrigeration cycle device 10 in the first embodiment including the cooling device 34 having the above-described configuration can obtain the same effects as those of the above-described cooling device 34.

[0118] Here, a method of manufacturing a cooling device in the first embodiment is simply described with ref-

erence to FIGS. 2 and 3.

[0119] The method of manufacturing a cooling device in the first embodiment includes the steps of: forming, in the previously prepared metallic member main body 51, the first and second openings 52 and 54 and the refrigerant flow path 56 provided in the metallic member main body 51 so as to be connected to the first opening 52 and the second opening 54 by the widely known technique to obtain the metallic member 45; joining the first connect tube 46 formed of the same metallic material as that for the metallic member main body 51 to the first opening 52; and joining the second connect tube 47 formed of the same metallic material as that for the metallic member main body 51 to the second opening 54.

[0120] The refrigerant flow path 56 can be formed by a technique such as machining and electrochemical machining, for example.

[0121] According to the method of manufacturing a cooling device in the first embodiment, the refrigerant flows through the refrigerant flow path 56 while contacting the portion of the metallic member main body 51 that defines the refrigerant flow path 56. Thus, the refrigerant can directly cool the metallic member main body 51. As a result, the cooling subject 33 that is housed in the control box and generates heat can be efficiently cooled by the cold of the refrigerant via the metallic member main body 51.

[0122] The first connect tube 46 is joined to the first opening 52, and the second connect tube 47 is joined to the second opening 54. Thus, the first and second refrigerant tubes 32A and 32B can be joined in a position away from the metallic member main body 51 (the first opening 52 and the second opening 54).

[0123] Thus, for example, in a case where the first and second refrigerant tubes 32A and 32B are formed of a metallic material different from that for the metallic member main body 51, the first and second moisture suppressing members 59 and 62 can be easily provided to the connection portions 58 and 61 (joint portions). This can suppress contact corrosion between dissimilar metals at the connection portions 58 and 61.

[0124] Note that the case where the first and second connect tubes 46 and 47 have an L shape is described as an example in the first embodiment, but the shape of the first and second connect tubes 46 and 47 is not limited to this. The first and second connect tubes 46 and 47 may have, for example, a shape extending in one direction or a shape bent at a plurality of areas.

[0125] In the first embodiment, the case where the cooling device 34 includes the first and second connect tubes 46 and 47 is described as an example. However, the first refrigerant tube 32A may be connected to the first opening 52 while the second refrigerant tube 32B may be connected to the second opening 54 by excluding the first and second connect tubes 46 and 47 from the configuration of the cooling device, and the first and second moisture suppressing members 59 and 62 may be provided at the connection portions.

[0126] Even in a case where the cooling device having such a configuration is used, the cooling subject 33 that is housed in the control box and generates heat can be efficiently cooled.

[0127] In the first embodiment, the case where the metallic material for the metallic member main body 51 is different from the metallic material for the first and second refrigerant tubes 32A and 32B is described as an example. However, the metallic member main body 51, the first refrigerant tube 32A, and the second refrigerant tube 32B may be formed of the same metallic material.

[0128] In this case, contact corrosion between dissimilar metals due to moisture does not occur even in a case where the first refrigerant tube 32A is directly connected to the first opening 52 while the second refrigerant tube 32B is directly connected to the second opening 54. Thus, the first and second moisture suppressing members 59 and 62 can be excluded from the structural components of the cooling device.

[0129] FIG. 5 is a system diagram illustrating a schematic configuration of a refrigeration cycle device according to a first modification of the first embodiment of the present invention. In FIG. 5, the same reference signs are used for constituent components that are the same as those illustrated in FIG. 1.

[0130] FIG. 5 illustrates a case where the first connect tube 46 and the second connect tube 47 forming the cooling device 34 extend in one direction as an example.

[0131] With reference to FIG. 5, a refrigeration cycle device 80 according to the first modification of the first embodiment has the same configuration as that of the refrigeration cycle device 10 except for that the liquid piping 32 forming the refrigeration cycle device 10 in the first embodiment is excluded from the structural components, a first refrigerant tube 29A and a second refrigerant tube 29B form liquid piping 29, and the first refrigerant tube 29A and the second refrigerant tube 29B are connected to the cooling device 34.

[0132] In other words, the refrigeration cycle device 80 is different from the refrigeration cycle device 10 in the arrangement position of the cooling device 34.

[0133] The first refrigerant tube 29A is connected to the first connect tube 46. The second refrigerant tube 29B is connected to the second connect tube 47.

[0134] The refrigeration cycle device 80 having such a configuration can also obtain the same effects as those of the refrigeration cycle device 10 in the first embodiment.

[0135] In the refrigeration cycle device 10 illustrated in FIG. 1 described above, the cooling device 34 is provided to the liquid piping 32 functioning as a bypass line. In contrast, in the refrigeration cycle device 80 illustrated in FIG. 5, the cooling device 34 is provided to the liquid piping 29 functioning as a main line.

[0136] This eliminates the need for the liquid piping 32, and the cooling device 34 can be constructed more easily in the refrigeration cycle device 80 than the refrigeration cycle device 10.

[0137] Therefore, a construction cost of the cooling device 34 can be reduced more in the refrigeration cycle device 80 than the refrigeration cycle device 10.

[0138] FIG. 6 is a system diagram illustrating a schematic configuration of a refrigeration cycle device according to a second modification of the first embodiment of the present invention. In FIG. 6, the same reference signs are used for constituent components that are the same as those illustrated in FIG. 1.

[0139] FIG. 6 illustrates a case where the first connect tube 46 and the second connect tube 47 forming the cooling device 34 extend in one direction as an example.

[0140] With reference to FIG. 6, a refrigeration cycle device 90 according to the second modification of the first embodiment has the same configuration as that of the refrigeration cycle device 10 except for that the liquid piping 32 forming the refrigeration cycle device 10 in the first embodiment is excluded from the structural components, a first refrigerant tube 26A and a second refrigerant tube 26B form gas piping 26, and the first refrigerant tube 26A and the second refrigerant tube 26B are connected to the cooling device 34.

[0141] In other words, the refrigeration cycle device 90 is different from the refrigeration cycle device 10 in the arrangement position of the cooling device 34.

[0142] The first refrigerant tube 26A is connected to the first connect tube 46. The second refrigerant tube 26B is connected to the second connect tube 47.

[0143] The refrigeration cycle device 90 having such a configuration can also obtain the same effects as those of the refrigeration cycle device 10 in the first embodiment.

[0144] The cooling device 34 is provided in the gas piping 26 located between the outdoor heat exchanger 25 and the receiver 28 in the refrigeration cycle device 90. Thus, the cooling device 34 is located on a front stage of the receiver 28 in a flow direction of the refrigerant during the cooling operation.

[0145] Therefore, even in a case where the refrigerant is temporarily brought into a phase state of a two phase in the cooling device 34 during the cooling operation, the refrigeration cycle device 90 can cause the receiver 28 located on a rear stage of the cooling device 34 to bring the refrigerant back into a fluid state.

Second Embodiment

[0146] FIG. 7 is a diagram illustrating a cooling device according to a second embodiment of the present invention. In FIG. 7, the same reference signs are used for constituent components that are the same as those illustrated in FIG. 2.

[0147] With reference to FIG. 7, a cooling device 95 in the second embodiment has the same configuration as that of the cooling device 34 except for that the cooling device 95 includes a metallic member 96 and a first connect tube 97 instead of the metallic member 45 and the first connect tube 46 forming the cooling device 34 in the

first embodiment.

[0148] The metallic member 96 has the same configuration as that of the metallic member 45 except for that the metallic member 96 includes a refrigerant flow path 99 having a length longer than that of the refrigerant flow path 56 instead of the refrigerant flow path 56 forming the metallic member 45 described in the first embodiment and a first opening 52 is provided on an outer surface 51b side of a metallic member main body 51. In this way, the first opening 52 and a second opening 54 may be disposed on the different outer surfaces of the metallic member main body 51.

[0149] A first end of the refrigerant flow path 99 is integrated with the first opening 52, and a second end thereof is integrated with the second opening 54.

[0150] The first connect tube 97 has the same configuration as that of the first connect tube 46 described in the first embodiment except for that the first connect tube 97 is bent at three areas.

[0151] The cooling device 95 in the second embodiment having such a configuration can increase a width of the metallic member main body 51 in the X direction.

[0152] The cooling device 95 in the second embodiment can obtain the same effects as those of the cooling device 34 in the first embodiment described above.

Third Embodiment

[0153] FIG. 8 is a diagram illustrating a cooling device according to a second embodiment of the present invention. In FIG. 8, the same reference signs are used for constituent components that are the same as those illustrated in FIG. 2.

[0154] With reference to FIG. 8, a cooling device 105 in the third embodiment has the same configuration as that of the cooling device 34 except for that the cooling device 105 includes a metallic member 106 instead of the metallic member 45 forming the cooling device 34 in the first embodiment.

[0155] The metallic member 106 has the same configuration as that of the metallic member 45 except for that the metallic member 106 includes a refrigerant flow path 108 having a length longer than that of the refrigerant flow path 56 instead of the refrigerant flow path 56 forming the metallic member 45 described in the first embodiment.

[0156] A first end of the refrigerant flow path 108 is integrated with a first opening 52, and a second end thereof is integrated with a second opening 54. The refrigerant flow path 108 is formed to have a length longer than that of the refrigerant flow path 99 illustrated in FIG. 7.

[0157] The cooling device 105 in the third embodiment having such a configuration can increase a width of the metallic member main body 51 in the X direction more than that of the metallic member main body 51 forming the cooling device 95 in the second embodiment.

[0158] The cooling device 105 in the third embodiment

can obtain the same effects as those of the cooling device 34 in the first embodiment described above.

Fourth Embodiment

[0159] FIG. 9 is a diagram illustrating a cooling device according to a fourth embodiment of the present invention. In FIG. 9, the same reference signs are used for constituent components that are the same as those illustrated in FIG. 2.

[0160] FIG. 10 is a diagram schematically illustrating a state where a metallic member and a U-shaped tube illustrated in FIG. 9 are located away from each other. In FIG. 10, the same reference signs are used for constituent components that are the same as those illustrated in FIG. 9.

[0161] FIG. 11 is a diagram when the metallic member illustrated in FIG. 10 is seen from a C view. In FIG. 11, the same reference signs are used for constituent components that are the same as those illustrated in FIGS. 4 and 10.

[0162] With reference to FIGS. 9 to 11, a cooling device 110 in the fourth embodiment has the same configuration as that of the cooling device 34 except for that the cooling device 110 includes a metallic member 111 and a U-shaped tube 113 instead of the metallic member 45 forming the cooling device 34 in the first embodiment.

[0163] The metallic member 111 has the same configuration as that of the metallic member 45 except for that the metallic member 111 includes a refrigerant flow path 115 instead of the refrigerant flow path 56 forming the metallic member 45 described in the first embodiment.

[0164] The refrigerant flow path 115 includes penetrating flow paths 116 and 117 (a plurality of penetrating flow paths). The penetrating flow paths 116 and 117 penetrate a metallic member main body 51 in the Y direction. The penetrating flow paths 116 and 117 are aligned in the X direction.

[0165] The penetrating flow path 116 includes a first opening 52 disposed at a first end of the penetrating flow path 116 and a third opening 116A disposed at a second end of the penetrating flow path 116. The third opening 116A is disposed on an outer surface 51b side of the metallic member main body 51.

[0166] The penetrating flow path 117 includes a second opening 54 disposed at a first end of the penetrating flow path 117 and a third opening 117A disposed at a second end of the penetrating flow path 117. The third opening 117A is disposed on the outer surface 51b side of the metallic member main body 51. The third openings 116A and 117A are exposed from the same outer surface 51b.

[0167] The U-shaped tube 113 includes a first end portion 113A and a second end portion 113B. The first end portion 113A is connected (joined) to the third opening 116A of the penetrating flow path 116. The second end portion 113B is connected (joined) to the third opening 117A of the penetrating flow path 117. The U-shaped

tube 113 may be formed of, for example, the same metallic material as that for the metallic member main body 51.

[0168] In this way, the U-shaped tube 113 is formed of the same metallic material as that for the metallic member main body 51. Thus, the same metallic material is joined together when the metallic member main body 51 is joined to the U-shaped tube 113. This eliminates occurrence of contact corrosion between dissimilar metals, and thus the U-shaped tube 113 and the metallic member main body can be joined together in an excellent state.

[0169] According to the cooling device 110 in the fourth embodiment, the refrigerant flow path 115 can be easily processed by forming the refrigerant flow path 115 with only the penetrating flow paths 116 and 117 in comparison with a case where the winding refrigerant flow paths 56, 99, and 108 (see FIGS. 2, 7, and 8) are processed.

[0170] Further, the refrigerant flow path 115 having a long length can be provided by using the metallic member main body 51 having the same size as that of the cooling device 34 in the first embodiment.

[0171] Note that the cooling device 110 in the fourth embodiment can obtain the same effects as those of the cooling device 34 in the first embodiment.

Fifth Embodiment

[0172] FIG. 12 is a diagram illustrating a cooling device according to a fifth embodiment of the present invention. In FIG. 12, the same reference signs are used for constituent components that are the same as those illustrated in FIGS. 2 and 7.

[0173] With reference to FIG. 12, a cooling device 120 in the fifth embodiment has the same configuration as that of the cooling device 95 except for that the cooling device 120 includes a metallic member 121 and two U-shaped tubes 113 instead of the metallic member 96 forming the cooling device 95 in the second embodiment.

[0174] The metallic member 121 has the same configuration as that of the metallic member 96 except for that the metallic member 121 includes a refrigerant flow path 123 having a length longer than that of the refrigerant flow path 99 instead of the refrigerant flow path 99 forming the metallic member 96 described in the second embodiment.

[0175] The refrigerant flow path 123 includes penetrating flow paths 124 to 125 (a plurality of penetrating flow paths) penetrating a metallic member main body 51 in the Y direction.

[0176] The penetrating flow path 124 includes a first opening 52 disposed on an outer surface 51b side and a third opening 124A disposed on an outer surface 51a side. The third opening 124A is connected (joined) to a first end portion 113A of one of the U-shaped tubes 113.

[0177] The penetrating flow path 125 has a third opening 125A disposed on the outer surface 51a side and a third opening 125B disposed on the outer surface 51b side. The third opening 125A is connected (joined) to a

second end portion 113B of one of the U-shaped tubes 113. The third opening 125B is connected (joined) to a first end portion 113A of the other U-shaped tube 113.

[0178] The penetrating flow path 126 includes a second opening 54 disposed on the outer surface 51a side and a third opening 126A disposed on the outer surface 51b side. The third opening 126A is connected (joined) to a second end portion 113B of the other U-shaped tube 113.

[0179] As in the above-described cooling device 120 in the fifth embodiment, the three penetrating flow paths 124 to 125 may form the refrigerant flow path 123, and one U-shaped tube 113 may be provided to each of the sides (the outer surface 51a and the outer surface 51b) of the metallic member main body 51.

[0180] The cooling device 120 in the fifth embodiment having such a configuration can obtain the same effects as those of the cooling device 95 in the second embodiment and the cooling device 110 in the fourth embodiment.

Sixth Embodiment

[0181] FIG. 13 is a diagram illustrating a cooling device according to a sixth embodiment of the present invention. In FIG. 13, the same reference signs are used for constituent components that are the same as those illustrated in FIGS. 2 and 8.

[0182] With reference to FIG. 13, a cooling device 130 in the sixth embodiment has the same configuration as that of the cooling device 105 except for that the cooling device 130 includes a metallic member 131 and three U-shaped tubes 113-1 to 113-3 instead of the metallic member 106 forming the cooling device 105 in the third embodiment.

[0183] The metallic member 131 has the same configuration as that of the metallic member 106 except for that the metallic member 131 includes a refrigerant flow path 133 having a length longer than that of the refrigerant flow path 108 instead of the refrigerant flow path 108 forming the metallic member 106 described in the third embodiment.

[0184] The refrigerant flow path 133 includes penetrating flow paths 135 to 138 (a plurality of penetrating flow paths) penetrating a metallic member main body 51 in the Y direction. The penetrating flow paths 135 to 138 are aligned at predetermined intervals in the X direction.

[0185] The penetrating flow path 135 includes a first opening 52 disposed on an outer surface 51a side and a third opening 135A disposed on an outer surface 51b side. The third opening 135A is connected (joined) to a first end portion 113-1A of the U-shaped tube 113-1.

[0186] The penetrating flow path 136 includes a third opening 136A disposed on the outer surface 51b side and a third opening 136B disposed on the outer surface 51a side. The third opening 136A is connected (joined) to a second end portion 113-1B of the U-shaped tube 113-1. The third opening 136B is connected (joined) to

a first end portion 113-2A of the U-shaped tube 113-2.

[0187] The penetrating flow path 137 includes a third opening 137A disposed on the outer surface 51b side and a third opening 137B disposed on the outer surface 51a side. The third opening 137A is connected (joined) to a first end portion 113-3A of the U-shaped tube 113-3. The third opening 137B is connected (joined) to a second end portion 113-2B of the U-shaped tube 113-2.

[0188] The penetrating flow path 138 includes a third opening 138A disposed on the outer surface 51b side and a second opening 54 disposed on the outer surface 51a side. The third opening 138A is connected (joined) to a second end portion 113-3B of the U-shaped tube 113-3.

[0189] The U-shaped tubes 113-1 to 113-3 can be formed of, for example, the same metallic material as that for the metallic member main body 51.

[0190] As in the above-described cooling device 130 in the sixth embodiment, the refrigerant flow path 133 can have a length longer than that of the refrigerant flow path 123 illustrated in FIG. 12 by forming the refrigerant flow path 133 with the four penetrating flow paths 135 to 138.

[0191] The cooling device 130 in the sixth embodiment having such a configuration can obtain the same effects as those of the cooling device 110 in the fourth embodiment.

Seventh Embodiment

[0192] FIG. 14 is a diagram illustrating a cooling device according to a seventh embodiment of the present invention. In FIG. 14, the same reference signs are used for constituent components that are the same as those illustrated in FIG. 9.

[0193] FIG. 15 is a diagram schematically illustrating a state where a U-shaped tube and a metallic member illustrated in FIG. 14 are located away from each other. In FIG. 15, the same reference signs are used for constituent components that are the same as those illustrated in FIG. 14.

[0194] FIG. 16 is a diagram schematically illustrating a stage before U-shaped piping illustrated in FIG. 15 has a diameter expanded. In FIG. 16, the same reference signs are used for constituent components that are the same as those illustrated in FIG. 15.

[0195] With reference to FIGS. 14 to 16, a cooling device 140 in the seventh embodiment has the same configuration as that of the cooling device 110 except for that the cooling device 140 includes U-shaped piping 142 instead of the first connect tube 46, the second connect tube 47, and the U-shaped tube 113 forming the cooling device 110 in the fourth embodiment.

[0196] The U-shaped piping 142 includes a first straight tube portion 144, a second straight tube portion 145, and a U-shaped tube portion 146.

[0197] First ends of the first and second straight tube portions 144 and 145 are formed integrally with the U-

shaped tube portion 146.

[0198] The first straight tube portion 144 extends in the Y direction and has a diameter expanded after being inserted into a penetrating flow path 116. The first straight tube portion 144 has a diameter expanded, thereby being in surface contact with a metallic member main body 51 that defines the penetrating flow path 116. A second end of the first straight tube portion 144 is connected to a first refrigerant tube 32A.

[0199] The second straight tube portion 145 extends in the Y direction and has a diameter expanded after being inserted into a penetrating flow path 117. The second straight tube portion 145 has a diameter expanded, thereby being in surface contact with the metallic member main body 51 that defines the penetrating flow path 117. A second end of the second straight tube portion 145 is connected to a second refrigerant tube 32B.

[0200] The U-shaped tube portion 146 connects the first straight tube portion 144 to the second straight tube portion 145. FIG. 14 does not illustrate a case where the U-shaped tube portion 146 does not have a diameter expanded as an example, but the U-shaped tube portion 146 may have a diameter expanded.

[0201] The U-shaped piping 142 having the above-described configuration may be formed of, for example, the same metallic material having a high coefficient of thermal conductivity as that for the metallic member main body 51.

[0202] For example, aluminum is preferable as the metallic material for the U-shaped piping 142.

[0203] The cooling device 140 in the seventh embodiment can obtain the same effects as those of the cooling device 34 in the first embodiment described above because the outer peripheral surfaces of the first and second straight tube portions 144 and 145 contact the surface of the metallic member main body 51 that defines the penetrating flow paths 116 and 117.

[0204] Next, a method for mounting the first and second straight tube portions 144 and 145 into the penetrating flow paths 116 and 117 will be described.

[0205] First, the U-shaped piping 142 before having a diameter expanded as illustrated in FIG. 16 is prepared. At this stage, an outer diameter of the first and second straight tube portions 144 and 145 are formed to be smaller than an inner diameter of the penetrating flow paths 116 and 117. In other words, when the first and second straight tube portions 144 and 145 are inserted into the penetrating flow paths 116 and 116, a gap is formed between the surface of the metallic member main body 51 that defines the penetrating flow paths 116 and 117 and the outer peripheral surfaces of the first and second straight tube portions 144 and 145.

[0206] Next, the first straight tube portion 144 is inserted into the penetrating flow path 116 formed in a metallic member 111, and the second straight tube portion 145 is inserted into the penetrating flow path 117.

[0207] Subsequently, a process of expanding a diameter of the first and second straight tube portions 144 and

145 is performed. For example, a mechanical tube expanding method with a tube expanding punch, a hydraulic tube expanding method by using water pressure, or the like is used as the method for expanding a diameter.

[0208] Thus, the outer peripheral surfaces of the first and second straight tube portions 144 and 145 contact the surface of the metallic member main body 51 that defines the penetrating flow paths 116 and 117.

[0209] Although preferable embodiments of the present invention have been described above in detail, the present invention is not limited to those specific embodiments. Various modifications and changes can be made to the embodiments without departing from the scope and spirit of the present invention described in the claims.

Industrial Applicability

[0210] The present invention is applicable to a cooling device, a refrigeration cycle device, and a method of manufacturing a cooling device.

Reference Signs List

[0211]

- 10, 80, 90 Refrigeration cycle device
- 11 Outdoor unit
- 12 Gas-side piping
- 12A, 12B Branched gas-side piping
- 14A, 14B, 17A, 17B Branching device
- 16 Liquid-side piping
- 16A, 16B Branched liquid-side piping
- 18, 19 Indoor unit
- 21 Compressor
- 22 Discharge piping
- 23 Four-way selector valve
- 24, 26, 36 Gas piping
- 25 Outdoor heat exchanger
- 27 Outdoor expansion valve
- 28 Receiver
- 29, 32 Liquid piping
- 31 Intake piping
- 26A, 29A, 32A First refrigerant tube
- 26B, 29B, 32B Second refrigerant tube
- 33 Cooling subject
- 34, 95, 105, 110, 120, 130, 140 Cooling device
- 35 Accumulator
- 37 Gas-side operation valve
- 39 Liquid-side operation valve
- 41 Outdoor fan
- 45, 96, 106, 111, 121, 131 Metallic member
- 46, 97 First connect tube
- 46A, 47A First end portion
- 46B, 47B Second end portion
- 47 Second connect tube
- 51 Metallic member main body
- 51A, 51b Outer surface

52 First opening
 54 Second opening
 56, 99, 108, 115, 123, 133 Refrigerant flow path
 58, 61 Connection portion
 59 First moisture suppressing member 5
 62 Second moisture suppressing member
 71 Indoor heat exchanger
 72 Indoor expansion valve
 74 Indoor fan
 113, 113-1, 113-2, 113-3 U-shaped tube 10
 113A, 113-1A, 113-2A, 113-3A First end portion
 113B, 113-1B, 113-2B, 113-3B Second end portion
 116, 117, 124 to 126, 135 to 138 Penetrating flow path
 116A, 117A, 124A, 125A, 125B, 126A, 135A, 136A, 15
 136B, 137A, 137B, 138A Third opening
 142 U-shaped piping
 144 First straight tube portion
 145 Second straight tube portion
 146 U-shaped tube portion 20

Claims

1. A cooling device for causing a cooling subject that is housed in a control box and generates heat and a refrigerant circulated in a refrigeration cycle device to exchange heat and thus cools the cooling subject, the cooling device comprising:
 - a metallic member including
 - a metallic member main body,
 - a pair of openings provided in the metallic member main body while being exposed from an outer surface of the metallic member main body and functioning as an entrance and an exit of the refrigerant, and
 - a refrigerant flow path provided in the metallic member main body while being connected to the pair of openings and through which the refrigerant flows,
 - wherein a portion of the metallic member main body that defines the refrigerant flow path contacts the refrigerant.
2. The cooling device according to claim 1, wherein the pair of openings include a first opening and a second opening, the cooling device includes:
 - a first connect tube formed of a metallic material that is the same as that for the metallic member main body and different from that for a first refrigerant tube forming the refrigeration cycle device; and
 - a second connect tube formed of a metallic material that is the same as that for the metallic member main body and different from that for a
- second refrigerant tube forming the refrigeration cycle device,
- a first end of the first connect tube is connected to the first opening, and a second end of the first connect tube is connected to the first refrigerant tube, and
- a first end of the second connect tube is connected to the second opening, and a second end of the second connect tube is connected to the second refrigerant tube.
3. The cooling device according to claim 1 or 2, wherein the refrigerant flow path includes a plurality of penetrating flow paths that penetrate the metallic member main body in a predetermined direction, the plurality of penetrating flow paths are provided in the metallic member main body and include third openings each disposed at an end to be exposed from an outer surface of the metallic member main body, and the cooling device further includes a U-shaped tube connected to two of the third openings provided in adjacent positions.
4. The cooling device according to claim 3, wherein the U-shaped tube is formed of the same metallic material as that for the metallic member main body.
5. The cooling device according to claim 2 further comprising:
 - a first moisture suppressing member covering a connection portion between the first connect tube and the first refrigerant tube; and
 - a second moisture suppressing member covering a connection portion between the second connect tube and the second refrigerant tube.
6. A refrigeration cycle device comprising:
 - an outdoor unit including the cooling device according to any one of claims 1 to 5; and
 - an indoor unit connected to the outdoor unit while the refrigerant flowing through the outdoor unit can be introduced into or led out from the indoor unit.
7. A method of manufacturing a cooling device including a metallic member that causes a cooling subject that is housed in a control box and generates heat and a refrigerant to exchange heat and thus cools the cooling subject, the method of manufacturing a cooling device comprising the steps of:
 - forming a first opening and a second opening functioning as an entrance and an exit of the refrigerant in a metallic member main body and

a refrigerant flow path provided in the metallic member main body so as to be connected to the first opening and the second opening to obtain the metallic member;
 joining a first connect tube formed of the same metallic material as that for the metallic member main body to the first opening; and
 joining a second connect tube formed of the same metallic material as that for the metallic member main body to the second opening.

Amended claims under Art. 19.1 PCT

1. [Amended] A cooling device for causing a cooling subject that is housed in a control box and generates heat and a refrigerant circulated in a refrigeration cycle device to exchange heat and thus cools the cooling subject, the cooling device comprising:

a metallic member including
 a metallic member main body,
 a pair of openings provided in the metallic member main body while being exposed from an outer surface of the metallic member main body and functioning as an entrance and an exit of the refrigerant, and
 a refrigerant flow path provided in the metallic member main body while being connected to the pair of openings and through which the refrigerant flows,
 wherein a portion of the metallic member main body that defines the refrigerant flow path contacts the refrigerant,
 the pair of openings include a first opening and a second opening,
 the cooling device further includes:

a first connect tube formed of a metallic material that is the same as that for the metallic member main body and different from that for a first refrigerant tube forming the refrigeration cycle device; and
 a second connect tube formed of a metallic material that is the same as that for the metallic member main body and different from that for a second refrigerant tube forming the refrigeration cycle device,

a first end of the first connect tube is connected to the first opening, and a second end of the first connect tube is connected to the first refrigerant tube, and
 a first end of the second connect tube is connected to the second opening, and a second end of the second connect tube is connected to the second refrigerant tube.

2. [Deleted]

3. [Amended] The cooling device according to claim 1,
 wherein the refrigerant flow path includes a plurality of penetrating flow paths that penetrate the metallic member main body in a predetermined direction,
 the plurality of penetrating flow paths are provided in the metallic member main body and include third openings each disposed at an end to be exposed from an outer surface of the metallic member main body, and
 the cooling device further includes a U-shaped tube connected to two of the third openings provided in adjacent positions.

4. The cooling device according to claim 3,
 wherein the U-shaped tube is formed of the same metallic material as that for the metallic member main body.

5. [Amended] The cooling device according to claim 1 further comprising:

a first moisture suppressing member covering a connection portion between the first connect tube and the first refrigerant tube; and
 a second moisture suppressing member covering a connection portion between the second connect tube and the second refrigerant tube.

6. [Amended] A refrigeration cycle device comprising:

an outdoor unit including the cooling device according to any one of Claims 1 and 3 to 5; and
 an indoor unit connected to the outdoor unit while the refrigerant flowing through the outdoor unit can be introduced into or led out from the indoor unit.

7. [Amended] A method of manufacturing a cooling device including a metallic member that causes a cooling subject that is housed in a control box and generates heat and a refrigerant circulated in a refrigeration cycle device to exchange heat and thus cools the cooling subject, the method of manufacturing a cooling device comprising the steps of:

forming a first opening and a second opening functioning as an entrance and an exit of the refrigerant in a metallic member main body and a refrigerant flow path provided in the metallic member main body so as to be connected to the first opening and the second opening to obtain the metallic member;
 joining a first end of a first connect tube formed of a metallic material that is the same as that for

the metallic member main body and different
from that for a first refrigerant tube forming the
refrigeration cycle device to the first opening;
joining a first end of a second connect tube
formed of a metallic material that is the same as 5
that for the metallic member main body and dif-
ferent from that for a second refrigerant tube
forming the refrigeration cycle device to the sec-
ond opening;
connecting a second end of the first connect 10
tube to the first refrigerant tube; and
connecting a second end of the second connect
tube to the second refrigerant tube.

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Statement under Art. 19.1 PCT

Claims 1 and 7 are amended as indicated on the
attached sheets. Specifically, the configuration of Claim
2 was added to the pre-amendment Claim 1. The limita- 20
tions (support of the amendment; paragraphs [0026] to
[0028] and paragraphs [0033] to [0054]) were added to
the pre-amendment Claim 7. The pre-amendment Claim
2 was deleted.

Along with the deletion of the pre-amendment Claim 25
2, the dependency relationships of the pre-amendment
Claims 3, 5, and 6 were revised.

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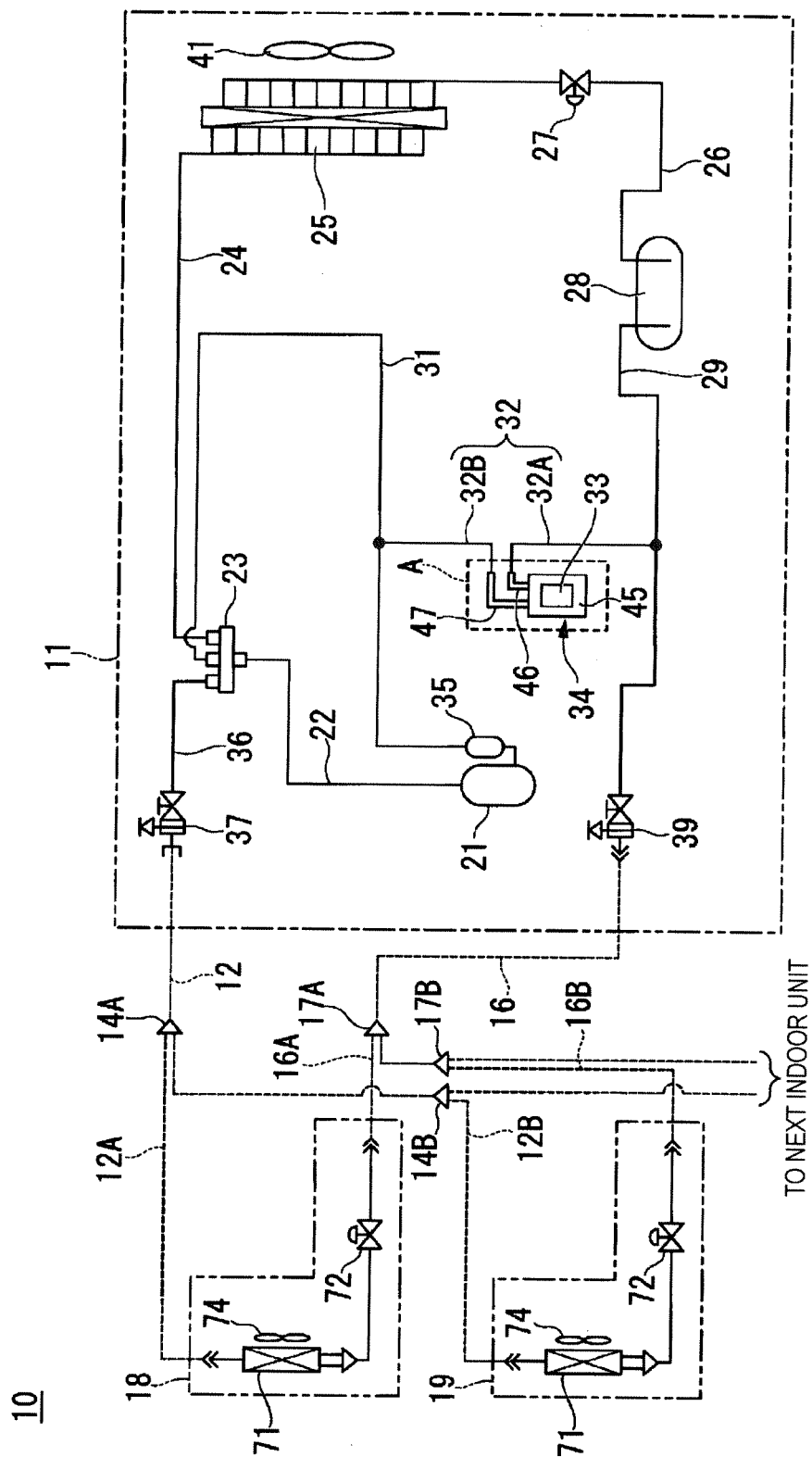


FIG. 1

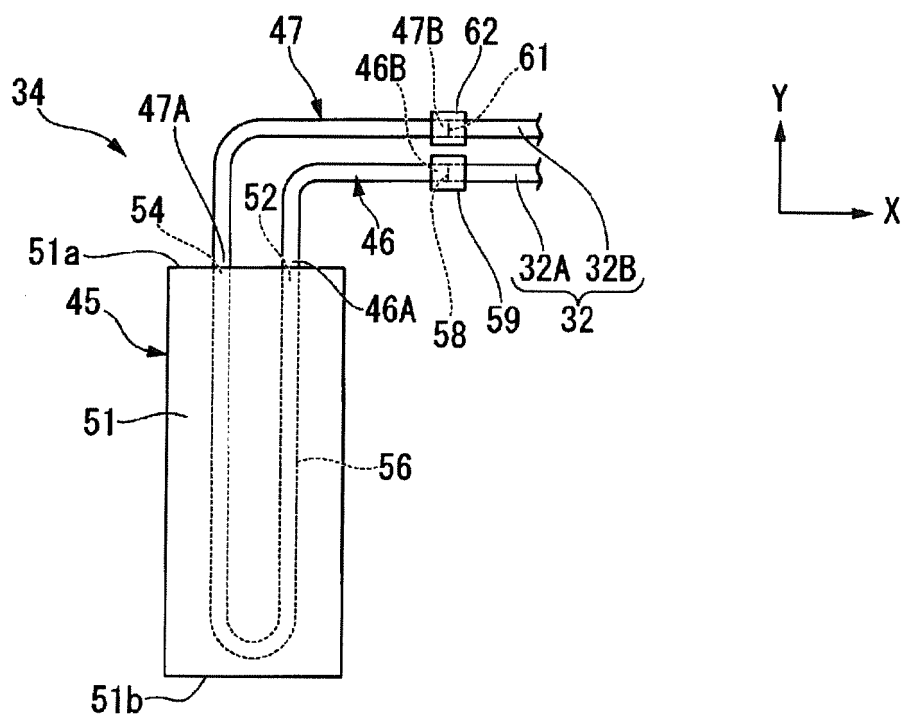


FIG. 2

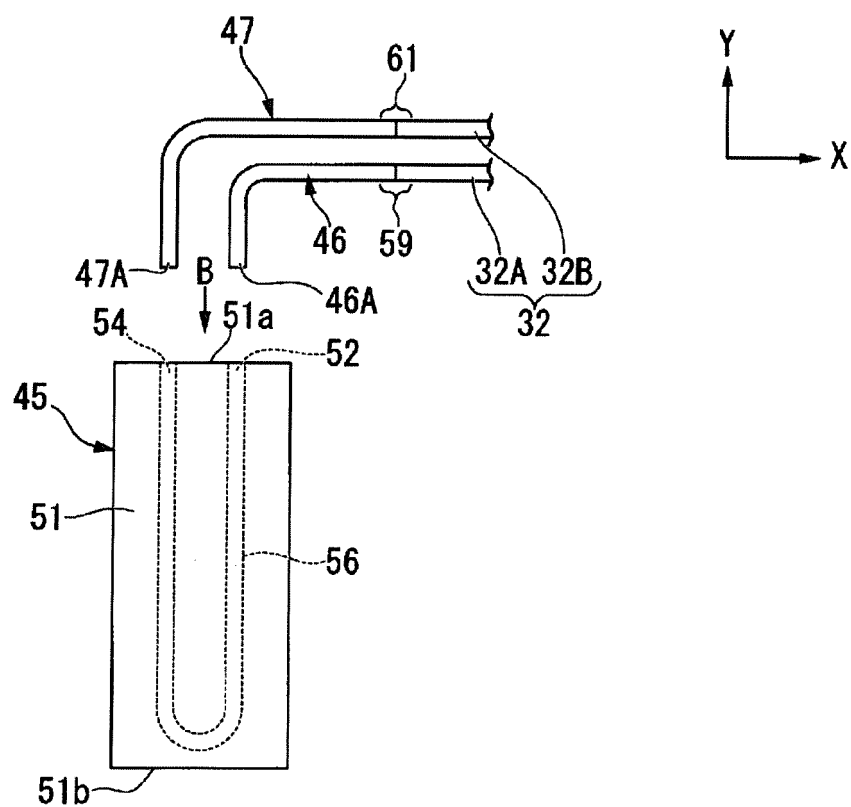


FIG. 3

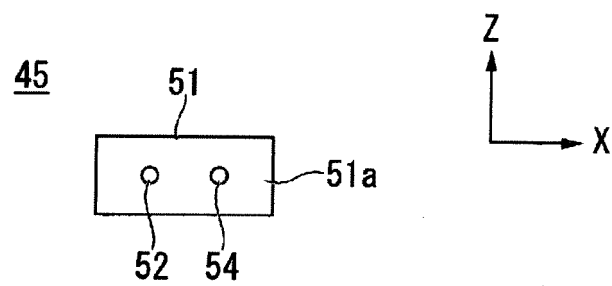


FIG. 4

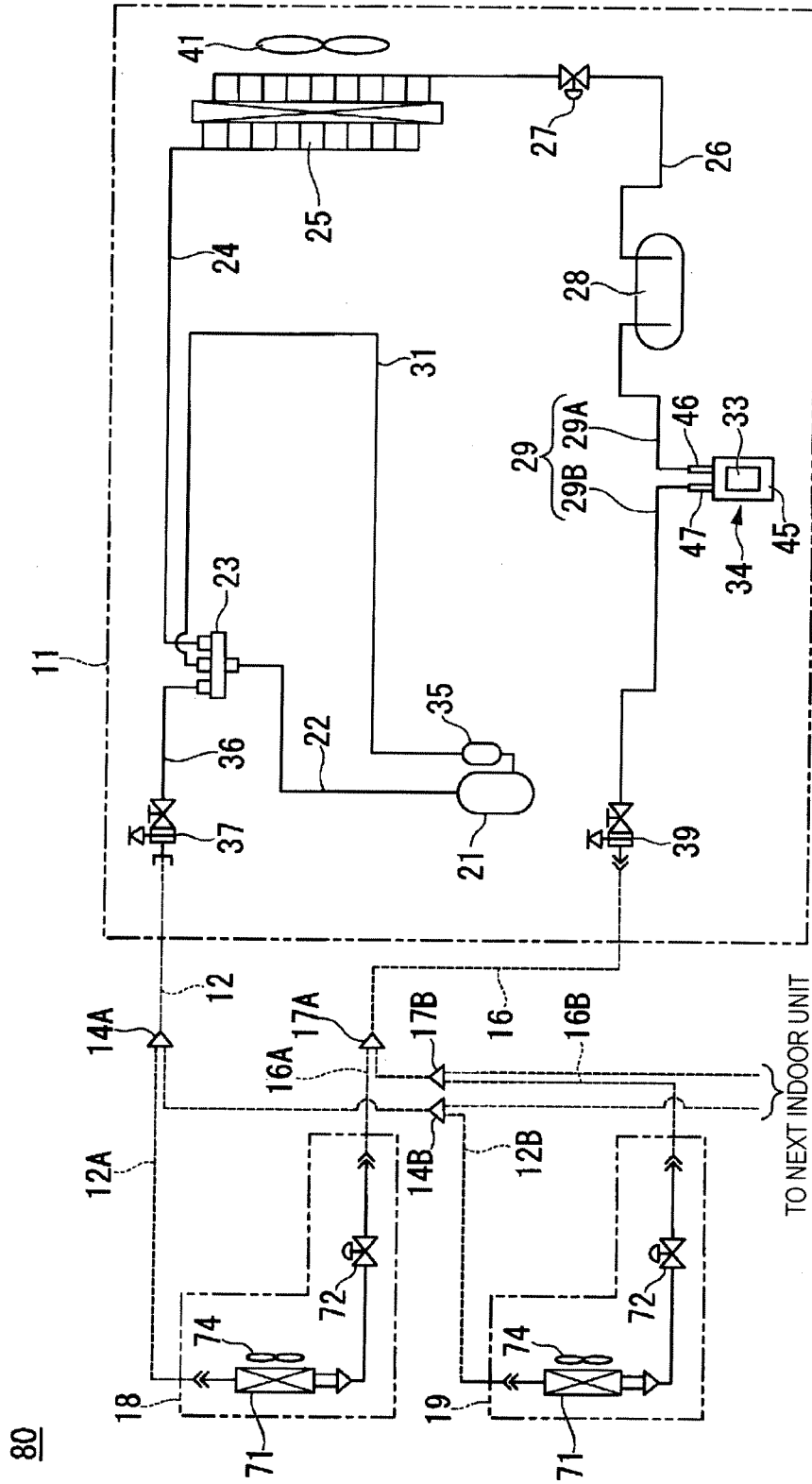


FIG. 5

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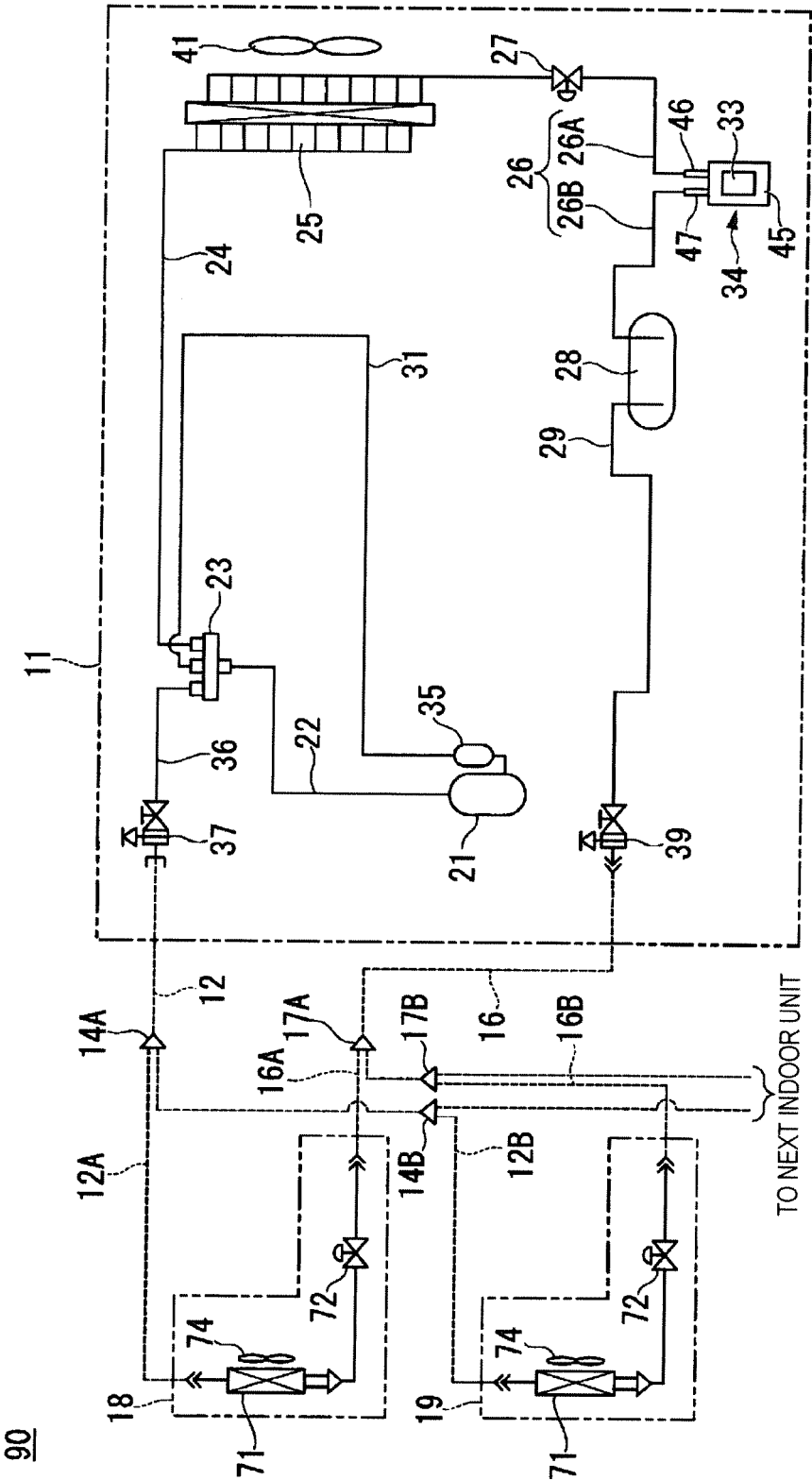


FIG. 6

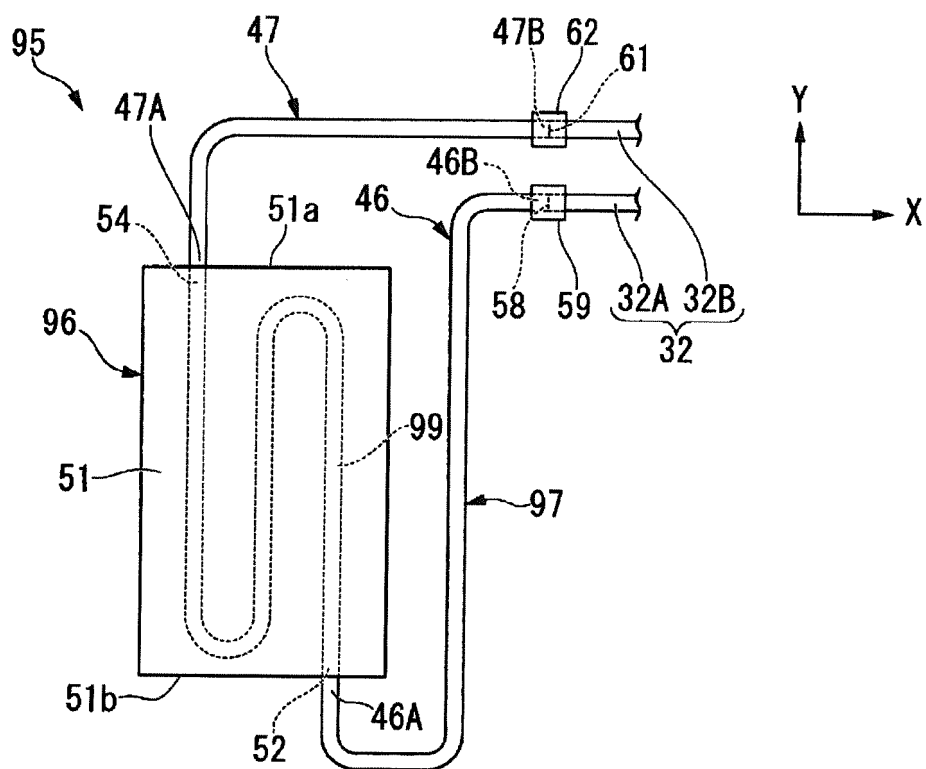


FIG. 7

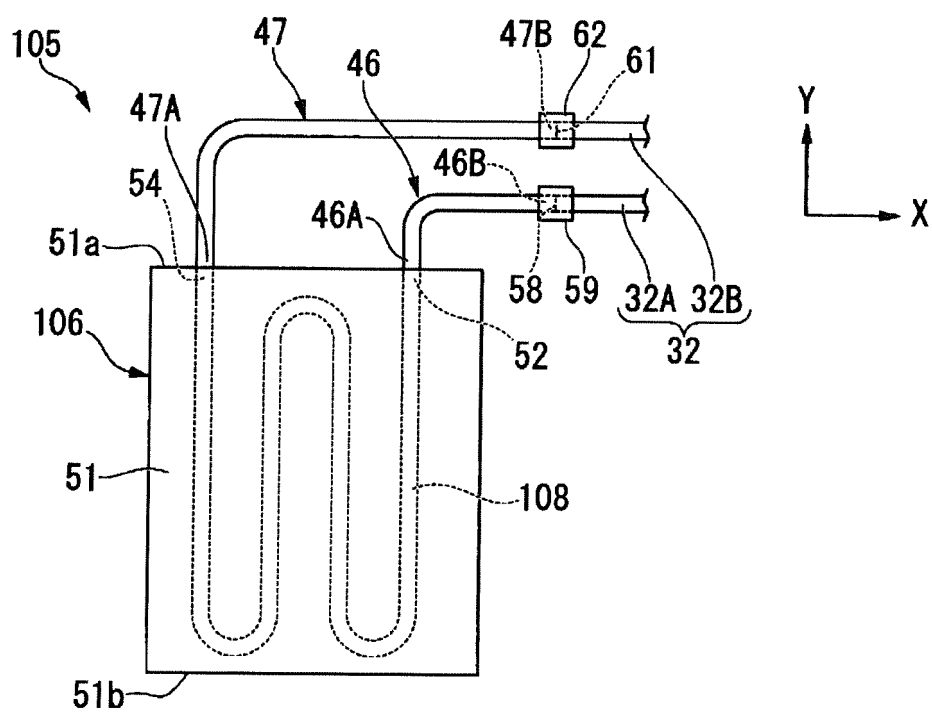


FIG. 8

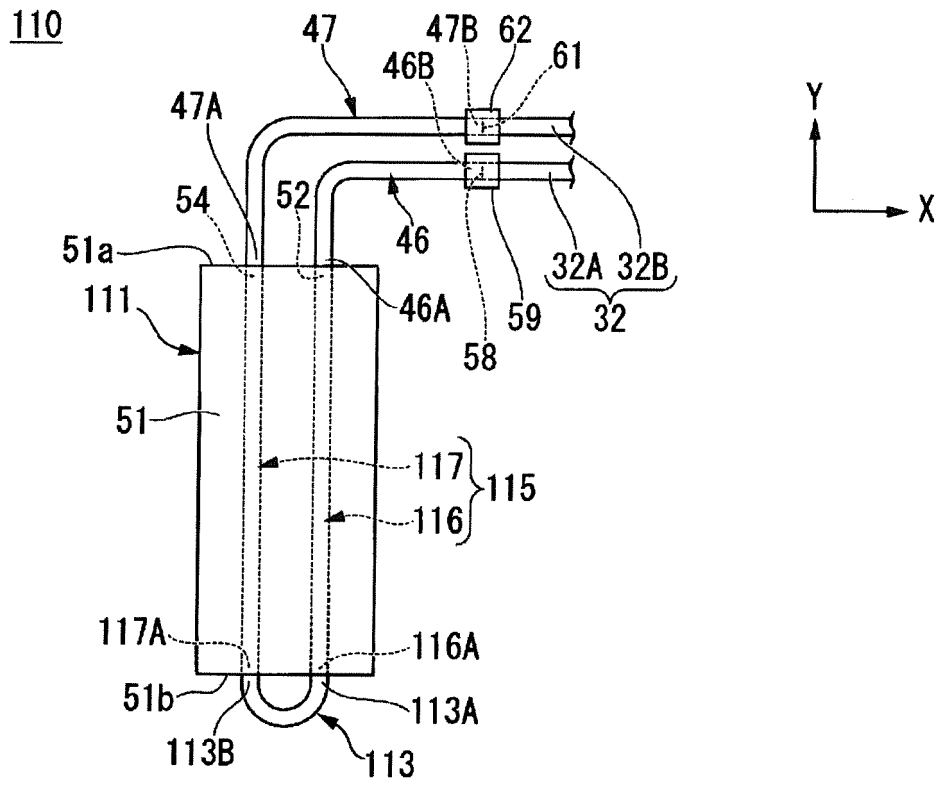


FIG. 9

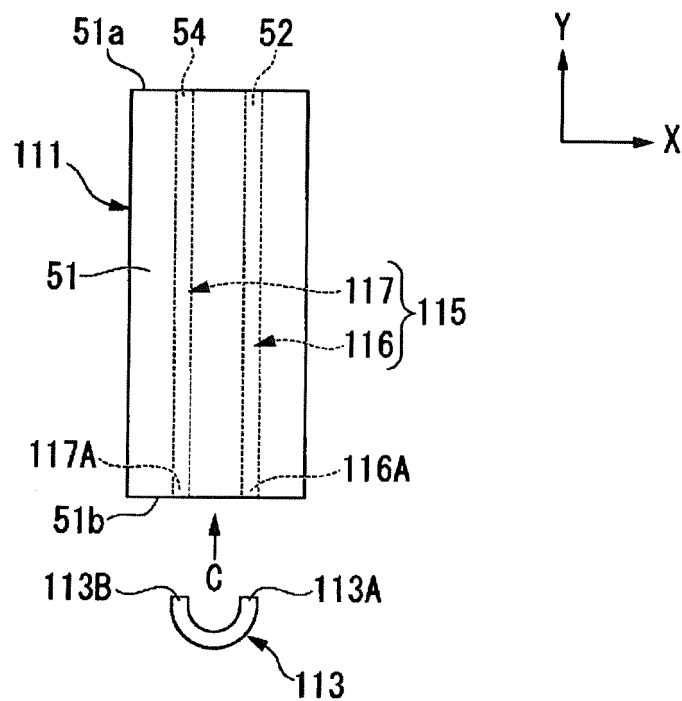


FIG. 10

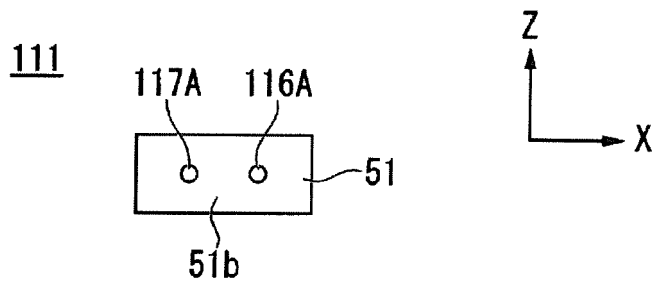


FIG. 11

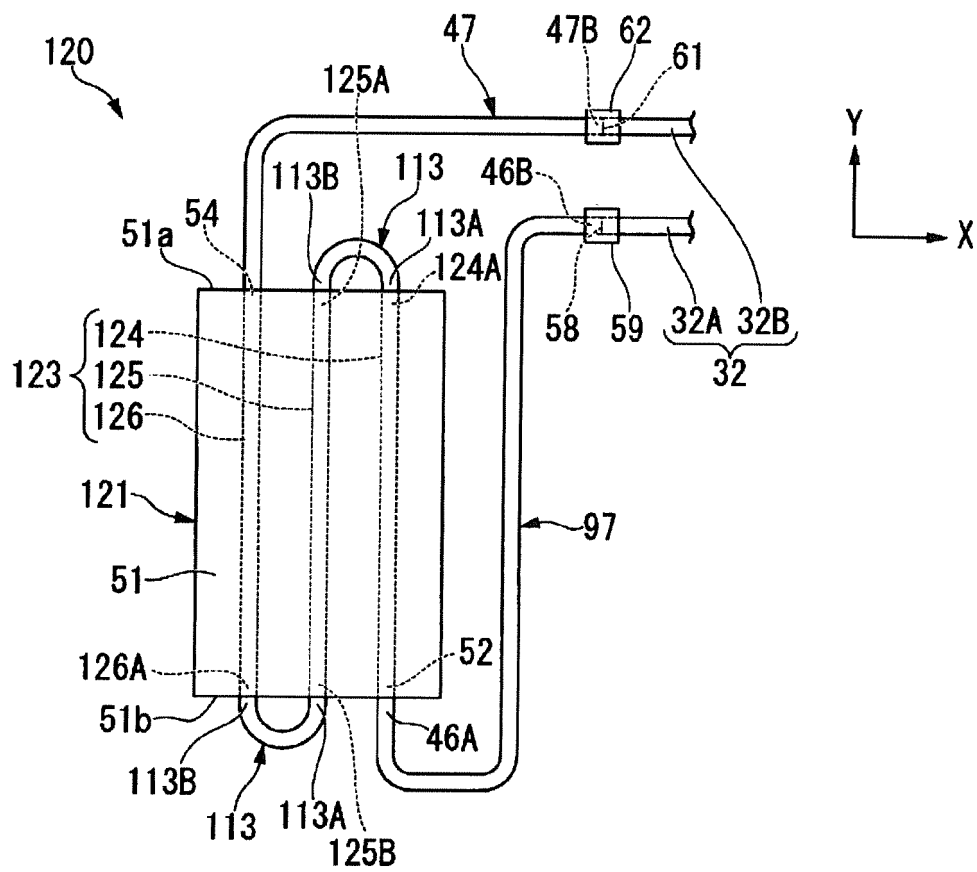


FIG. 12

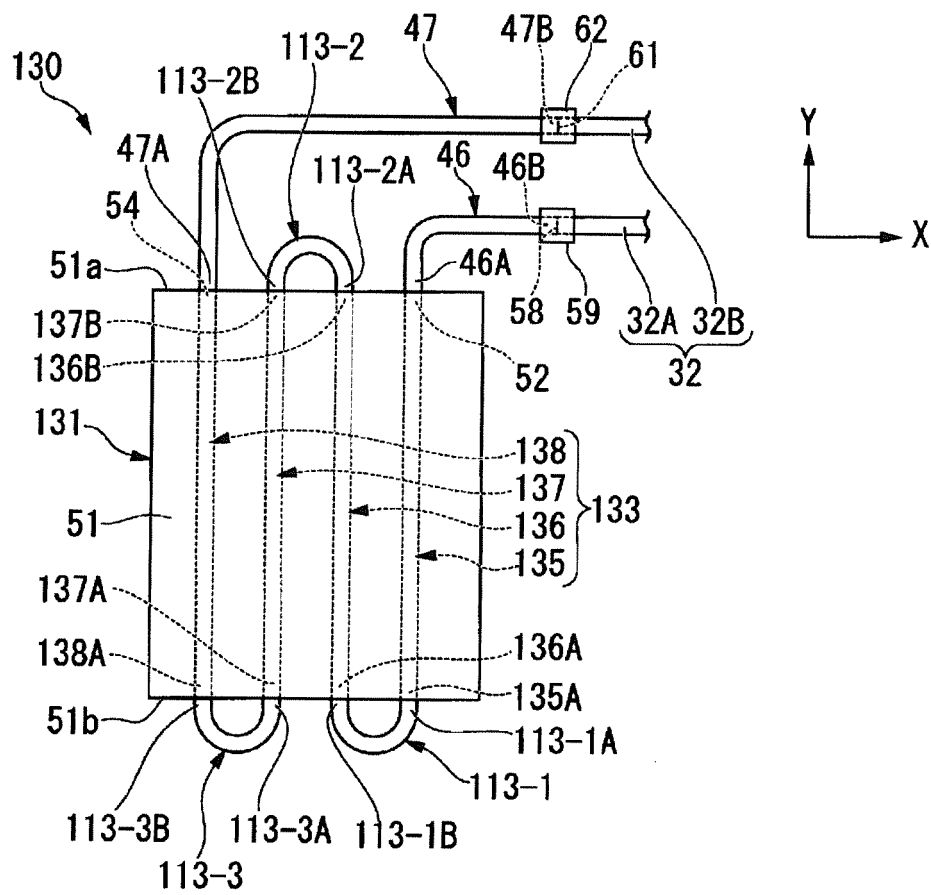


FIG. 13

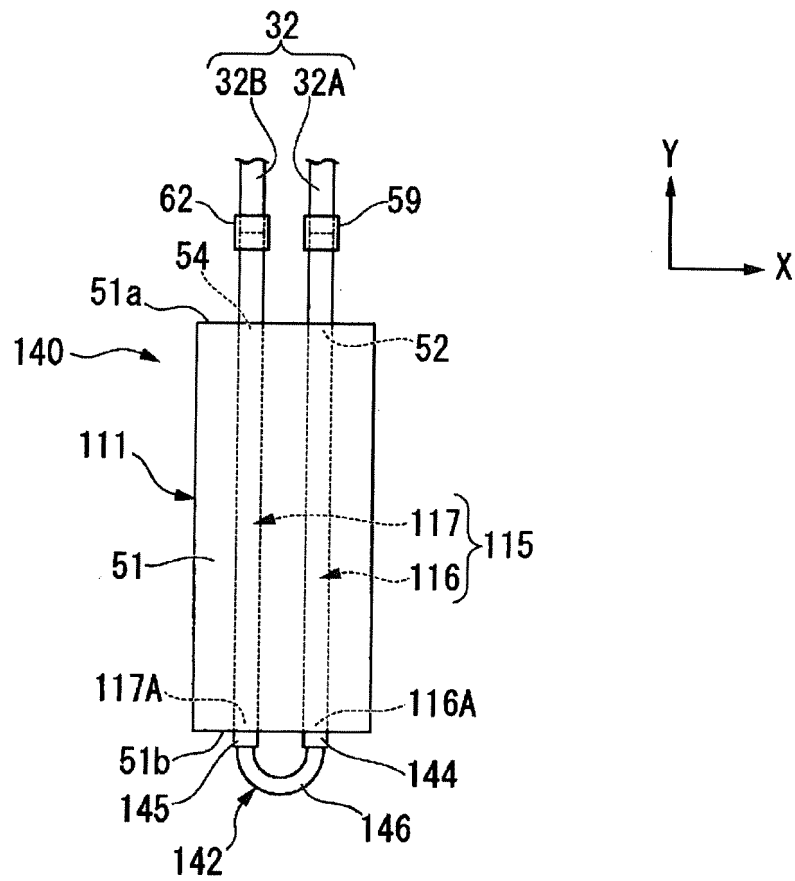


FIG. 14

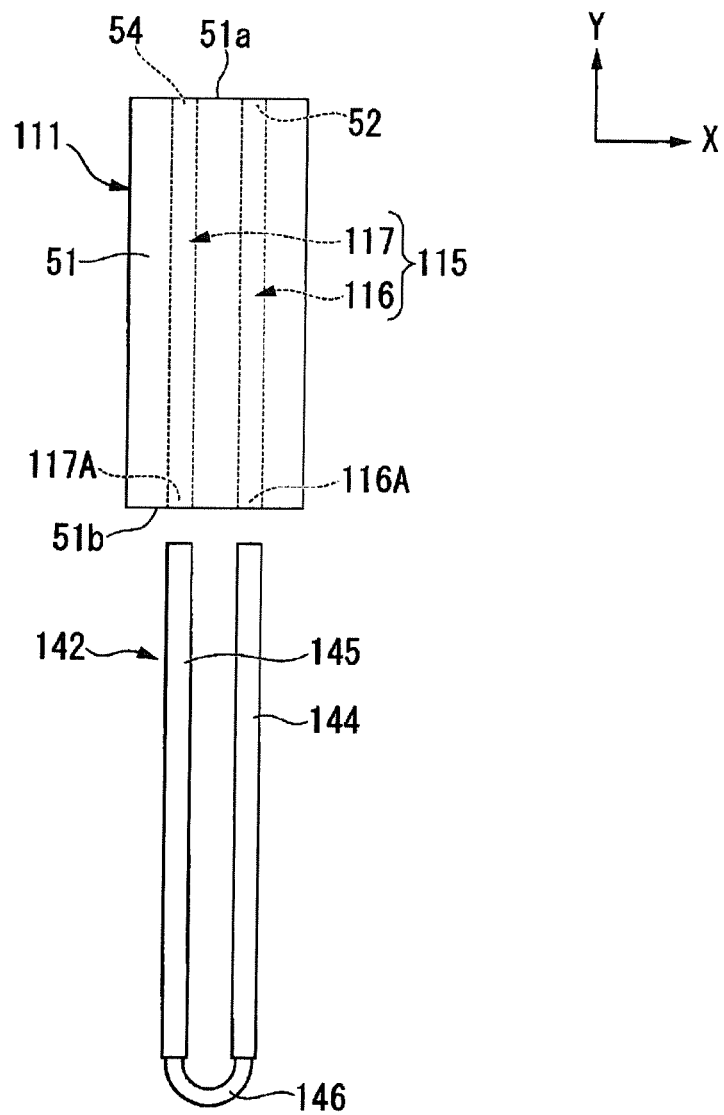


FIG. 15

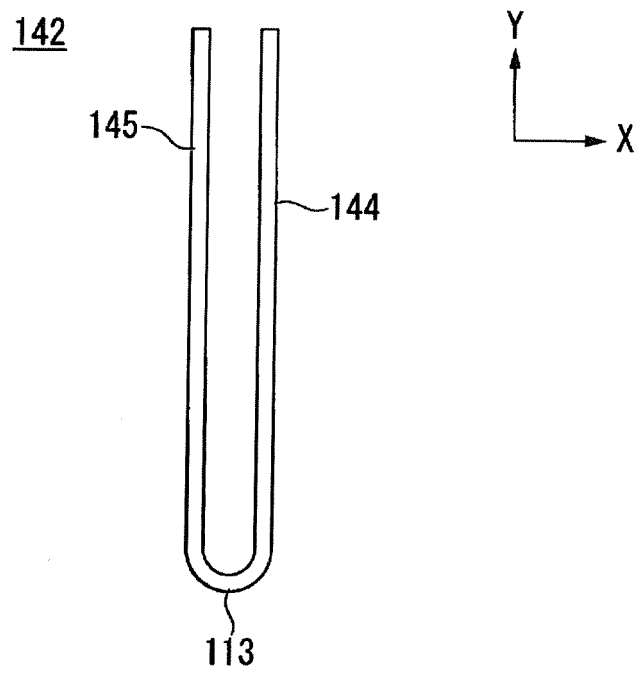


FIG. 16

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/014232

A. CLASSIFICATION OF SUBJECT MATTER

F25B1/00(2006.01)i, F24F1/24(2011.01)i, F25B41/00(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)

F25B1/00, F24F1/24, F25B41/00

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 Y	JP 2011-158241 A (Daikin Industries, Ltd.), 18 August 2011 (18.08.2011), paragraphs [0031] to [0035], [0083]; fig. 1 to 3, 7 to 8 (Family: none)	1-4, 6-7 5
X Y A	JP 2011-142116 A (Daikin Industries, Ltd.), 21 July 2011 (21.07.2011), paragraphs [0025] to [0029], [0043], [0047]; fig. 1 to 4 (Family: none)	1-2 5 3-4, 6-7
X Y A	JP 2015-207670 A (Daikin Industries, Ltd.), 19 November 2015 (19.11.2015), paragraphs [0021] to [0022], [0028] to [0034]; fig. 1 to 4 (Family: none)	1-2 5 3-4, 6-7

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

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search
16 June 2017 (16.06.17)Date of mailing of the international search report
27 June 2017 (27.06.17)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/JP2017/014232

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2007-162743 A (Daikin Industries, Ltd.), 28 June 2007 (28.06.2007), paragraphs [0024] to [0025]; fig. 2 (Family: none)	5
A	JP 2011-153785 A (Hitachi, Ltd.), 11 August 2011 (11.08.2011), paragraphs [0020] to [0028]; fig. 1 to 2 (Family: none)	1-7
A	JP 2015-216295 A (Toyota Motor Corp.), 03 December 2015 (03.12.2015), fig. 1 to 4 (Family: none)	1-7
A	JP 7-86473 A (Toshiba Corp.), 31 March 1995 (31.03.1995), paragraph [0012]; fig. 1 to 2 (Family: none)	1-7
A	JP 8-46381 A (Miyachi Technos Corp.), 16 February 1996 (16.02.1996), fig. 1 to 3 (Family: none)	1-7

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 4488093 B [0005]