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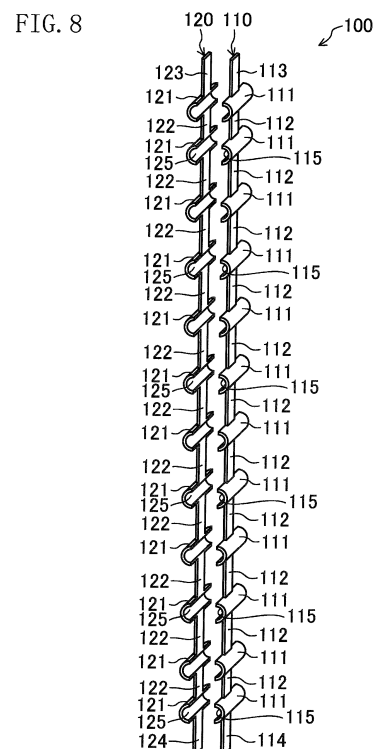
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(54) **REFRIGERANT FLOW DIVIDER**

(57) A refrigerant flow divider (70) includes: a cylindrical divider body (71) extending in a longitudinal direction of a header collecting pipe (80) and having a plurality of communication holes (130) arranged in the longitudinal direction; and a coupling member (100) having a first member (110) and a second member (120) which extend in a longitudinal direction of the header collecting pipe (80) and the divider body (71) and overlap with each other, the first and second members (110, 120), overlapping with each other, forming a plurality of dividing pipes (101), each of which connects an associated pair of communication holes (130, 140) of the header collecting pipe (80) and the divider body (71).



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## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to a refrigerant flow divider.

### BACKGROUND ART

**[0002]** A heat exchanger through which a refrigerant flows, and a refrigerant flow divider which divides the refrigerant into refrigerant flows that go into the heat exchanger have been known.

**[0003]** Patent Document 1 discloses a heat exchanger including a plurality of flat tubes (heat transfer tubes), each of which has an end and the other end connected to header collecting pipes, respectively. A plurality of partition plates are provided in each header collecting pipe to partition the interior of the header collecting pipe into a plurality of spaces. The refrigerant flow divider includes an inlet pipe into which the refrigerant flows, and a plurality of dividing pipes into which the refrigerant that has passed through the inlet pipe flows. An outlet end of each dividing pipe is connected to the header collecting pipe to communicate with the spaces in the header collecting pipe. In the heat exchanger, a liquid refrigerant that has entered the flow divider flows through the dividing pipes, and goes into the spaces in the header collecting pipe. The refrigerant exchanges heat with air while flowing through the flat tubes to cool the air.

### CITATION LIST

### PATENT DOCUMENTS

**[0004]** [Patent Document 1] Japanese Unexamined Patent Publication No. 2012-163319

### SUMMARY OF THE INVENTION

### TECHNICAL PROBLEM

**[0005]** To connect the refrigerant flow divider of Patent Document 1 to the heat exchanger, the dividing pipes of the flow divider need to be connected to the header collecting pipe. This increases the number of steps of connecting the dividing pipes separately. Further, the plurality of dividing pipes are essential to the refrigerant flow divider, which increases the parts count. This leads to an increase in the manufacturing cost. Such a problem becomes more remarkable as the number of dividing pipes increases.

**[0006]** In view of the foregoing problem, it is therefore an object of the present invention to provide a refrigerant flow divider which can be manufactured from fewer parts through fewer steps.

## SOLUTION TO THE PROBLEM

**[0007]** A first aspect of the present invention is directed to a refrigerant flow divider which divides a refrigerant into refrigerant flows that go into a plurality of spaces (86) in a header collecting pipe (80) via communication holes (140) formed through the header collecting pipe (80), the header collecting pipe (80) being connected to ends of a plurality of heat transfer tubes (63). The refrigerant flow divider includes: a cylindrical divider body (71) extending in a longitudinal direction of the header collecting pipe (80) and having a plurality of communication holes (130) arranged in the longitudinal direction; and a coupling member (100) having a first member (110) and a second member (120) which extend in the longitudinal direction of the header collecting pipe (80) and the divider body (71) and overlap with each other, the first and second members (110, 120), overlapping with each other, forming a plurality of dividing pipes (101), each of which connects an associated pair of communication holes (130, 140) of the header collecting pipe (80) and the divider body (71).

**[0008]** According to the first aspect, the coupling member (100) connects associated pairs of the communication holes (130, 140) of the header collecting pipe (80) and the divider body (71). The first and second members (110, 120) of the coupling member (100) overlap with each other to form a plurality of dividing pipes (101), each of which connects an associated pair of the communication holes (130, 140). Thus, unlike generally known refrigerant flow dividers, there is no need to use a plurality of dividing pipes configured as individual parts, which can reduce the parts count. Further, the number of steps of connecting the plurality of dividing pipes can also be reduced.

**[0009]** A second aspect of the present invention is an embodiment of the first aspect. In the second aspect, the first member (110) has a plurality of first protruding portions (111), each of which extends from one of the pair of communication holes (130, 140) to the other and forms a first groove (115) which faces the second member (120), and a plurality of first intermediate portions (112), each of which is continuous with an adjacent pair of the first protruding portions (111), the second member (120) has a plurality of second protruding portions (121), each of which extends from one of the pair of communication holes (130, 140) to the other and forms a second groove (125) which faces the first groove (115), and a plurality of second intermediate portions (122), each of which is continuous with an adjacent pair of the second protruding portions (121), an adjacent pair of the first protruding portion (111) and the second protruding portion (121) constitutes the dividing pipe (101) inserted into the pair of communication holes (130, 140) adjacent to each other, and an adjacent pair of the first groove (115) and the second groove (125) forms, in the dividing pipe (101), a communication passage (102) which allows the pair of communication holes (130, 140) to communicate with

each other.

**[0010]** According to the second aspect, the first member (110) includes a plurality of first protruding portions (111) and a plurality of first intermediate portions (112) connecting the first protruding portions (111). The second member (120) includes a plurality of second protruding portions (121) and a plurality of second intermediate portions (122) connecting the second protruding portions (121). The first protruding portions (111) of the first member (110) and the second protruding portions (121) of the second member (120) overlap with each other so that each of the first protruding portions (111) and each of the second protruding portions (121) form the dividing pipe (101). The dividing pipes (101) are connected to the communication holes (140) of the header collecting pipe (80) and the communication holes (130) of the divider body (71). In each of the dividing pipes (101), the first groove (115) formed by the first protruding portion (111) and the second groove (125) formed by the second protruding portion (121) form the communication passage (102). Each of these communication passages (102) allows the inside of the divider body (71) to communicate with an associated one of the spaces (86) in the header collecting pipe (80).

**[0011]** In this way, the first and second members (110, 120) overlapping with each other allow a plurality of dividing pipes (101) to be formed collectively. Further, the dividing pipes (101) can be collectively inserted into the communication holes (130, 140) of the divider body (71) and the header collecting pipe (80).

**[0012]** A third aspect of the present invention is an embodiment of the second aspect. In the third aspect, each of the plurality of first protruding portions (111) has ends protruding toward both sides in an axial direction of the dividing pipe (101) from the first intermediate portions (112), and each of the plurality of second protruding portions (121) has ends protruding toward both sides in the axial direction of the dividing pipe (101) from the second intermediate portions (122).

**[0013]** According to the third aspect, each of the first protruding portions (111) has ends protruding toward both sides in the axial direction of the dividing pipe (101) from the first intermediate portions (112). Each of the second protruding portions (121) has ends protruding toward both sides in the axial direction of the dividing pipe (101) from the second intermediate portions (122). Thus, when the first and second members (110, 120) overlap with each other, the dividing pipes (101) protrude toward both sides from the intermediate portions (112, 122) overlapping with each other. When the dividing pipes (101) of the coupling member (100) are inserted into the communication holes (130) of the divider body (71) and the communication holes (140) of the header collecting pipe (80), both side edges of each intermediate portion (112, 122) come into contact with an outer peripheral surface of the header collecting pipe (80) and an outer peripheral surface of the divider body (71), respectively. Thus, the length of a portion of each dividing pipe (101) inserted in

the divider body (71) and the header collecting pipe (80) (so-called "insertion length") can be adjusted as appropriate based on the width of each of the intermediate portions (112, 122).

**[0014]** A fourth aspect of the invention is an embodiment of any one of the first to third aspects. In the fourth aspect, the first and second members (110, 120) are separated from each other.

**[0015]** According to the fourth aspect, the first and second members (110, 120) are configured to be completely separated from each other. The coupling member (100) is provided when the first and second members (110, 120) overlap with each other.

**[0016]** A fifth aspect of the invention is an embodiment of any one of the first to third aspects. In the fifth aspect, the coupling member (100) includes a connector (150) which integrally connects the first and second members (110, 120).

**[0017]** According to the fifth aspect, the connector (150) integrally connects the first and second members (110, 120). That is, the coupling member (100) is configured as a single integrated part.

#### ADVANTAGES OF THE INVENTION

**[0018]** According to the present invention, the first and second members (110, 120) which overlap with each other form the plurality of dividing pipes (101), which can be collectively connected to the communication holes (130) of the divider body (71) and the communication holes (140) of the header collecting pipe (80). Thus, unlike generally known refrigerant flow dividers, the refrigerant is divided into refrigerant flows that go into the spaces in the header collecting pipe (80) without need of providing a plurality of dividing pipes configured as individual parts. This eliminates the need of connecting the dividing pipes (101) separately to the header collecting pipe (80), thereby reducing the manufacturing steps and costs. Moreover, the parts count of the refrigerant flow divider (70) can also be reduced.

**[0019]** According to the second aspect, the two protruding portions (111, 121), each of which forms the groove (115, 125), overlap with each other to form the plurality of dividing pipes (101) having the communication passages (102).

**[0020]** According to the third aspect, when the intermediate portions (112, 122) that are overlapping with each other are brought into contact with the divider body (71) and the header collecting pipe (80), the insertion length of each of the dividing pipes (101) in each of the divider body (71) and the header collecting pipe (80) can be adjusted as appropriate.

**[0021]** According to the fourth aspect, the first and second members (110, 120), which are individual parts, facilitate the formation of the coupling member (100). Moreover, according to the fifth aspect, the coupling member (100) is configured as a single part, which can reduce the parts count of the refrigerant flow divider.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0022]**

[FIG. 1] FIG. 1 illustrates a general configuration of an air conditioner according to an embodiment of the present invention.

[FIG. 2] FIG. 2 is a general perspective view illustrating an outdoor heat exchanger.

[FIG. 3] FIG. 3 illustrates, on an enlarged scale, a portion of a heat exchange section of FIG. 2.

[FIG. 4] FIG. 4 is a view corresponding to FIG. 3, illustrating the case where corrugated fins are used as heat transfer fins.

[FIG. 5] FIG. 5 illustrates a general configuration of an outdoor heat exchanger.

[FIG. 6] FIG. 6 illustrates, on an enlarged scale, an inlet/outlet header and a refrigerant flow divider shown in FIG. 2.

[FIG. 7] FIG. 7 is a plan view of a flow divider member.

[FIG. 8] FIG. 8 is an exploded perspective view of a coupling member.

[FIG. 9] FIG. 9 is a vertical cross-sectional view of the coupling member.

[FIG. 10] FIG. 10 is a side view of the coupling member.

[FIG. 11] FIG. 11 is a side view illustrating, on an enlarged scale, the refrigerant flow divider shown in FIG. 6 and its vicinity.

[FIG. 12] FIG. 12 is a development (an elevation view) illustrating a coupling member of an alternative example, before folding the coupling member at a connector plate.

## DESCRIPTION OF EMBODIMENTS

**[0023]** An embodiment of the present invention will now be described in detail with reference to the drawings. The embodiment described below is merely an exemplary one in nature, and is not intended to limit the scope, applications, or use of the invention.

«Embodiment of Invention»

**[0024]** In this embodiment, a refrigerant flow divider (70) is applied to a heat exchange unit (U) of an air conditioner (1).

<Basic Configuration of Air Conditioner>

**[0025]** FIG. 1 illustrates a general configuration of an air conditioner (1) including a refrigerant flow divider (70) of the present invention. The air conditioner (1) is an example of a refrigeration apparatus of the present invention (a refrigeration apparatus in a broad sense used for refrigerating or cooling the interior of storage or any other space, or air-conditioning a room).

**[0026]** The air conditioner (1) is able to cool and heat

a room in, for example, a building by performing a vapor compression refrigeration cycle. The air conditioner (1) includes, as its main components, an outdoor unit (2) and an indoor unit (4) connected together. The outdoor unit (2) and the indoor unit (4) are connected to each other via a liquid refrigerant connection pipe (5), and a gas refrigerant connection pipe (6). Specifically, a refrigerant circuit (10) of a vapor compression type in the air conditioner (1) comprises the outdoor unit (2) and the indoor unit (4) connected together via the refrigerant connection pipes (5, 6).

[Indoor Unit]

**[0027]** The indoor unit (4) is placed inside the room, and forms part of the refrigerant circuit (10). The indoor unit (4) includes, as a main component, an indoor heat exchanger (second heat exchanger) (41).

**[0028]** The indoor heat exchanger (41) functions as an evaporator for the refrigerant to cool indoor air during a cooling operation, and as a radiator for the refrigerant to heat the indoor air during a heating operation. A liquid end of the indoor heat exchanger (41) is connected to the liquid refrigerant connection pipe (5), and a gas end of the indoor heat exchanger (41) is connected to the gas refrigerant connection pipe (6).

**[0029]** The indoor unit (4) includes an indoor fan (42) which sucks the indoor air into the indoor unit (4) so that the indoor air exchanges heat with the refrigerant in the indoor heat exchanger (41), and then supplies the air as supply air into the room. Specifically, the indoor unit (4) includes the indoor fan (42) serving as a fan which supplies the indoor air, as a source for heating or cooling the refrigerant flowing through the indoor heat exchanger (41), to the indoor heat exchanger (41). In this embodiment, a centrifugal fan or a multi-blade fan driven by an indoor fan motor (42a) is used as the indoor fan (42).

[Outdoor Unit]

**[0030]** The outdoor unit (2) is placed outside the room, and forms part of the refrigerant circuit (10). The outdoor unit (2) includes, as its main components, a compressor (21), a four-way switching valve (22), an outdoor heat exchanger (first heat exchanger) (23), an expansion valve (expansion mechanism) (24), a liquid stop valve (25), and a gas stop valve (26).

**[0031]** The compressor (21) compresses a refrigerant at a low pressure of the refrigeration cycle to a high pressure. The compressor (21) is a hermetic compressor in which a compressor motor (21a) drives a rotary or scroll positive-displacement compression element (not shown) to rotate. The compressor (21) has a suction side connected to a suction pipe (31) and a discharge side connected to a discharge pipe (32). The suction pipe (31) is a refrigerant pipe which connects the suction side of the compressor (21) and the four-way switching valve (22). The discharge pipe (32) is a refrigerant pipe which con-

nects the discharge side of the compressor (21) and the four-way switching valve (22).

**[0032]** The four-way switching valve (22) switches the direction of the flow of the refrigerant in the refrigerant circuit (10). During the cooling operation, the four-way switching valve (22) switches the operation state to a cooling cycle state in which the outdoor heat exchanger (23) functions as a radiator for a refrigerant that has been compressed in the compressor (21), and the indoor heat exchanger (41) functions as an evaporator for a refrigerant that has dissipated heat in the outdoor heat exchanger (23). Specifically, during the cooling operation, the four-way switching valve (22) connects the discharge side (the discharge pipe (32) in this embodiment) of the compressor (21) and the gas side (the first gas refrigerant pipe (33) in this embodiment) of the outdoor heat exchanger (23) (see one of solid curves in the four-way switching valve (22) shown in FIG. 1). At the same time, the suction side of the compressor (21) (the suction pipe (31) in this embodiment) is connected to the gas refrigerant connection pipe (6) (the second gaseous refrigerant pipe (34) in this embodiment) (see the other solid curve in the four-way switching valve (22) shown in FIG. 1).

**[0033]** During the heating operation, the four-way switching valve (22) switches the operation state to a heating cycle state in which the outdoor heat exchanger (23) functions as an evaporator for a refrigerant that has dissipated heat in the indoor heat exchanger (41), and the indoor heat exchanger (41) functions as a radiator for a refrigerant that has been compressed in the compressor (21). Specifically, the four-way switching valve (22) connects the discharge side of the compressor (21) (the discharge pipe (32) in this embodiment) and the gas refrigerant connection pipe (6) (the second gas refrigerant pipe (34) in this embodiment) (see one of broken curves in the four-way switching valve (22) shown in FIG. 1). At the same time, the suction side of the compressor (21) (the suction pipe (31) in this embodiment) is connected to the gas side of the outdoor heat exchanger (23) (the first gas refrigerant pipe (33) in this embodiment) (see the other broken curve in the four-way switching valve (22) shown in FIG. 1). The first gas refrigerant pipe (33) connects the four-way switching valve (22) and the gas side of the outdoor heat exchanger (23). The second gas refrigerant pipe (34) connects the four-way switching valve (22) and the gas stop valve (26).

**[0034]** The outdoor heat exchanger (23) functions as a radiator for a refrigerant (refrigerant radiator) which uses the outdoor air as a cooling source during the cooling operation, and functions as an evaporator for a refrigerant (refrigerant evaporator) which uses the outdoor air as a heating source during the heating operation. The outdoor heat exchanger (23) has a liquid end connected to a liquid refrigerant pipe (35), and has a gas end connected to the first gas refrigerant pipe (33). The liquid refrigerant pipe (35) connects the liquid end of the outdoor heat exchanger (23) and the liquid refrigerant con-

nection pipe (5).

**[0035]** In the cooling operation, the expansion valve (24) reduces the pressure of a refrigerant that has dissipated heat in the outdoor heat exchanger (23) and has a high pressure of the refrigeration cycle to a low pressure of the refrigeration cycle. Further, in the heating operation, the expansion valve (24) reduces the pressure of a refrigerant that has dissipated heat in the indoor heat exchanger (41) and has the high pressure of the refrigeration cycle to the low pressure of the refrigeration cycle. The expansion valve (24) is provided adjacent to the liquid stop valve (25) of the liquid refrigerant pipe (35). The expansion valve (24) used herein is an electric expansion valve.

**[0036]** The liquid stop valve (25) and the gas stop valve (26) are provided for ports of connection with external devices and piping (specifically, the liquid refrigerant connection pipe (5) and the gas refrigerant connection pipe (6)). The liquid stop valve (25) is provided at an end of the liquid refrigerant pipe (35). The gas stop valve (26) is provided at an end of the second gas refrigerant pipe (34).

**[0037]** The outdoor unit (2) includes an outdoor fan (36) which sucks the outdoor air into the outdoor unit (2) so that the outdoor air exchanges heat with the refrigerant in the outdoor heat exchanger (23), and then discharges the outdoor air to the outside. Specifically, the outdoor unit (2) includes the outdoor fan (36) as a fan which supplies the outdoor air, as a source for cooling or heating the refrigerant flowing through the outdoor heat exchanger (23), to the outdoor heat exchanger (23). In this embodiment, a propeller fan driven by an outdoor fan motor (36a) is used as the outdoor fan (36).

#### [Refrigerant Connection Pipe]

**[0038]** When the air conditioner (1) is installed in an installation site such as a building, the refrigerant connection pipes (5, 6) are assembled at the installation site. The connection pipes (5, 6) may have various lengths and diameters depending on installation conditions such as the installation site and a combination of the outdoor unit (2) and the indoor unit (4).

#### <Basic Configuration of Outdoor Heat Exchanger>

**[0039]** The configuration of the outdoor heat exchanger (23) will be described in detail below with reference to FIGS. 1-5. FIG. 2 is a general perspective view of a heat exchange unit (U) (the outdoor heat exchanger (23)). FIG. 3 illustrates, on an enlarged scale, a portion of a heat exchange section (60) of FIG. 2. FIG. 4 is a view corresponding to FIG. 3, illustrating the case where corrugated fins are used as heat transfer fins (64). FIG. 5 illustrates a general configuration of the outdoor heat exchanger (23). In the following description, unless otherwise specified, terms related to directions and planes indicate directions and planes with respect to a state where

the outdoor heat exchanger (23) is placed in a casing (not shown) of the outdoor unit (2).

**[0040]** The outdoor heat exchanger (23) is a heat exchange panel which is substantially L-shaped when viewed in plan. The outdoor heat exchanger (23) includes, as its main components, a heat exchange section (60) which allows the outdoor air and the refrigerant to exchange heat, an inlet/outlet header (80) (a first header collecting pipe) provided at an end of the heat exchange section (60), and an intermediate header (90) (a second header collecting pipe) provided at the other end of the heat exchange section (60). The outdoor heat exchanger (23) is comprised of the inlet/outlet header (80), the intermediate header (90), and the heat exchange section (60), which are all made of aluminum or an aluminum alloy.

**[0041]** The heat exchange section (60) includes a plurality of (12 in this example) principal heat exchange subsections (61A-61L) which constitute an upper part of the outdoor heat exchanger (23), and a plurality of (12 in this example) auxiliary heat exchange subsections (62A-62L) which constitute a lower part of the outdoor heat exchanger (23). The principal heat exchange subsections (61A-61L) are arranged such that the principal heat exchange subsection (61A) is located at the top, and the remaining principal heat exchange subsections (61B-61L) are sequentially arranged downward from the bottom of the principal heat exchange subsection (61A). The auxiliary heat exchange subsections (62A-62L) are arranged such that the auxiliary heat exchange subsection (62A) is located at the bottom, and the remaining auxiliary heat exchange subsections (62B-62L) are sequentially arranged upward from the top of the auxiliary heat exchange subsection (62A).

**[0042]** The heat exchange section (60) is a so-called "fin-insertion type" heat exchanger comprised of multiple heat transfer tubes (63) made of flat tubes, and multiple heat transfer fins (64). The heat transfer tube (63) is made of aluminum or an aluminum alloy, and has flat surfaces (63a) facing in the vertical direction and serving as heat transfer surfaces, and multiple small internal passages (63b) through each of which the refrigerant flows. The multiple heat transfer tubes (63) are stacked one above the other to be spaced from each other in the vertical direction. Each of the heat transfer tubes (63) has an end connected to the inlet/outlet header (80), and the other end connected to the intermediate header (90). The heat transfer fins (64) are made of aluminum or an aluminum alloy. Multiple narrow notches (64a) extending in the horizontal direction are formed at one side edge of each heat transfer fin (64) so that the heat transfer tubes (63) arranged between the inlet/outlet header (80) and the intermediate header (90) are respectively inserted in the notches. The shape of the notch (64a) of the heat transfer fin (64) is almost the same as the cross sectional shape of the heat transfer tube (63).

**[0043]** The multiple heat transfer tubes (63) are classified into the principal heat exchange subsections (61A-

61L) and the auxiliary heat exchange subsections (62A-62L). Among the heat transfer tubes (63), groups of a predetermined number (about 3 to 8) of heat transfer tubes (63) from the top of the outdoor heat exchanger (23) respectively constitute the principal heat exchange subsections (61A-61L). Among the heat transfer tubes (63), groups of a predetermined number (about 1 to 3) of heat transfer tubes (63) from the bottom of the outdoor heat exchanger (23) respectively constitute the auxiliary heat exchange subsections (62A-62L).

**[0044]** The outdoor heat exchanger (23) is not limited to the fin-insertion type heat exchanger using the insertion fins (see FIG. 3) as the heat transfer fins (64), and may be a heat exchanger including multiple corrugated fins (see FIG. 4) as the heat transfer fins (64).

[Configuration of Intermediate Header]

**[0045]** The configuration of the intermediate header (90) will be described with reference to FIG. 5. In the following description, unless otherwise specified, terms related to directions and planes indicate directions and planes with respect to the state where the outdoor heat exchanger (23) including the intermediate header (90) is placed in the outdoor unit (2).

**[0046]** The intermediate header (90) is a vertically extending cylindrical member made of aluminum or an aluminum alloy, and has a hollow, vertically elongated intermediate header case (91).

**[0047]** Space inside the intermediate header case (91) is divided into vertically aligned spaces by a plurality of (11 in this example) principal intermediate baffles (92), a plurality of (11 in this example) auxiliary intermediate baffles (93), and a boundary intermediate baffle (94). The plurality of principal intermediate baffles (92) are sequentially arranged in the vertical direction to divide an upper portion of the internal space of the intermediate header case (91) into principal intermediate spaces (95A-95K) respectively communicating with the other ends of the principal heat exchange subsections (61A-61K). The plurality of auxiliary intermediate baffles (93) are sequentially arranged in the vertical direction to divide a lower portion of the internal space of the intermediate header case (91) into auxiliary intermediate spaces (96A-96K) respectively communicating with the other ends of the auxiliary heat exchange subsections (62A-62K). The boundary intermediate baffle (94) is provided to divide a space in the intermediate header case (91) between the lowermost principal intermediate baffle (92) and the uppermost auxiliary intermediate baffle (93) into a principal intermediate space (95L) communicating with the other end of the principal heat exchange subsection (61L) and an auxiliary intermediate space (96L) communicating with the other end of the auxiliary heat exchange subsection (62L).

**[0048]** A plurality of (11 in this example) intermediate connection pipes (97A-97K) are connected to the intermediate header case (91). The intermediate connection

pipes (97A-97K) allow the principal intermediate spaces (95A-95K) to communicate with the auxiliary intermediate spaces (96A-96K). In this configuration, the principal heat exchange subsections (61A-61K) and the auxiliary heat exchange subsections (62A-62K) communicate with each other via the intermediate header (90) and the intermediate connection pipes (97A-97K), which provides refrigerant paths (65A-65K) of the outdoor heat exchanger (23). The boundary intermediate baffle (94) is provided with an intermediate baffle hole (94a) which allows the principal intermediate space (95L) and the auxiliary intermediate space (96L) to communicate with each other. In this configuration, the principal heat exchange subsection (61L) and the auxiliary heat exchange subsection (62L) communicate with each other via the intermediate header (90) and the intermediate baffle hole (94a), which provides a refrigerant path (65L) of the outdoor heat exchanger (23). Thus, the outdoor heat exchanger (23) is configured to have multiple (12 in this example) refrigerant paths (65A-65L).

#### [Configuration of Inlet/Outlet Header]

**[0049]** The configuration of the inlet/outlet header (80) will be described with reference to FIGS. 5 and 6. In the following description, unless otherwise specified, terms related to directions and planes indicate directions and planes with respect to the state where the outdoor heat exchanger (23) including the inlet/outlet header (80) is placed in the outdoor unit (2). The flow of the refrigerant will be described on the premise that the outdoor heat exchanger (23) functions as an evaporator.

**[0050]** The inlet/outlet header (80) is a vertically extending member made of aluminum or an aluminum alloy, and has a hollow, vertically elongated inlet/outlet header case (81). The inlet/outlet header case (81) has an inlet/outlet header tube (82) which is a cylindrical member having an upper open end and a lower open end closed by two closing baffles (83), respectively. Space inside the inlet/outlet header case (81) is divided by a boundary inlet/outlet baffle (84) into an upper inlet/outlet space (85) and lower supply spaces (86A-86L), which are arranged in the vertical direction. The inlet/outlet space (85) communicates with an end of each of the principal heat exchange subsections (61A-61L), and serves as an outlet space in which a refrigerant that has passed through the refrigerant paths (65A-65L) meet together. Thus, an upper portion of the inlet/outlet header (80) having the inlet/outlet space (85) serves as a refrigerant outlet at which the flows of the refrigerant that have passed through the refrigerant paths (65A-65L) meet together.

**[0051]** The inlet/outlet header (80) is connected to the first gas refrigerant pipe (33) to communicate with the inlet/outlet space (85). The supply spaces (86A-86L) are a plurality of (12 in this example) spaces divided by a plurality of (11 in this example) supply-side inlet/outlet baffles (87). Each of the supply spaces (86A-86L) communicates with one end of each of the auxiliary heat ex-

change subsections (62A-62L), and allows the refrigerant to flow into an associated one of the refrigerant paths (65A-65L). Thus, a lower portion of the inlet/outlet header (80) having the plurality of supply spaces (86A-86L) serves as a refrigerant supply part (86) from which the refrigerant flows into the plurality of refrigerant paths (65A-65L).

#### <Refrigerant Flow Divider>

**[0052]** The configuration of the refrigerant flow divider (70) will be described in detail below with reference to FIGS. 5-11.

**[0053]** The refrigerant flow divider (70) is a component which divides a refrigerant that has flowed therein via the liquid refrigerant pipe (35) into refrigerant flows, and allows the refrigerant flows to go downstream (into the plurality of heat transfer tubes (63) in this example). The refrigerant flow divider (70) is provided at one end of the outdoor heat exchanger (23), and is connected to an end of each of the heat transfer tubes (63) via the refrigerant supply part (86) of the inlet/outlet header (80). The refrigerant flow divider (70) is made of aluminum or an aluminum alloy. The refrigerant flow divider (70) is integrated with the outdoor heat exchanger (23) to constitute a heat exchange unit (U).

**[0054]** The refrigerant flow divider (70) includes a hollow, vertically elongated divider body (71). The divider body (71) has a cylindrical barrel (72) having an upper open end and a lower open end. The barrel (72) has a plurality of slits (72a, 72b, 72c) arranged along the axial direction (vertical direction) of the barrel (72). The plurality of baffles (73, 77, 77a) are inserted in the slits (72a, 72b, 72c), respectively. The divider body (71) is not limited to the cylindrical body, and may be, for example, in the shape of a polygonal cylinder, such as a rectangular cylinder.

**[0055]** The slits (72a, 72b, 72c) include two end slits (72a, 72a), a single nozzle slit (72c), and multiple intermediate slits (72b). The end slits (72a, 72a) are formed at the upper and lower ends of the barrel (72), respectively. The nozzle slit (72c) is one of the slits (72a, 72b, 72c) which is the closest to the lower end slit (72a). The multiple intermediate slits (72b) are formed between the upper end slit (72a) and the nozzle slit (72c).

**[0056]** The plurality of baffles (73, 77, 77a) include two end baffles (73, 73), and multiple intermediate baffles (77). The end baffles (73, 73) are round plate-shaped, and inserted into the end slits (72a, 72a), respectively. The end baffles (73, 73) close the upper and lower open ends of the barrel (72) of the divider body (71), respectively.

**[0057]** The intermediate baffles (77) are inserted one by one into the nozzle slit (72c) and the intermediate slits (72b). The nozzle slit (72c) also receives a nozzle member (79) inserted therein under the intermediate baffle (77). A nozzle baffle (77a) and the intermediate baffles (77) each constitute an annular plate member having a

substantially round insertion hole (77b) formed through the center thereof. The multiple intermediate baffles (77) receive a rod-shaped flow divider member (74) inserted therein to pass through the insertion holes (77b).

**[0058]** A bottom space (78) and multiple transit spaces (76A-76L) are formed inside the divider body (71). The bottom space (78) is defined between the lower end baffle (73) and the nozzle member (79). An open end of the liquid refrigerant pipe (35) communicates with the bottom space (78). Each of the multiple transit spaces (76A-76L) is formed between the flow divider member (74) and a pair of intermediate baffles (77) adjacent to each other in the vertical direction. Specifically, each of the multiple transit spaces (76A-76L) is a substantially cylindrical space formed around the flow divider member (74).

**[0059]** The flow divider member (74) is a vertically extending rod-shaped member. The flow divider member (74) is made of aluminum or an aluminum alloy. The flow divider member (74) is provided with a plurality of (12 in this example) dividing passages (74A-74L) arranged in a circumferential direction of the flow divider member (74). The dividing passages (74A-74L) are formed by, for example, extrusion molding the flow divider member (74) in the longitudinal direction of the flow divider member (74). The flow divider member (74) has a solid portion surrounded by the plurality of dividing passages (74A-74L).

**[0060]** An upper end of the flow divider member (74) is in contact with a lower surface of the upper end baffle (73). An upper opening of each of the dividing passages (74A-74L) is substantially blocked by the upper end baffle (73). A lower end of the flow divider member (74) is in contact with an upper surface of the nozzle member (79). A lower opening of each of the dividing passages (74A-74L) communicates with a single dividing space (75) formed inside the nozzle member (79).

**[0061]** Multiple (12 in this example) peripheral holes (74a) are formed through an outer peripheral surface of the flow divider member (74). The peripheral holes (74a) are arranged in a helical fashion so that they are gradually misaligned in the circumferential direction from the bottom to top of the flow divider member (74). The peripheral holes (74a) communicate with the transit spaces (76A-76L) in a one-to-one relationship. Specifically, each of the peripheral holes (74a) communicates with the associated transit space (76A-76L) only, and does not communicate with other transit spaces (76A-76L) which are not in association with it.

**[0062]** The nozzle member (79) is inserted into the nozzle slit (72c) together with the lowermost intermediate baffle (77). Specifically, the nozzle member (79) is maintained in the divider body (71), with the intermediate baffle (77) being stacked thereon. The nozzle member (79) is made of aluminum or an aluminum alloy. The nozzle member (79) is a disc-shaped plate member, and has a round nozzle hole (70c) formed through a radially center portion thereof. A recess (70b) is formed at an upper surface of the nozzle member (79). The recess (70b) has

a larger inner diameter than the nozzle hole (70c). The columnar dividing space (75) is formed inside the recess (70b). A lower end of the dividing space (75) communicates with the nozzle hole (70c). An upper end of the dividing space (75) communicates with each of the dividing passages (74A-74L).

[Coupling Member]

**[0063]** As shown in FIGS. 6 and 8-11, the refrigerant flow divider (70) includes a coupling member (100) which allows the transit spaces (76A-76L) of the divider body (71) to communicate with the supply spaces (86A-86L) of the inlet/outlet header (80) on a one-to-one basis.

**[0064]** The coupling member (100) of the present embodiment includes a first part (110) (first member) and a second part (120) (second member). The first and second parts (110, 120) are made of aluminum or an aluminum alloy. Specifically, the coupling member (100) is preferably made of a material of the same type as the divider body (71) and the inlet/outlet header (80). The first and second parts (110, 120) extend in the vertical direction along the axial direction (longitudinal direction) of the divider body (71) and the inlet/outlet header (80). Each of the first and second parts (110, 120) is a plate member formed by press molding, for example. The first and second parts (110, 120) preferably have the same shape. Thus, the two parts (110, 120) can be molded using the same molding machine. The first and second parts (110, 120) overlap with each other in their thickness direction.

[First Part]

**[0065]** The first part (110) includes a plurality of (12 in this example) first pipe portions (111) (first protruding portions), a plurality of (11 in this example) first intermediate plates (112) (first intermediate parts), a single first upper end plate (113), and a single first lower plate (114).

**[0066]** Each of the first pipe portions (111) is a plate member which is substantially semicylindrical. A surface of the first pipe portion (111) facing the second part (120) forms a first groove (115). The first groove (115) creates therein a space which is substantially semicircular when viewed in vertical section. The first groove (115) is not limited to be semicircular when viewed in vertical section, and may be rectangular, or may have any other suitable shape.

**[0067]** Each of the first intermediate plates (112) extends continuously between a pair of first pipe portions (111) adjacent to each other in the vertical direction. Each of the first intermediate plates (112) is a vertically elongated rectangular plate. The first intermediate plate (112) has longitudinal ends, each of which is continuous with the first pipe portions (111). Specifically, the first intermediate plate (112) is continuous with the center of each of the adjacent first pipe portions (111) in an axial direction thereof (a widthwise direction of the first intermediate

plate (112)). In other words, the first pipe portion (111) protrudes toward both sides in the axial direction from side edges of the first intermediate plate (112) in the widthwise direction thereof.

**[0068]** The first upper end plate (113) is continuous with the top of the uppermost first pipe portion (111). The first lower end plate (114) is continuous with the bottom of the lowermost first pipe portion (111). Each of the first upper end plate (113) and the first lower end plate (114) is a vertically elongated rectangular plate. Each of the first upper end plate (113) and the first lower end plate (114) is continuous with the axial center of the adjacent first pipe portion (111), just like the first intermediate plate (112). The first upper end plate (113), the first lower end plate (114), and the first intermediate plates (112) have the same width.

[Second Part]

**[0069]** The second part (120) includes a plurality of (12 in this example) second pipe portions (121) (second protruding portions), a plurality of (11 in this example) second intermediate plates (122) (second intermediate parts), a single second upper end plate (123), and a single second lower plate (124). A surface of the second pipe portion (121) facing the first groove (115) of the first part (111) forms a second groove (125).

**[0070]** Each of the second pipe portions (121) is a substantially semicylindrical member. A surface of the second pipe portion (121) facing the first part (110) forms a second groove (125). The second groove (125) forms a space which is substantially semicircle when viewed in vertical section.

**[0071]** Each of the second intermediate plates (122) extends continuously between a pair of second pipe portions (121) adjacent to each other in the vertical direction. Each of the second intermediate plates (122) is a rectangular plate elongated in the vertical direction. The second intermediate plate (122) has longitudinal ends which are respectively continuous with the second pipe portions (121). Specifically, the second intermediate plate (122) is continuous with the center of each of the adjacent second pipe portions (121) in an axial direction (a widthwise direction of the second intermediate plate (122)). In other words, the second pipe portion (121) protrudes toward both sides in the axial direction from side edges of the second intermediate plate (122) in the widthwise direction thereof. The second pipe portion (121) preferably protrudes by the same length as the first pipe portion (111).

**[0072]** The second upper end plate (123) is continuous with the top of the uppermost second pipe portion (121). The second lower end plate (124) is continuous with the bottom of the lowermost second pipe portion (121). Each of the second upper end plate (123) and the second lower end plate (124) is a vertically elongated rectangular plate. Each of the second upper end plate (123) and the second lower end plate (124) is continuous with the axial center

of the adjacent second pipe portion (121), just like the second intermediate plate (122). The second upper end plate (123), the second lower end plate (124), and the second intermediate plates (122) have the same width W2. The width W2 is preferably the same as the width W1 of the first upper end plate (113), the first lower end plate (114), and the first intermediate plates (112). Specifically, in a preferred embodiment, the first and second parts (110, 120) have the same shape, and are arranged symmetrically with each other in the thickness direction of the first and second parts (110, 120).

[Coupling Member in Coupled State]

**[0073]** As shown in FIGS. 9-11, the first and second parts (110, 120) overlap with each other, and are joined together. As will be described in detail later, the first and second parts (110, 120) are joined together by a brazing material, and thus coupled with each other. In the coupled state, the first and second pipe portions (111) and (121) adjacent to each other are joined together, and the first and second intermediate plates (112) and (122) adjacent to each other are joined together. Further, in the coupled state, the first and second upper end plates (113) and (123) adjacent to each other are joined together, and the first and second lower end plates (114) and (124) adjacent to each other are joined together.

**[0074]** In the coupled state, the first pipe portions (111) and the second pipe portions (121) of the coupling member (100) adjacent to each other constitute a plurality of dividing pipes (101). In each of the dividing pipes (101), the first and second grooves (115) and (125) adjacent to each other form a communication passage (102). The communication passage (102) has a round cross sectional shape when cut in a direction perpendicular to the axis thereof.

**[0075]** In the coupling member (100) in the coupled state, the plural pairs of first and second intermediate plates (112) and (122) adjacent to each other, the first and second upper end plates (113) and (123) adjacent to each other, and the first and second lower end plates (114) and (124) adjacent to each other constitute a rod-shaped support (103) which supports the plurality of dividing pipes (101). Note that the first upper end plate (113), the first lower end plate (114), the second upper end plate (123), and the second lower end plate (124) may be omitted, and only the first and second intermediate plates (112) and (122) may constitute the support (103).

**[0076]** As shown in FIG. 11, the coupling member (100) in the coupled state is arranged between the divider body (71) and the inlet/outlet header (80) to allow a pair of communication holes (130, 140) of the divider body (71) and the inlet/outlet header (80) to communicate with each other.

**[0077]** Specifically, the divider body (71) is provided with a plurality of (12 in this example) divider's communication holes (130) respectively communicating with the

plurality of transit spaces (76A-76L). The divider's communication holes (130) are formed through the peripheral wall of the divider body (71) at predetermined intervals in the vertical direction to face the inlet/outlet header (80). The inlet/outlet header (80) is provided with a plurality of (12 in this example) header's communication holes (140) respectively communicating with the plurality of supply spaces (86A-86L). The header's communication holes (140) are formed through the peripheral wall of the inlet/outlet header (80) at predetermined intervals in the vertical direction to face the divider body (71). That is, the header's communication holes (140) face the adjacent divider's communication holes (130) in a one-to-one relationship.

**[0078]** Each of the dividing pipes (101) of the coupling member (100) is connected to an associated (adjacent) pair of communication holes (130, 140). Specifically, one end of the dividing pipe (101) in the axial direction is inserted in the header's communication hole (140), and the other axial end of the dividing pipe (101) is inserted in the divider's communication hole (130). Thus, the transit space (76A-76L) and the supply space (86A-86L) adjacent to each other communicate with each other via the communication passage (102) of the dividing pipe (101). In this state, one side edge of the support (103) of the coupling member (100) is in contact with the peripheral wall of the inlet/outlet header (80), and the other side edge of the support (103) of the coupling member (100) is in contact with the peripheral wall of the divider body (71).

[Refrigerant Flow in Heat Exchange Unit in Heating Operation]

**[0079]** How the refrigerant flows in the heat exchange unit (U) in the heating operation will be described in detail with reference to FIGS. 5, 6, and 11.

**[0080]** A two-phase gas-liquid refrigerant flows through the liquid refrigerant pipe (35), and then flows into the bottom space (78) of the refrigerant flow divider (70). The refrigerant passes through the nozzle hole (70c), the dividing space (75), the dividing passages (74A-74L), and the peripheral holes (74a) to have its pressure reduced further, and then flows into the transit spaces (76A-76L). The refrigerant in each transit space (76A-76L) flows through the communication passage (102) of the dividing pipe (101), and then flows into the supply space (86A-86L) of the inlet/outlet header (80).

**[0081]** The refrigerant in each supply space (86A-86L) flows through the heat transfer tube (63) of the auxiliary heat exchange subsection (62A-62L) to absorb heat from the air, and then flows into the auxiliary intermediate space (96A-96K) of the intermediate header (90). The refrigerant in each auxiliary intermediate space (96A-96K) flows through the intermediate connection pipe (97A-97K), and then flows into the principal intermediate space (95A-95K).

**[0082]** The refrigerant in each principal intermediate

space (95A-95K) flows through the heat transfer tube (63) of the principal heat exchange subsection (61A-61L) to absorb heat from the air, and then flows into the inlet/outlet space (85) of the inlet/outlet header (80). This refrigerant flows through the first gas refrigerant pipe (33), and is sent to the suction side of the compressor (21).

<Process of Manufacturing Heat Exchange Unit>

**[0083]** A process of manufacturing the heat exchange unit (U) will be described below with reference to FIGS. 5, 6, and 8-11. The heat exchange unit (U) is manufactured by assembling components made of aluminum or an aluminum alloy into a single piece, and furnace brazing the piece.

**[0084]** The process of manufacturing the heat exchange unit (U) includes a step of assembling the outdoor heat exchanger (23). In this step, the ends of the heat transfer tubes (63) are connected to the intermediate header (90) and the inlet/outlet header (80). Then, the intermediate connection pipes (97A-97K) are connected to the intermediate header (90). Thus, the outdoor heat exchanger (23) is temporarily assembled. In this outdoor heat exchanger (23), a brazing material is applied to at least a junction between the intermediate header (90) and the inlet/outlet header (80).

**[0085]** The process of manufacturing the heat exchange unit (U) also includes a step of assembling the refrigerant flow divider (70). In this step, first, the first parts (110) and the second parts (120) are made to overlap with each other (step A). Through the step A, the coupling member (100) including a plurality of dividing pipes (101) supported by the support (103) is obtained.

**[0086]** Then, one end of each of the dividing pipes (101) of the coupling member (100) after the step A is inserted into an associated one of the header's communication holes (140) of the inlet/outlet header (80) (step B). In the step B, each of the dividing pipes (101) is inserted deep into the header's communication hole (140) until one of the side edges of the support (103) of the coupling member (100) comes into contact with the peripheral wall of the inlet/outlet header (80). Thus, the length of a portion of the dividing pipe (101) inserted in the inlet/outlet header (80), i.e., a so-called "insertion length," can be adjusted.

**[0087]** After the step B, the other end of each of the dividing pipes (101) of the coupling member (100) is inserted in an associated one of the divider's communication holes (130) of the divider body (71) (step C). In the step C, each of the dividing pipes (101) is inserted deep into the divider's communication hole (130) until the other side edge of the support (103) of the coupling member (100) comes into contact with the peripheral wall of the divider body (71). Thus, the insertion length of the dividing pipe (101) with respect to the divider body (71) can be adjusted. Note that the assembly of the refrigerant flow divider (the manufacture of the refrigerant flow divider)

may be achieved through the steps A, C, and B performed in this order.

**[0088]** In this way, the heat exchange unit (U) including the outdoor heat exchanger (23) and the refrigerant flow divider (70) integrated with each other is temporarily assembled. In this state, the heat exchange unit (U) is furnace-brazed to allow each of the junctions of the heat exchange unit (U) to be joined together. Thus, the heat exchange unit (U) is manufactured.

**[0089]** Among the inlet/outlet header (80), the divider body (71), and the coupling member (100), the brazing material is applied at least to the junctions of the inlet/outlet header (80) and divider body (71), but is not applied to the coupling member (100). When the furnace brazing is performed, the brazing material applied to the inlet/outlet header (80) and the divider body (71) penetrates into the gap between the first and second parts (110, 120) by capillarity. As a result, the first and second parts (110, 120) are firmly joined together after the furnace brazing, thereby providing the coupling member (100). Thus, the first and second parts (110, 120) can be joined tightly without applying the brazing material in advance to the coupling member (100).

#### -Advantages of Embodiment-

**[0090]** The above embodiment provides the following advantages and effects.

**[0091]** In the above-described embodiment, two parts (110, 120) overlapping with each other form the coupling member (100). Thus, the coupling member (100) can be provided with a plurality of dividing pipes (101) in an integrated manner. As a result, the dividing pipes (101) can be simultaneously inserted into the header's communication holes (140) and the divider's communication holes (130), which can reduce the number of steps required for connecting the dividing pipes (101). Further, in this embodiment, the plurality of dividing pipes (101) can be made of two parts (the first and second parts (110, 120)). This can greatly reduce the parts count as compared with the case where the dividing pipes are separately provided.

**[0092]** In the above-described embodiment, each of the dividing pipes (101) protrudes toward both sides from the support (103). This allows the dividing pipes (101) to be inserted into the communication holes (130, 140), and allows the side edges of the support (103) to be in contact with the inlet/outlet header (80) and the divider body (71). As a result, the insertion length of the dividing pipes (101) can be adjusted as appropriate depending on the width of the support (103) (i.e., the width of the two intermediate plates (112, 122)). This can facilitate the connection of the dividing pipes (101) without need of fine adjustment of the insertion length of the dividing pipes (101).

**[0093]** In the above-described embodiment, the brazing material applied to the inlet/outlet header (80) and the divider body (71) is guided to the gap between the two parts (110, 120) by capillarity. This makes it possible

to obtain the coupling member (100) with no gaps, without need of application of the brazing material to the parts (110, 120) or joining the parts (110, 120) by any other method.

#### «Alternative Examples of Embodiment»

**[0095]** A heat exchange unit (U) according to an alternative example of the embodiment includes a coupling member (100) made of a single part. As shown in FIG. 12, the coupling member (100) includes a plurality of (e.g., two) connector plates (150) (connectors) which integrally connects first and second parts (110, 120) similar to those of the embodiment described above. FIG. 12 shows the coupling member (100) in which the first and second parts (110, 120) which do not overlap with each other yet. Specifically, in this state, the intermediate plates (112, 122) of the first and second parts (110, 120) are substantially flush with the connector plates (150) arranged between them. The coupling member (100) shown in FIG. 12 is formed by, for example, pressing sheet metal. In this state, each of the connector plates (150) of the coupling member (100) is folded at its center portion (a portion through which a center line c shown in FIG. 12 passes). Then, the first and second parts (110, 120) face each other. In this way, in the same manner as in the above-described embodiment, the coupling member (100) can be provided with a plurality of dividing pipes (101) supported by the support (103). The position and shape of the connector plates (150) are determined so as not to interfere with the inlet/outlet header (80) and the divider body (71) when the dividing pipes (101) are inserted into the inlet/outlet header (80) and the divider body (71). In the example shown in FIG. 12, the connector plates (150) are respectively provided at the upper and lower ends of the coupling member (100). Alternatively, the connector plate (150) may be provided at only one of the upper and lower ends. Alternatively, the connector plate (150) may be provided at an intermediate portion between the upper and lower ends of the coupling member (100).

#### «Other Embodiments»

**[0096]** The above-described embodiment may be modified as follows.

**[0097]** For example, the specific configurations of the outdoor heat exchanger (23) and refrigerant flow divider (70) described in the embodiment are merely examples, and may be modified as appropriate. For example, the outdoor heat exchanger (23) is not necessarily in the shape of L when viewed in plan, and the number of heat transfer tubes may be changed as needed. Further, the outdoor heat exchanger (23) may include a plurality of (e.g., two) heat exchange sections (60) arranged in an air flow direction.

**[0098]** The refrigerant flow divider of the present invention is not limited to the air conditioner (1), and may be applied to an indoor heat exchanger of a refrigeration apparatus for cooling the interior of storage or any other

space.

**[0099]** The heat transfer tubes of the above-described embodiment are not limited to the flat tubes (63), and may be cylindrical heat transfer tubes generally used in a cross-fin-type heat exchanger, for example.

#### INDUSTRIAL APPLICABILITY

**[0100]** As can be seen from the foregoing, the present invention is useful as a refrigerant flow divider.

#### DESCRIPTION OF REFERENCE CHARACTERS

##### **[0101]**

|     |                                                         |    |
|-----|---------------------------------------------------------|----|
| 63  | Heat Transfer Tube (Flat Tube)                          |    |
| 70  | Refrigerant Flow Divider                                |    |
| 71  | Divider Body                                            |    |
| 80  | Inlet/Outlet Header (Header Collecting Pipe)            |    |
| 100 | Coupling Member                                         | 20 |
| 101 | Dividing Pipe                                           |    |
| 102 | Communication Passage                                   |    |
| 110 | First Part (First Member)                               |    |
| 111 | First Protruding Portion (First Pipe Portion)           |    |
| 112 | First Intermediate Plate (First Intermediate Portion)   | 25 |
| 115 | First Groove                                            |    |
| 120 | Second Part (Second Member)                             |    |
| 121 | Second Protruding Portion (Second Pipe Portion)         |    |
| 122 | Second Intermediate Plate (Second Intermediate Portion) | 30 |
| 125 | Second Groove                                           |    |
| 130 | Divider's Communication Hole (Communication Hole)       |    |
| 140 | Header's Communication Hole (Communication Hole)        | 35 |
| 150 | Connector Plate (Connector)                             |    |

#### Claims

**1.** A refrigerant flow divider which divides a refrigerant into refrigerant flows that go into a plurality of spaces (86) in a header collecting pipe (80) via communication holes (140) formed through the header collecting pipe (80), the header collecting pipe (80) being connected to ends of a plurality of heat transfer tubes (63), the refrigerant flow divider comprising:

a cylindrical divider body (71) extending in a longitudinal direction of the header collecting pipe (80) and having a plurality of communication holes (130) arranged in the longitudinal direction, and

**characterized in that**

a coupling member (100) having a first member (110) and a second member (120) which extend in the longitudinal direction of the header col-

lecting pipe (80) and the divider body (71) and overlap with each other, the first and second members (110, 120) overlapping with each other forming a plurality of dividing pipes (101), each of which connects an associated pair of communication holes (130, 140) of the header collecting pipe (80) and the divider body (71).

**2.** The refrigerant flow divider of claim 1, wherein the first member (110) has a plurality of first protruding portions (111), each of which extends from one of the pair of communication holes (130, 140) to the other and forms a first groove (115) which faces the second member (120), and a plurality of first intermediate portions (112), each of which is continuous with an adjacent pair of the first protruding portions (111), the second member (120) has a plurality of second protruding portions (121), each of which extends from one of the pair of communication holes (130, 140) to the other and forms a second groove (125) which faces the first groove (115), and a plurality of second intermediate portions (122), each of which is continuous with an adjacent pair of the second protruding portions (121), an adjacent pair of the first protruding portion (111) and the second protruding portion (121) constitutes the dividing pipe (101) inserted into the pair of communication holes (130, 140) adjacent to each other, and an adjacent pair of the first groove (115) and the second groove (125) forms, in the dividing pipe (101), a communication passage (102) which allows the pair of communication holes (130, 140) to communicate with each other.

**3.** The refrigerant flow divider of claim 2, wherein each of the plurality of first protruding portions (111) has ends protruding toward both sides in an axial direction of the dividing pipe (101) from the first intermediate portions (112), and each of the plurality of second protruding portions (121) has ends protruding toward both sides in the axial direction of the dividing pipe (101) from the second intermediate portions (122).

**4.** The refrigerant flow divider of any one of claims 1 to 3, wherein the first and second members (110, 120) are separated from each other.

**5.** The refrigerant flow divider of any one of claims 1 to 3, wherein the coupling member (100) includes a connector (150) which integrally connects the first and second members (110, 120).

FIG. 1

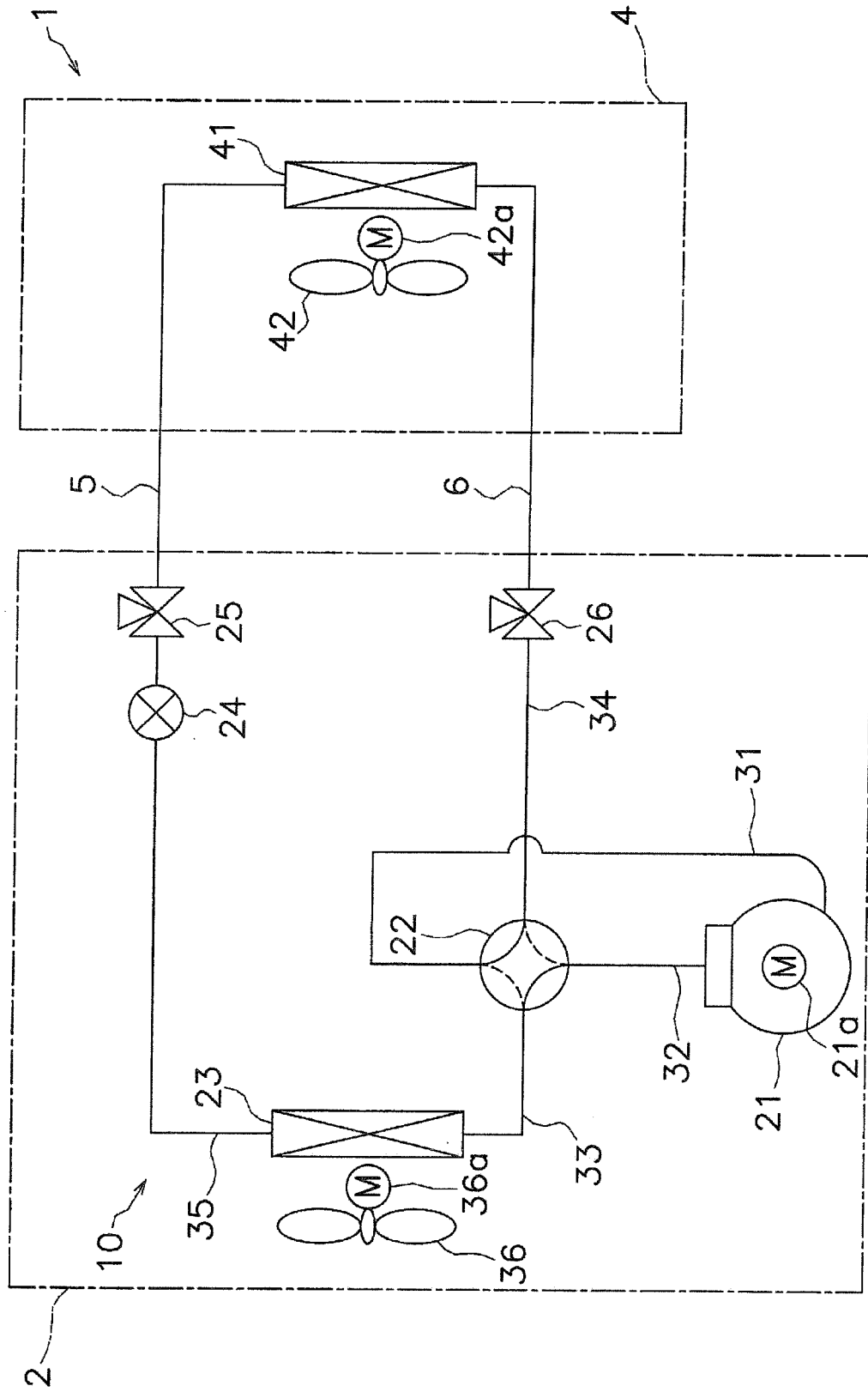


FIG. 2

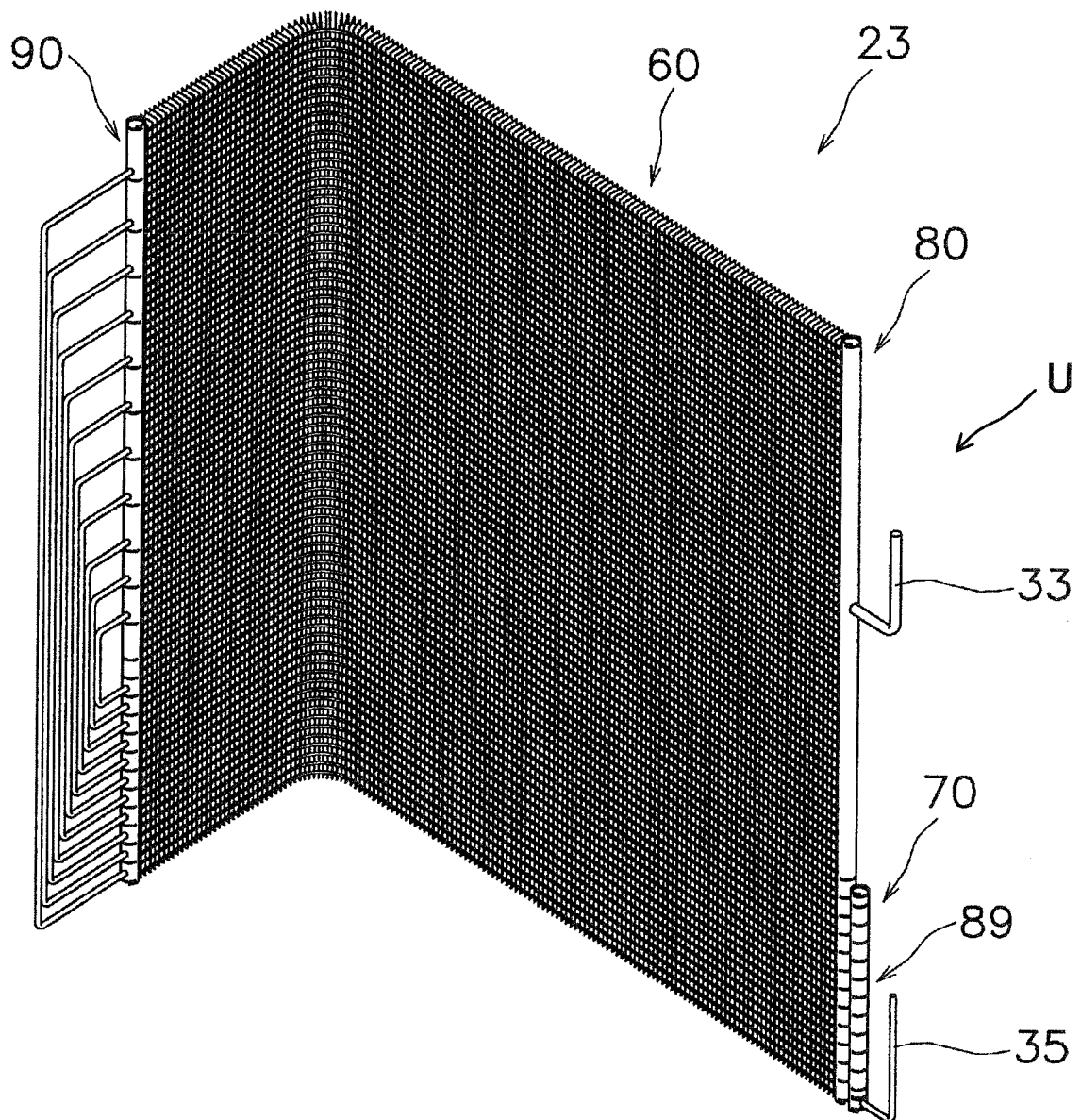


FIG. 3

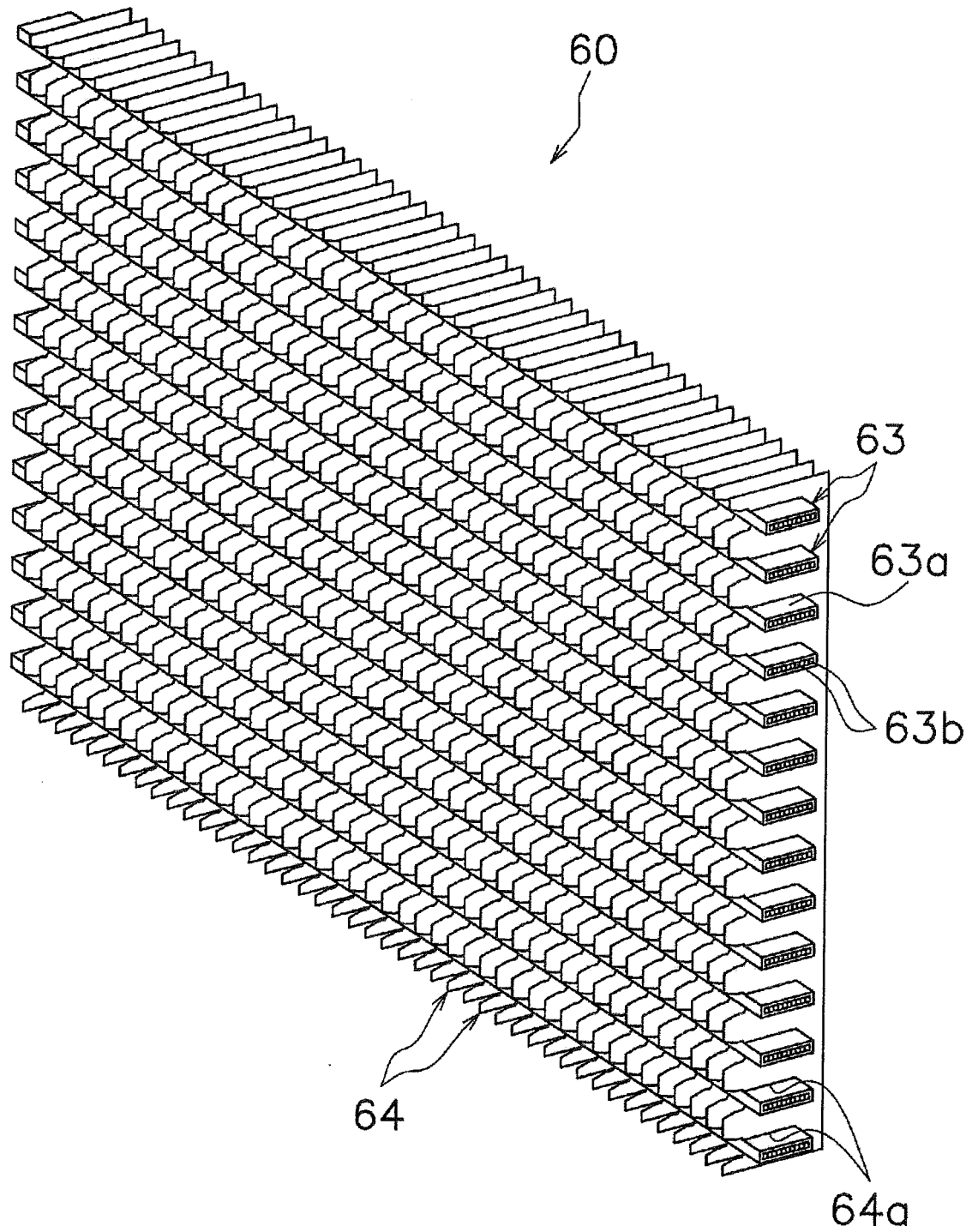


FIG. 4

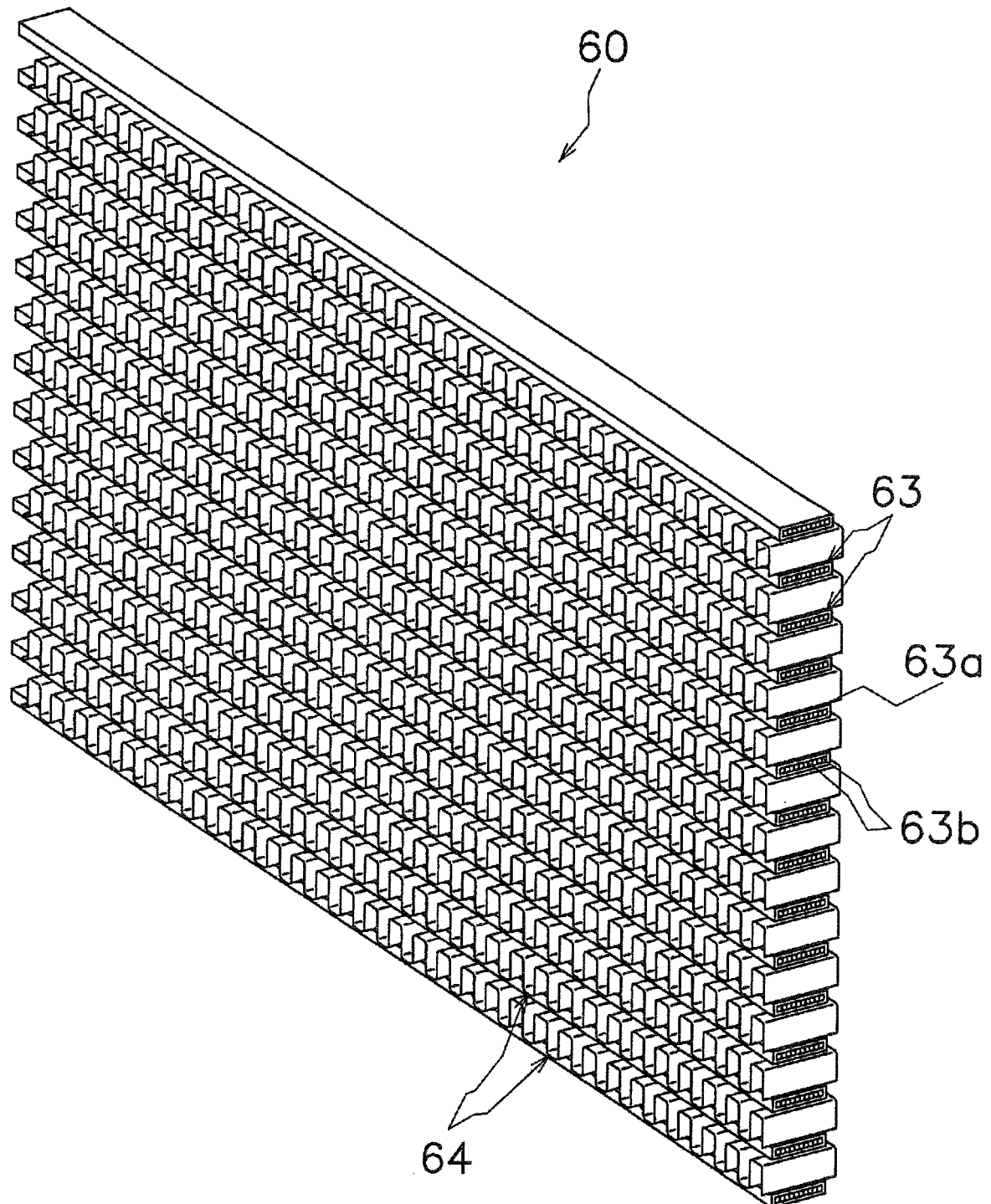


FIG. 5

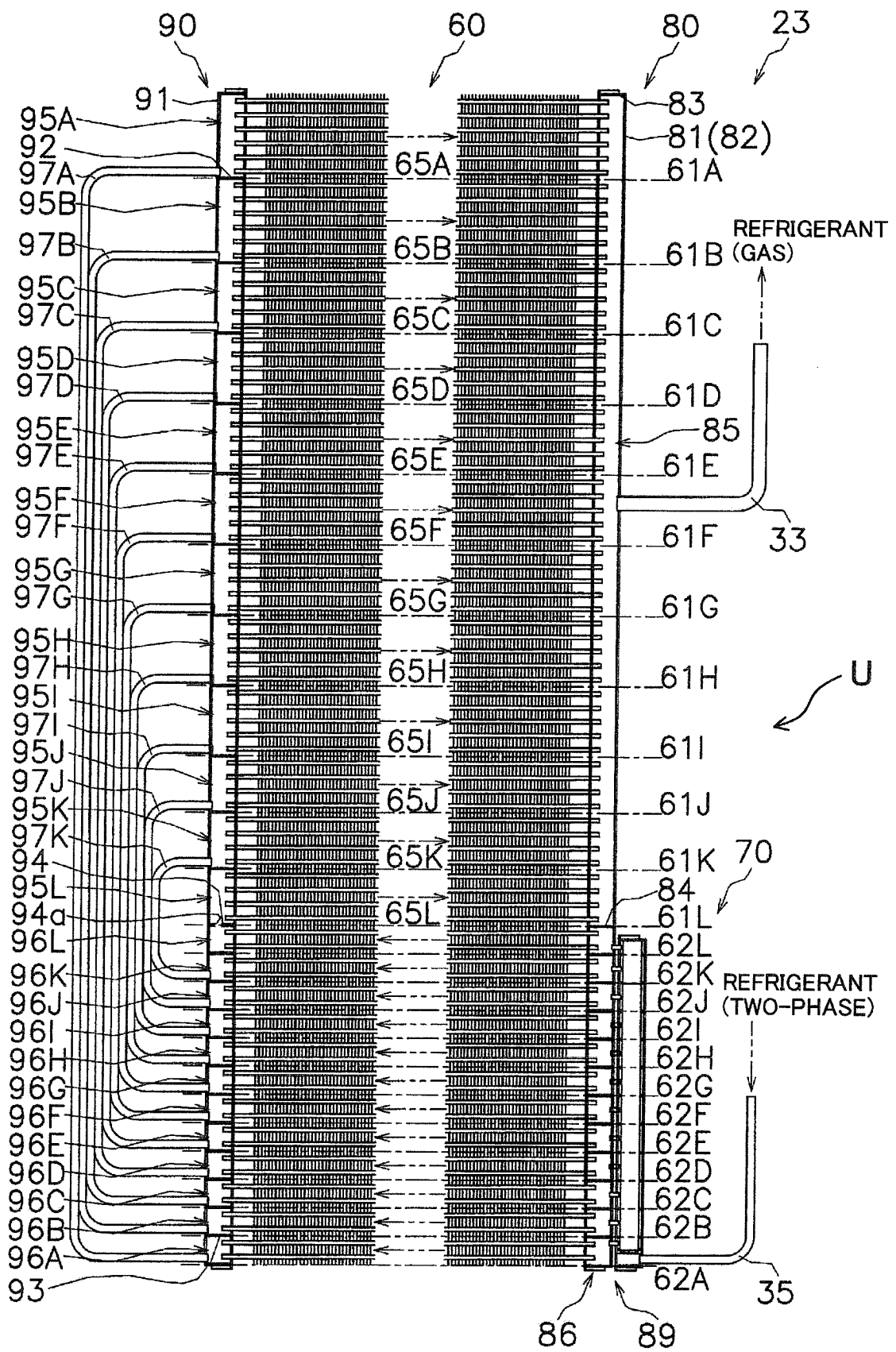


FIG. 6

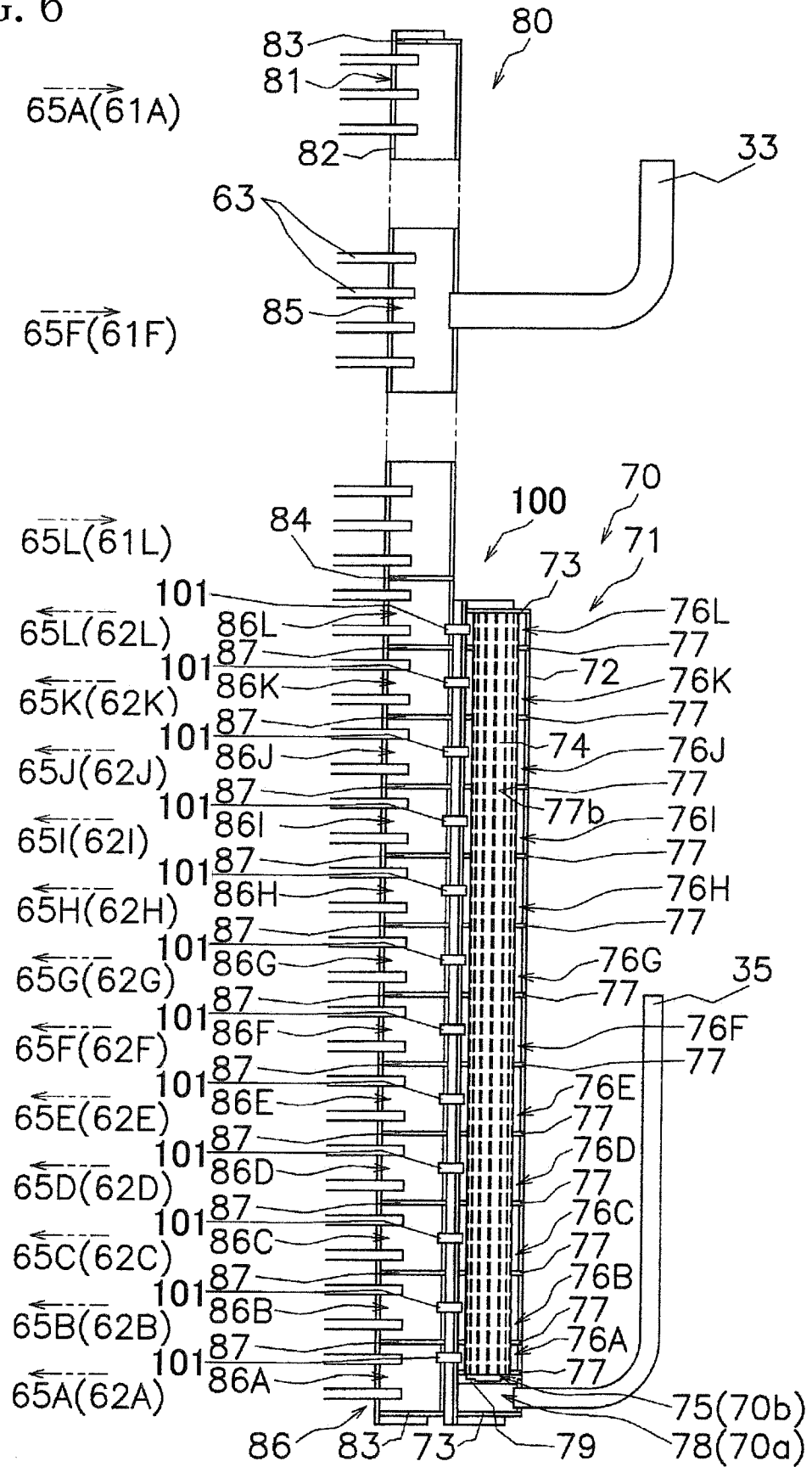


FIG. 7

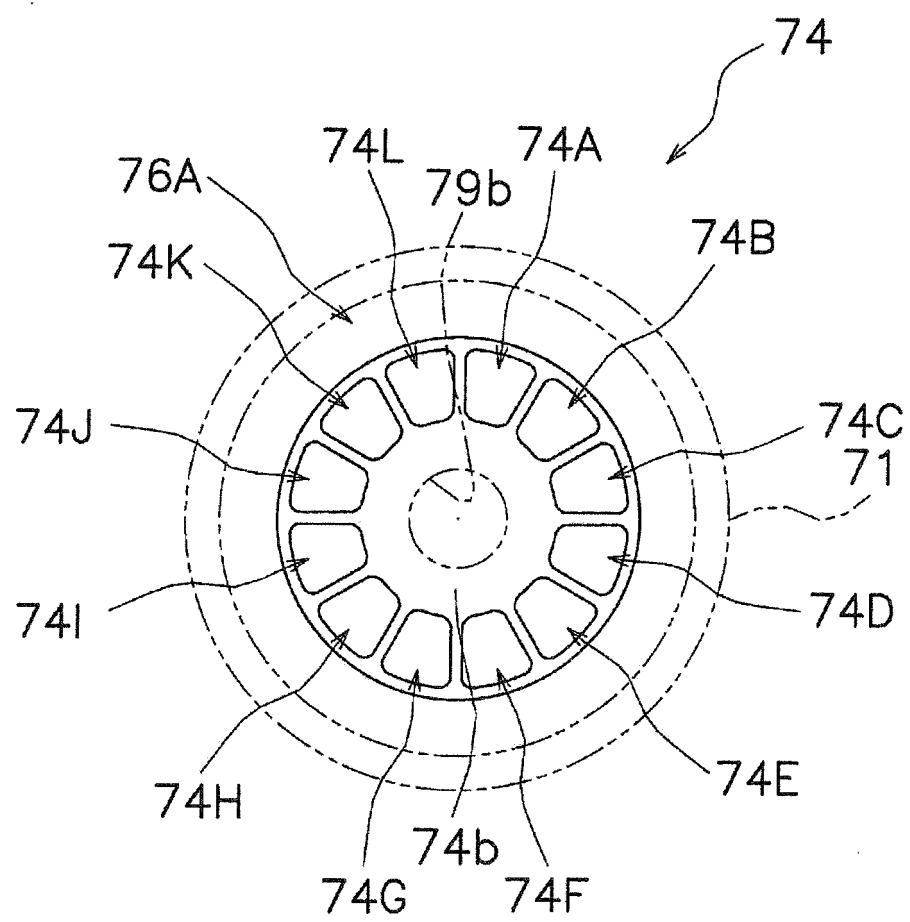


FIG. 8

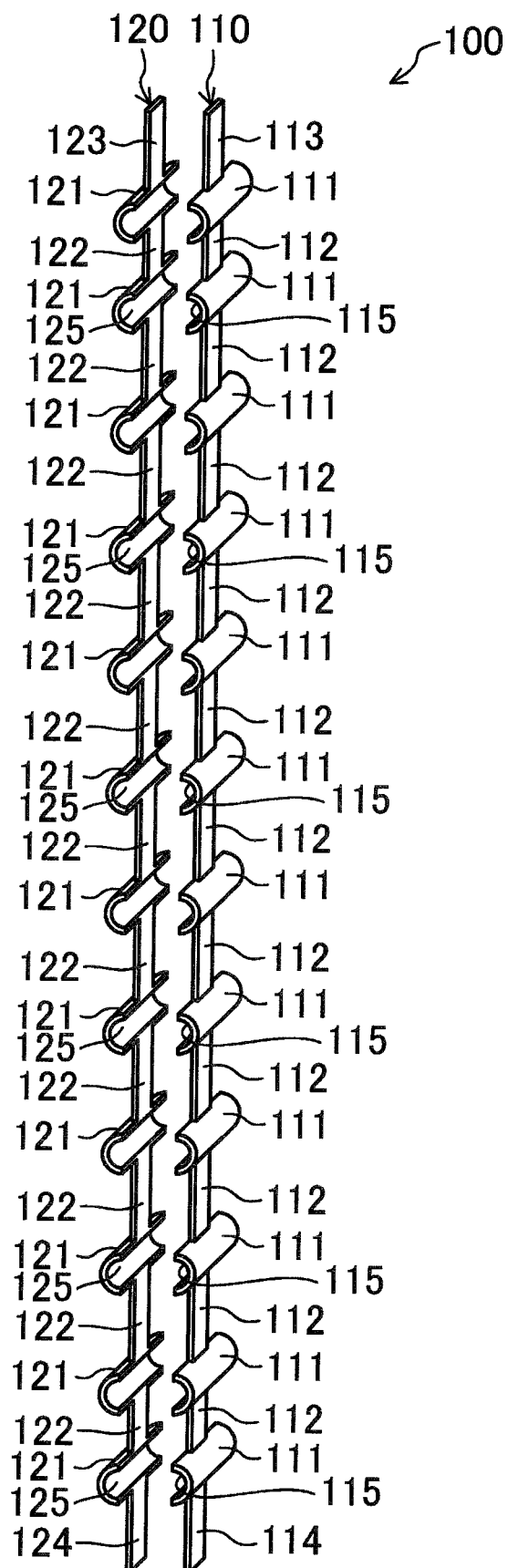


FIG. 9

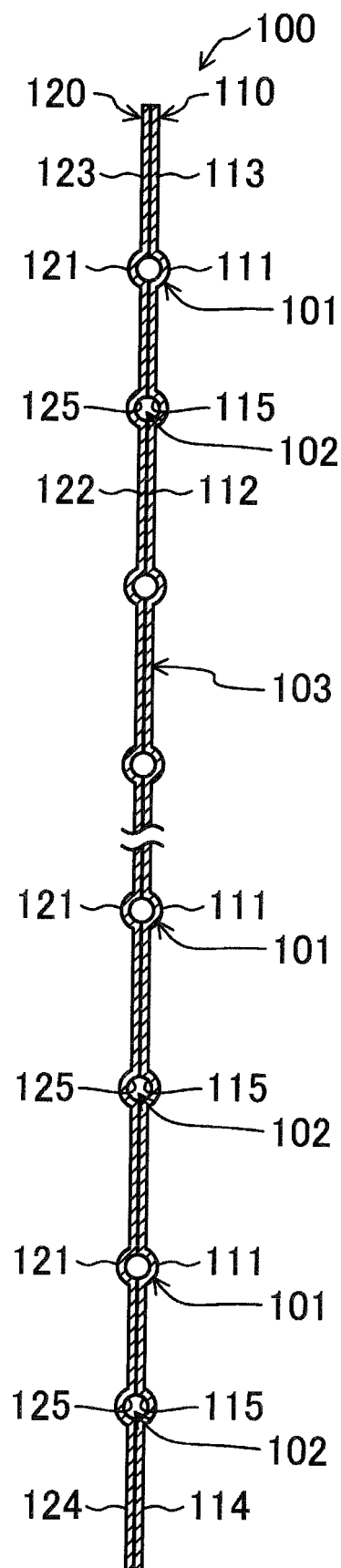


FIG. 10

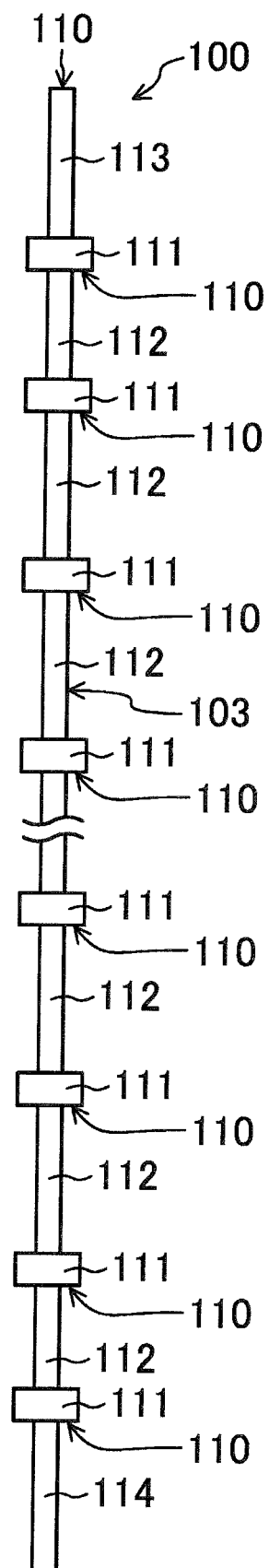


FIG. 11

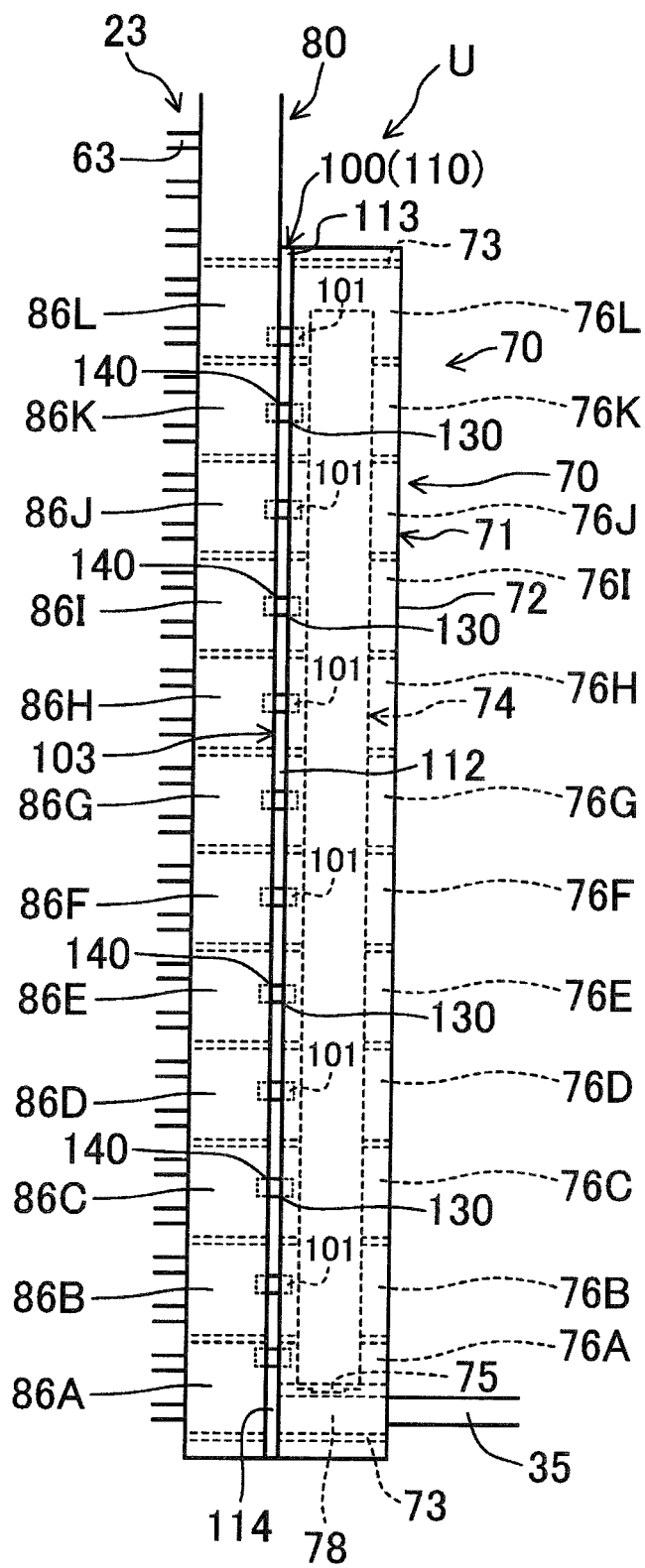
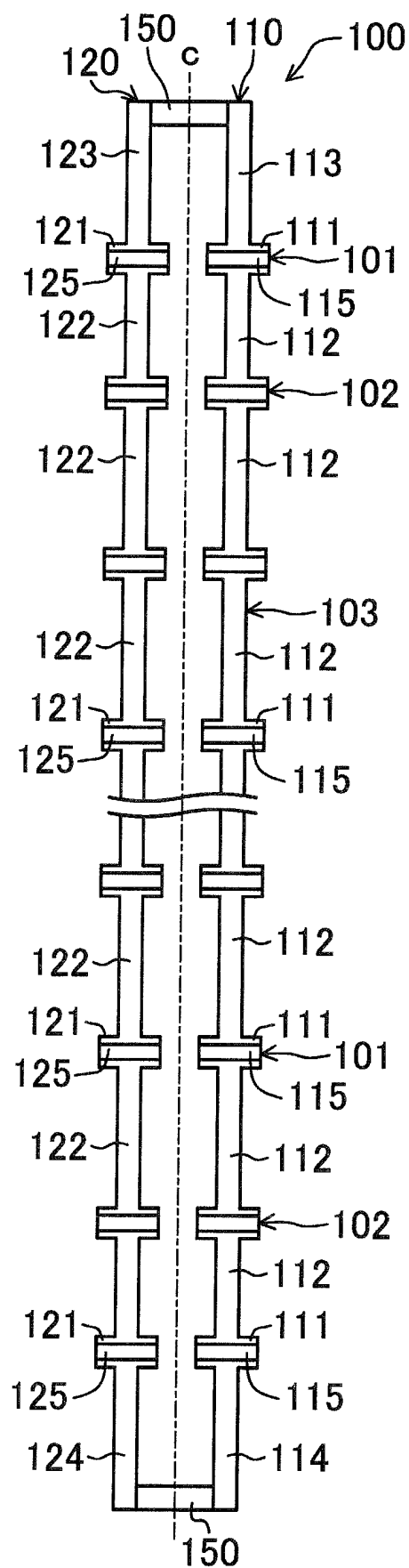


FIG. 12



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/003557

## A. CLASSIFICATION OF SUBJECT MATTER

F25B41/00(2006.01)i, F25B39/00(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)

F25B41/00, F25B39/00

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 1996-2016

Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                 | Relevant to claim No. |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Y<br>A    | US 2015/0129180 A1 (FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.),<br>14 May 2015 (14.05.2015),<br>paragraphs [0070] to [0075]; fig. 2A to 3<br>& WO 2013/182666 A1 & EP 2859296 A<br>& DE 102012011520 A | 1-2, 4-5<br>3         |
| Y         | JP 4-316785 A (Mitsubishi Electric Corp.),<br>09 November 1992 (09.11.1992),<br>paragraphs [0043] to [0044]; fig. 23 to 24<br>(Family: none)                                                                                       | 1-2, 4-5              |
| Y         | JP 4-302964 A (Daikin Industries, Ltd.),<br>26 October 1992 (26.10.1992),<br>paragraphs [0024] to [0032]; fig. 1<br>(Family: none)                                                                                                 | 1-2, 4-5              |



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&amp;" document member of the same patent family

Date of the actual completion of the international search

24 October 2016 (24.10.16)

Date of mailing of the international search report

01 November 2016 (01.11.16)

Name and mailing address of the ISA/

Japan Patent Office

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Tokyo 100-8915, Japan

Authorized officer

Telephone No.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/003557

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                  | Relevant to claim No. |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Y<br>A    | EP 0566899 A1 (BEHR GMBH & CO.),<br>27 October 1993 (27.10.1993),<br>column 3, line 13 to column 4, line 56; fig. 1<br>to 4<br>& DE 59307185 D & DE 4212721 A1<br>& ES 2106909 T                    | 1-2, 4-5<br>3         |
| Y<br>A    | JP 2000-234890 A (Hitachi Cable Ltd.),<br>29 August 2000 (29.08.2000),<br>paragraphs [0024] to [0029]; fig. 1<br>(Family: none)                                                                     | 1-2, 4-5<br>3         |
| Y<br>A    | JP 2002-153931 A (Mitsubishi Heavy Industries,<br>Ltd.),<br>28 May 2002 (28.05.2002),<br>paragraph [0030]; fig. 5<br>(Family: none)                                                                 | 1-2, 4-5<br>3         |
| Y         | JP 2007-147273 A (Denso Corp.),<br>14 June 2007 (14.06.2007),<br>paragraph [0032]; fig. 3<br>(Family: none)                                                                                         | 5                     |
| A         | WO 99/46544 A1 (Hitachi, Ltd.),<br>16 September 1999 (16.09.1999),<br>page 6, line 14 to page 8, line 2; fig. 6<br>(Family: none)                                                                   | 1-5                   |
| A         | US 2007/0266730 A1 (SON, Young Bok),<br>22 November 2007 (22.11.2007),<br>paragraph [0042]; fig. 3<br>& WO 2005/026641 A1 & KR 10-2005-0028224 A                                                    | 1-5                   |
| A         | US 4524823 A (SUDDEUTSCH KUHLEFABRIK JULIUS<br>FR. BEHR GMBH & CO. KG),<br>25 June 1985 (25.06.1985),<br>entire text; all drawings<br>& EP 121079 A1 & DE 3311579 A<br>& DE 3460027 D & ES 286088 U | 1-5                   |

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**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 2012163319 A [0004]