



(11) **EP 1 953 480 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
06.08.2008 Bulletin 2008/32

(51) Int Cl.: **F25B 39/04** (2006.01) **F24F 5/00** (2006.01)
F25B 41/00 (2006.01)

(21) Application number: **06822260.3**

(86) International application number:
PCT/JP2006/321283

(22) Date of filing: **25.10.2006**

(87) International publication number:
WO 2007/052515 (10.05.2007 Gazette 2007/19)

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
 HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI
 SK TR**

(72) Inventors:

- **KINOSHITA, Hidehiko**
Sakai-shi, Osaka 5918511 (JP)
- **MAKINO, Tatsuya**
Sakai-shi, Osaka 5918511 (JP)

(30) Priority: **31.10.2005 JP 2005315996**

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(71) Applicant: **DAIKIN INDUSTRIES, LTD.**
Osaka-shi, Osaka 530-8323 (JP)

(54) **HEAT EXCHANGER FOR OUTDOOR UNIT**

(57) To prevent, in a heat exchanger for an outdoor unit that has a structure where mutually independent plural refrigerant flow paths are arranged in multiple stages in a vertical direction and where one end side of these plural refrigerant flow paths is connected to a refrigerant flow distributor via capillary tubes, a situation where liquid refrigerant accumulates in the refrigerant flow path of the lowermost stage and the subcooling degree ends up becoming excessively large when the heat exchanger is caused to function as a condenser of refrigerant. An outdoor heat exchanger (26) includes plural refrigerant flow paths (26a to 26f) that are mutually independent and arranged in multiple stages in a vertical direction, capillary tubes (64a to 64f) that are respectively connected to one end side of the plural refrigerant flow paths (26a to 26f), and a refrigerant flow distributor (65) with which the capillary tubes (64a to 64f) merge. The lowermost stage capillary tube (64f) that is connected to the refrigerant flow path (26f) of the lowermost stage of the plural refrigerant flow paths (26a to 26f) includes a coil portion (70) having a coiled shape.

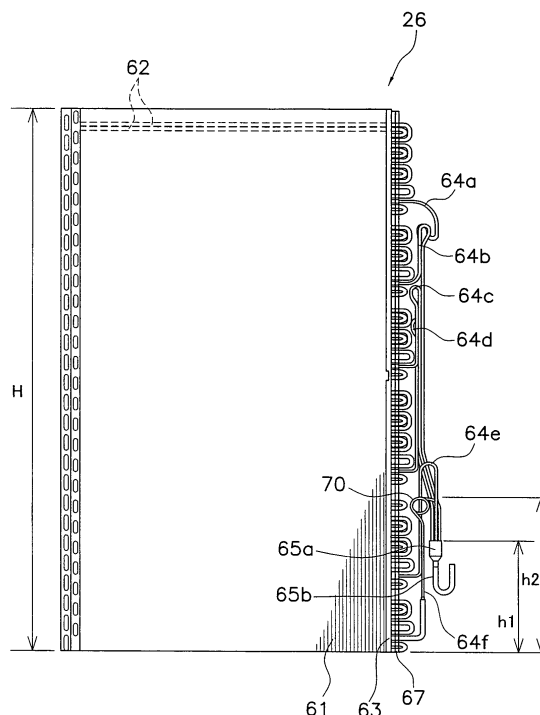


Fig. 6

Description

TECHNICAL FIELD

[0001] The present invention relates to a heat exchanger for an outdoor unit and particularly to a heat exchanger for an outdoor unit that has a structure where mutually independent plural refrigerant flow paths are arranged in multiple stages in a vertical direction and where one end side of these plural refrigerant flow paths is connected to a refrigerant flow distributor via capillary tubes.

BACKGROUND ART

[0002] Conventionally, there has been an air conditioner where an indoor unit and an outdoor unit are interconnected via communication pipes. As the outdoor unit of such an air conditioner, for example, there is an outdoor unit that has a structure (so-called trunk type structure) where the space inside a substantially rectangular parallelepiped box-shaped casing is divided into a blower chamber and a machine chamber by a partition plate that extends in a vertical direction. A heat exchanger for an outdoor unit and an outdoor fan are mainly installed in the blower chamber (e.g., see Patent Document 1).

<Patent Document 1>

[0003] Japanese Patent Application Publication No. 9-236284

DISCLOSURE OF THE INVENTION

[0004] Additionally, as the heat exchanger for an outdoor unit that is installed inside the blower chamber of the outdoor unit, there is a heat exchanger that has a structure where mutually independent plural refrigerant flow paths are arranged in multiple stages in a vertical direction, with one end side of these plural refrigerant flow paths being connected to a refrigerant flow distributor via capillary tubes and the other end side being connected to a header via header communication pipes.

[0005] When this heat exchanger for an outdoor unit is caused to function as a condenser of refrigerant, there is the problem that a large quantity of liquid refrigerant ends up accumulating in the refrigerant flow path of the lowermost stage and the subcooling degree ends up becoming excessively large.

[0006] On the other hand, in relation to the distribution of refrigerant to each of the refrigerant flow paths in this heat exchanger for an outdoor unit, when the heat exchanger is caused to function as an evaporator of refrigerant, it is difficult for the refrigerant to flow to the refrigerant flow path of the upper stage because of a liquid head from the refrigerant flow distributor to each of the refrigerant flow paths, so it is necessary to control, by adjustment such as lengthening the length of the capillary tube of the refrigerant flow path of the lower stage, mald-

istribution of the refrigerant between the refrigerant flow path of the upper stage and the refrigerant flow path of the lower stage.

[0007] However, when such adjustment of the capillary tube is performed, the problem that it becomes easier for the liquid refrigerant to accumulate in the refrigerant flow path of the lowermost stage and for the subcooling degree to become excessively large is exacerbated even more when the heat exchanger for an outdoor unit is caused to function as a condenser of refrigerant.

[0008] It is an object of the present invention to prevent, in a heat exchanger for an outdoor unit that has the aforementioned structure, a situation where liquid refrigerant accumulates in the refrigerant flow path of the lowermost stage and the subcooling degree ends up becoming excessively large when the heat exchanger is caused to function as a condenser of refrigerant.

[0009] A heat exchanger for an outdoor unit pertaining to a first invention comprises: plural refrigerant flow paths that are mutually independent and arranged in multiple stages in a vertical direction; capillary tubes that are respectively connected to one end side of the plural refrigerant flow paths; and a refrigerant flow distributor with which the plural capillary tubes merge, wherein the heat exchanger functions as a condenser of refrigerant to condense gas refrigerant flowing in from the other end side of the plural refrigerant flow paths and thereafter discharge liquid refrigerant via the capillary tubes and the refrigerant flow distributor from the one end side of the plural refrigerant flow paths. Additionally, the lowermost stage capillary tube that is the capillary tube connected to the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths includes a horizontal U-shaped portion having a shape that extends in a horizontal direction and then reverses and a vertical U-shaped portion having a shape that extends in the vertical direction and then reverses.

[0010] In this heat exchanger for an outdoor unit, the lowermost stage capillary tube includes the horizontal U-shaped portion and the vertical U-shaped portion, so the height distance from the lower end of the refrigerant flow path of the lowermost stage to the upper end of the refrigerant flow distributor can be made smaller. Thus, it becomes easier for the refrigerant inside the refrigerant flow path of the lowermost stage to flow when the heat exchanger is caused to function as a condenser of the refrigerant, so a situation where the liquid refrigerant accumulates in the refrigerant flow path of the lowermost stage and the subcooling degree ends up becoming excessively large can be prevented.

[0011] A heat exchanger for an outdoor unit pertaining to a second invention comprises the heat exchanger for an outdoor unit pertaining to the first invention, wherein a height from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the lowermost stage capillary tube is equal to or less than 1/2 times a height from the lower end of the refrigerant flow path of the lowermost stage

of the plural refrigerant flow paths to the upper end of the refrigerant flow path of the uppermost stage.

[0012] In this heat exchanger for an outdoor unit, the height from the lower end of the refrigerant flow path of the lowermost stage to the upper end of the lowermost stage capillary tube is made equal to or less than 1/2 times the height from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the refrigerant flow path of the uppermost stage, so the refrigerant inside the refrigerant flow path of the lowermost stage can be made even easier to flow when the heat exchanger is caused to function as a condenser of the refrigerant.

[0013] A heat exchanger for an outdoor unit pertaining to a third invention comprises the heat exchanger for an outdoor unit pertaining to the first or second invention, wherein a length of the lowermost stage capillary tube is equal to or greater than 2/5 times a length of the longest capillary tube of the other capillary tubes excluding the lowermost stage capillary tube.

[0014] In this heat exchanger for an outdoor unit, the length of the lowermost stage capillary tube is made equal to or greater than 2/5 times the length of the longest capillary tube, so when the heat exchanger is caused to function as an evaporator of the refrigerant, pressure loss of the refrigerant flowing from the refrigerant flow distributor into the refrigerant flow path of the lowermost stage via the lowermost stage capillary tube can be secured as much as possible and maldistribution of the refrigerant between the refrigerant flow path of the lowermost stage and the other refrigerant flow paths can be controlled.

[0015] A heat exchanger for an outdoor unit pertaining to a fourth invention comprises: plural refrigerant flow paths that are mutually independent and arranged in multiple stages in a vertical direction; capillary tubes that are respectively connected to one end side of the plural refrigerant flow paths; and a refrigerant flow distributor with which the plural capillary tubes merge, wherein the heat exchanger functions as a condenser of refrigerant to condense gas refrigerant flowing in from the other end side of the plural refrigerant flow paths and thereafter discharge liquid refrigerant via the capillary tubes and the refrigerant flow distributor from the one end side of the plural refrigerant flow paths. Additionally, the lowermost stage capillary tube that is the capillary tube connected to the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths includes a coil portion having a coiled shape.

[0016] In this heat exchanger for an outdoor unit, the lowermost stage capillary tube includes the coil portion, so the height distance from the lower end of the refrigerant flow path of the lowermost stage to the upper end of the refrigerant flow distributor can be made smaller. Thus, it becomes easier for the refrigerant inside the refrigerant flow path of the lowermost stage to flow when the heat exchanger is caused to function as a condenser of the refrigerant, so a situation where the liquid refrigerant accumulates in the refrigerant flow path of the low-

ermost stage and the subcooling degree ends up becoming excessively large can be prevented.

[0017] A heat exchanger for an outdoor unit pertaining to a fifth invention comprises the heat exchanger for an outdoor unit pertaining to the fourth invention, wherein a height from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the lowermost stage capillary tube is equal to or less than 1/2 times a height from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the refrigerant flow path of the uppermost stage.

[0018] In this heat exchanger for an outdoor unit, the height from the lower end of the refrigerant flow path of the lowermost stage to the upper end of the lowermost stage capillary tube is made equal to or less than 1/2 times the height from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the refrigerant flow path of the uppermost stage, so the refrigerant inside the refrigerant flow path of the lowermost stage can be made even easier to flow when the heat exchanger is caused to function as a condenser of the refrigerant.

[0019] A heat exchanger for an outdoor unit pertaining to a sixth invention comprises the heat exchanger for an outdoor unit pertaining to the fourth or fifth invention, wherein a length of the lowermost stage capillary tube is equal to or greater than 2/5 times a length of the longest capillary tube of the other capillary tubes excluding the lowermost stage capillary tube.

[0020] In this heat exchanger for an outdoor unit, the length of the lowermost stage capillary tube is made equal to or greater than 2/5 times the length of the longest capillary tube, so when the heat exchanger is caused to function as an evaporator of the refrigerant, pressure loss of the refrigerant flowing from the refrigerant flow distributor into the refrigerant flow path of the lowermost stage via the lowermost stage capillary tube can be secured as much as possible and maldistribution of the refrigerant between the refrigerant flow path of the lowermost stage and the other refrigerant flow paths can be controlled.

[0021] A heat exchanger for an outdoor unit pertaining to a seventh invention comprises: plural refrigerant flow paths that are mutually independent and arranged in multiple stages in a vertical direction; capillary tubes that are respectively connected to one end side of the plural refrigerant flow paths; and a refrigerant flow distributor with which the plural capillary tubes merge, wherein the heat exchanger functions as a condenser of refrigerant to condense gas refrigerant flowing in from the other end side of the plural refrigerant flow paths and thereafter discharge liquid refrigerant via the capillary tubes and the refrigerant flow distributor from the one end side of the plural refrigerant flow paths. Additionally, a height from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the refrigerant flow distributor is equal to or less than 1/4 times a height from the lower end of the refrigerant

flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the refrigerant flow path of the uppermost stage of the plural refrigerant flow paths.

[0022] In this heat exchanger for an outdoor unit, the height from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the refrigerant flow distributor is equal to or less than $1/4$ times the height from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the refrigerant flow distributor, so the height distance from the lower end of the refrigerant flow path of the lowermost stage to the upper end of the refrigerant flow distributor can be made smaller. Thus, it becomes easier for the refrigerant inside the refrigerant flow path of the lowermost stage to flow when the heat exchanger is caused to function as a condenser of the refrigerant, so a situation where the liquid refrigerant accumulates in the refrigerant flow path of the lowermost stage and the subcooling degree ends up becoming excessively large can be prevented.

[0023] A heat exchanger for an outdoor unit pertaining to an eighth invention comprises the heat exchanger for an outdoor unit pertaining to the seventh invention, wherein a height from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the lowermost stage capillary tube is equal to or less than $1/2$ times a height from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the refrigerant flow path of the uppermost stage.

[0024] In this heat exchanger for an outdoor unit, the height from the lower end of the refrigerant flow path of the lowermost stage to the upper end of the lowermost stage capillary tube is made equal to or less than $1/2$ times the height from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the refrigerant flow path of the uppermost stage, so the refrigerant inside the refrigerant flow path of the lowermost stage can be made even easier to flow when the heat exchanger is caused to function as a condenser of the refrigerant.

[0025] A heat exchanger for an outdoor unit pertaining to a ninth invention comprises the heat exchanger for an outdoor unit pertaining to the seventh or eighth invention, wherein a length of the lowermost stage capillary tube is equal to or greater than $2/5$ times a length of the longest capillary tube of the other capillary tubes excluding the lowermost stage capillary tube.

[0026] In this heat exchanger for an outdoor unit, the length of the lowermost stage capillary tube is made equal to or greater than $2/5$ times the length of the longest capillary tube, so when the heat exchanger is caused to function as an evaporator of the refrigerant, pressure loss of the refrigerant flowing from the refrigerant flow distributor into the refrigerant flow path of the lowermost stage via the lowermost stage capillary tube can be secured

as much as possible and maldistribution of the refrigerant between the refrigerant flow path of the lowermost stage and the other refrigerant flow paths can be controlled.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

FIG. 1 is a general refrigerant circuit diagram of an air conditioner that includes an outdoor unit in which a heat exchanger for an outdoor unit pertaining to an embodiment of the present invention is employed. FIG. 2 is a plan diagram of the outdoor unit (shown excluding a top plate and refrigerant circuit components).

FIG. 3 is a front diagram of the outdoor unit (shown excluding left and right front plates and refrigerant circuit components).

FIG. 4 is a diagram showing an outdoor heat exchanger as seen from the front side of the outdoor unit.

FIG. 5 is a diagram schematically showing the structure of the outdoor heat exchanger.

FIG. 6 is a diagram showing an outdoor heat exchanger pertaining to modification 1 as seen from the front side of the outdoor unit.

FIG. 7 is a diagram showing an outdoor heat exchanger pertaining to modification 2 as seen from the front side of the outdoor unit.

DESCRIPTION OF THE REFERENCE SYMBOLS

[0028]

26	Outdoor Heat Exchanger (Heat Exchanger for Outdoor Unit)
26a to 26f	Refrigerant Flow Paths
64a to 64f	Capillary Tubes
65	Refrigerant Flow Distributor

BEST MODE FOR CARRYING OUT THE INVENTION

[0029] Below, a heat exchanger for an outdoor unit pertaining to the present invention will be described on the basis of the drawings.

(1) Configuration of Refrigerant Circuit of Air Conditioner

[0030] FIG. 1 is a general refrigerant circuit diagram of an air conditioner 1 that includes an outdoor unit 2 in which a heat exchanger for an outdoor unit pertaining to an embodiment of the present invention is employed. The air conditioner 1 is a so-called separate type air conditioner, is mainly disposed with the outdoor unit 2, an indoor unit 4, and a liquid refrigerant communication pipe 5 and a gas refrigerant communication pipe 6 that interconnect the outdoor unit 2 and the indoor unit 4, and configures a vapor compression type refrigerant circuit

10.

<Configuration of Refrigerant Circuit of Indoor Unit>

[0031] The indoor unit 4 is installed indoors and is disposed with an indoor refrigerant circuit 10a that configures part of the refrigerant circuit 10. The indoor refrigerant circuit 10a mainly includes an indoor heat exchanger 41.

[0032] The indoor heat exchanger 41 comprises a cross fin type fin-and-tube heat exchanger configured by heat transfer tubes and numerous fins, for example, and is a heat exchanger that functions as an evaporator of refrigerant to cool indoor air during cooling operation and functions as a condenser of refrigerant to heat indoor air during heating operation. A liquid side of the indoor heat exchanger 41 is connected to the liquid refrigerant communication pipe 5, and a gas side of the indoor heat exchanger 41 is connected to the gas refrigerant communication pipe 6.

<Configuration of Refrigerant Circuit of Outdoor Unit>

[0033] The outdoor unit 2 is installed outdoors and is disposed with an outdoor refrigerant circuit 10b that configures part of the refrigerant circuit 10. The outdoor refrigerant circuit 10b mainly includes a compressor 22, a four-way switch valve 24, an outdoor heat exchanger 26, an expansion valve 28, a liquid close valve 29, and a gas close valve 31. A suction port of the compressor 22 and the four-way switch valve 24 are interconnected by a suction pipe 21. A discharge port of the compressor 22 and the four-way switch valve 24 are interconnected by a discharge pipe 23. The four-way switch valve 24 and a gas side of the outdoor heat exchanger 26 are interconnected by a first gas refrigerant pipe 25. The outdoor heat exchanger 26 and the liquid close valve 29 are interconnected by a liquid refrigerant pipe 27. Additionally, the expansion valve 28 is disposed in the liquid refrigerant pipe 27. Additionally, the liquid close valve 29 is connected to the liquid refrigerant communication pipe 5. The four-way switch valve 24 and the gas close valve 31 are interconnected by a second gas refrigerant pipe 30. Additionally, the gas close valve 31 is connected to the gas refrigerant communication pipe 6.

[0034] The compressor 22 is a positive displacement compressor that includes the function of sucking in low pressure gas refrigerant from the suction pipe 21, compressing the low pressure gas refrigerant into high pressure gas refrigerant, and then discharging the high pressure gas refrigerant into the discharge pipe 23.

[0035] The four-way switch valve 24 is a valve for switching the direction of the flow of the refrigerant when switching between cooling operation and heating operation such that, during cooling operation, the four-way switch valve 24 is capable of interconnecting the discharge pipe 23 and the first gas refrigerant pipe 25 and also interconnecting the suction pipe 21 and the second

gas refrigerant pipe 30, and such that, during heating operation, the four-way switch valve 24 is capable of interconnecting the discharge pipe 23 and the second gas refrigerant pipe 30 and also interconnecting the suction pipe 21 and the first gas refrigerant pipe 25.

[0036] The outdoor heat exchanger 26 is a heat exchanger that functions as a condenser of refrigerant using outdoor air as a heat source during cooling operation and functions as an evaporator of refrigerant using outdoor air as a heat source during heating operation.

[0037] The expansion valve 28 is an electrically powered expansion valve that is capable of depressurizing high pressure liquid refrigerant that has been condensed in the outdoor heat exchanger 26 during cooling operation before sending it to the indoor heat exchanger 41 and depressurizing high pressure liquid refrigerant that has been condensed in the indoor heat exchanger 41 during heating operation before sending it to the outdoor heat exchanger 26.

[0038] The liquid close valve 29 and the gas close valve 31 are three-way close valves disposed with a service port that are capable of being communicated with the outside of the refrigerant circuit 10.

(2) Structure of Outdoor Unit

[0039] Next, the structure of the outdoor unit 2 disposed with the outdoor refrigerant circuit 10b will be described using FIG. 2 and FIG. 3. Here, FIG. 2 is a plan diagram of the outdoor unit 2 (shown excluding a top plate 53 and refrigerant circuit components). FIG. 3 is a front diagram of the outdoor unit 2 (shown excluding left and right front plates 54 and 56 and refrigerant circuit components).

[0040] The outdoor unit 2 has a structure (so-called trunk type structure) where the inside of a substantially rectangular parallelepiped box-shaped unit casing 51 is divided into a blower chamber S 1 and a machine chamber S2 by a partition plate 58 that extends vertically, and the outdoor unit 2 is mainly disposed with the substantially rectangular box-shaped unit casing 51, the outdoor heat exchanger 26, outdoor fans 32, the compressor 22, refrigerant circuit components (see FIG. 1; these are not shown in FIG. 2 and FIG. 3) that configure the outdoor refrigerant circuit 10b together with the outdoor heat exchanger 26 and the compressor 22, and an electrical component assembly (not shown) that performs control of the operation of the outdoor unit 2.

<Unit Casing>

[0041] The unit casing 51 is mainly disposed with a bottom plate 52, a top plate 53, a left front plate 54, a right front plate 56, a right side plate 57, and the partition plate 58.

[0042] The bottom plate 52 is a plate-shaped member that is made of metal, has a horizontally long substantially rectangular shape, and configures the bottom surface

portion of the unit casing 51. The peripheral edge portion of the bottom plate 52 is bent upward. Two fixed legs 59 fixed to an on-site installation surface are disposed on the outer surface of the bottom plate 52. The fixed legs 59 are plate-shaped members that are made of metal, are substantially U-shaped when the unit casing 51 is seen from the front, and extend from the front side to the rear side of the unit casing 51. The top plate 53 is a plate-shaped member that is made of metal, has a horizontally long substantially rectangular shape, and configures the top surface portion of the outdoor unit 2. The left front plate 54 is a plate-shaped member that is made of metal and mainly configures the left front surface portion and the left side surface portion of the unit casing 51, and the lower portion of the left front plate 54 is fixed to the bottom plate 52 by screws or the like. A suction opening 55a through which air is sucked inside the unit casing 51 by the outdoor fans 32 is formed in the left front plate 54. Further, a blowout opening 54a for blowing out, to the outside, air that has been taken into the inside from the rear surface side and the left side surface side of the unit casing 51 by the outdoor fans 32 is disposed in the left front plate 54. A fan grill 60 is disposed in the blowout opening 54a.

[0043] The right front plate 56 is a plate-shaped member that is made of metal and mainly configures the right front surface portion and the front portion of the right side surface of the unit casing 51, and the lower portion of the right front plate 56 is fixed to the bottom plate 52 by screws or the like. Further, the left end portion of the right front plate 56 is fixed to the right end portion of the left front plate 54 by screws or the like.

[0044] The right side plate 57 is a plate-shaped member that is made of metal and mainly configures the rear portion of the right side surface and the right rear surface portion of the unit casing 51, and the lower portion of the right side plate 57 is fixed to the bottom plate 52 by screws or the like. Additionally, a suction opening 55b through which air is sucked inside the unit casing 51 by the outdoor fans 32 is formed between the rear end portion of the left front plate 54 and the rear surface side end portion of the right side plate 57 in the left-right direction.

[0045] The partition plate 58 is a plate-shaped member that is made of metal, extends vertically, and is disposed on the bottom plate 52, and the partition plate 58 is disposed so as to partition the space inside the unit casing 51 into two spaces left and right (that is, the spaces S1 and S2). The lower portion of the partition plate 58 is fixed to the bottom plate 52 by screws or the like. Further, the right end portion of the left front plate 54 is fixed to the front end portion of the partition plate 58 by screws or the like. Moreover, the rear surface side end portion of the right side plate 57 is fixed to a tube plate 63 of the outdoor heat exchanger 26 by screws or the like.

[0046] In this manner, the space inside the unit casing 51 is divided into the blower chamber S1 and the machine chamber S2 by the partition plate 58. More specifically, the blower chamber S1 is a space enclosed by the bottom

plate 52, the top plate 53, the left front plate 54 and the partition plate 58, and the outdoor fans 32 and the outdoor heat exchanger 26 are disposed in the blower chamber S1. The machine chamber S2 is a space enclosed by the bottom plate 52, the top plate 53, the right front plate 56, the right side plate 57 and the partition plate 58, and the compressor 22, the refrigerant circuit components and the electrical component assembly are disposed in the machine chamber S2. The unit casing 51 is configured such that the inside of the machine chamber S2 may be seen by removing the right front plate 56.

<Compressor>

[0047] The compressor 22 is a hermetic compressor that houses a compressor motor 22a (see FIG. 1) inside a housing and is disposed inside the machine chamber S2. As the compressor motor 22a, a so-called inverter control type motor capable of frequency control is used. The compressor 22 has an upright circular cylinder shape with a height of about 1/3 to 1/2 the entire height of the unit casing 51, and the lower portion of the compressor 22 is fixed to the bottom plate 52. Further, when the unit casing 51 is seen in plan view, the compressor 22 is disposed in the vicinity of the center of the unit casing 51 in the front-rear direction.

<Outdoor Fans>

[0048] The outdoor fans 32 are propeller fans that include plural blades and are disposed on the front side of the outdoor heat exchanger 26 inside the blower chamber S1. Here, there are two of the outdoor fans 32 disposed vertically inside the blower chamber S1. Each of the outdoor fans 32 is configured to be driven to rotate by an outdoor fan motor 32a. When the outdoor fans 32 are driven, air is taken inside through the suction openings 55a and 55b in the rear surface and the left side surface of the unit casing 51 and passes through the outdoor heat exchanger 26, and the air is thereafter blown out to the outside of the unit casing 51 from the blowout opening 54a in the front surface of the unit casing 51.

<Refrigerant Circuit Components>

[0049] The refrigerant circuit components are mainly parts that configure the outdoor refrigerant circuit 10b (excluding the compressor 22 and the outdoor heat exchanger 26) including the suction pipe 21, the discharge pipe 23, the four-way switch valve 24, the first gas refrigerant pipe 25, the liquid refrigerant pipe 27, the expansion valve 28, the liquid close valve 29, the second gas refrigerant pipe 30 and the gas close valve 31. The refrigerant circuit components are mainly disposed on the front side, the upper side, the right transverse side and the rear side of the compressor 22 inside the machine chamber S2.

<Electrical Component Assembly>

[0050] The electrical component assembly is disposed with various electrical components such as an inverter board and a control P board including a microcomputer and the like for performing operation control, and the electrical component assembly is disposed on the upper side of the compressor 22 and close to the partition plate 58 inside the machine chamber S2.

<Outdoor Heat Exchanger>

[0051] The major portion of the outdoor heat exchanger 26 is disposed inside the blower chamber S1, and the outdoor heat exchanger 26 performs heat exchange with the air that has been taken inside the unit casing 51 by the outdoor fans 32. The outdoor heat exchanger 26 is substantially L-shaped when the unit casing 51 is seen in plan view and is disposed so as to follow the left side surface to the rear surface of the unit casing 51. Further, the upper end of the outdoor heat exchanger 26 extends as far as the vicinity of the top plate 53, and the lower end of the outdoor heat exchanger 26 extends as far as the bottom plate 52. Further, the tube plate 63 is disposed on the right end portion of the outdoor heat exchanger 26.

[0052] Next, the detailed structure of the outdoor heat exchanger 26 will be described using FIG. 4 and FIG. 5. Here, FIG. 4 is a diagram showing the outdoor heat exchanger 26 as seen from the front side of the outdoor unit 2. FIG. 5 is a diagram schematically showing the structure of the outdoor heat exchanger 26.

[0053] In the present embodiment, the outdoor heat exchanger 26 comprises a cross fin type fin-and-tube heat exchanger and mainly includes numerous fins 61 that are arranged at predetermined intervals so as to follow the left side surface to the rear surface of the unit casing 51, numerous heat transfer tubes 62 that are attached in a state where they penetrate these fins 61 in a plate thickness direction, and the tube plate 63 that is fixed to the end portion on the rear surface side of the partition plate 58. In this outdoor heat exchanger 26, the heat transfer tubes 62 are separated into six systems in the vertical direction, and these are a first refrigerant flow path 26a to a sixth refrigerant flow path 26f that are mutually independent. Additionally, one end side of each of the refrigerant flow paths 26a to 26f (here, end portions that become a refrigerant outflow side when the outdoor heat exchanger 26 functions as a condenser of the refrigerant) is respectively connected to a refrigerant flow distributor 65 via a first capillary tube 64a to a sixth capillary tube 64f, and the other end side of each of the refrigerant flow paths 26a to 26f (here, end portions that become a refrigerant inflow side when the outdoor heat exchanger 26 functions as a condenser of the refrigerant) is respectively connected to a header 67 via a first header communication pipe 66a to a sixth header communication pipe 66f. That is, the first refrigerant flow path 26a to the sixth refrigerant flow path 26f are connected in

parallel to each other via the refrigerant flow distributor 65 and the header 67; when the outdoor heat exchanger 26 functions as a condenser of the refrigerant, all of the refrigerant flow paths function as condensers of the refrigerant, and when the outdoor heat exchanger 26 functions as an evaporator of the refrigerant, all of the refrigerant flow paths function as evaporators of the refrigerant. It will be noted that these pipe members 64a to 64f, 65, 66a to 66f and 67 are disposed in a space on the right side plate 57 side of the tube plate 63 -- that is, in a space inside the machine chamber S2 surrounded by the tube plate 63 and the right side plate 57.

[0054] The header 67 is a pipe member that extends from the first refrigerant flow path 26a to the sixth refrigerant flow path 26f of the outdoor heat exchanger 26, and the end portion of the header 67 is connected to the first gas refrigerant pipe 25. Each of the header communication pipes 66a to 66f is a pipe member that extends towards the header 67 from the other end side of each of the refrigerant flow paths 26a to 26f.

[0055] The refrigerant flow distributor 65 is a pipe member that causes the first to sixth capillary tubes 64a to 64f that are connected to the one end side of each of the refrigerant flow paths 26a to 26f to merge, and the refrigerant flow distributor 65 mainly includes a flow distributor body 65a and a nozzle portion 65b. The flow distributor body 65a is a substantially cylindrical portion, with the first to sixth capillary tubes 64a to 64f being connected to the upper end thereof and the nozzle portion 65b being formed on the lower end thereof. The nozzle portion 65b is a U-shaped pipe member through which flows refrigerant after the refrigerant has merged in the flow distributor body 65a, and the end portion of the nozzle portion 65b is connected to the liquid refrigerant pipe 27.

[0056] The first capillary tube 64a extends downward from the one end side of the first refrigerant flow path 26a, then reverses and extends upward, then again reverses and extends downward, and is connected to the upper end of the flow distributor body 65a. The second capillary tube 64b extends upward from the one end side of the second refrigerant flow path 26b, then reverses and extends downward, and is connected to the upper end of the flow distributor body 65a. The third capillary tube 64c extends upward from the one end side of the third refrigerant flow path 26c, then reverses and extends downward, and is connected to the upper end of the flow distributor body 65a. The fourth capillary tube 64d extends upward from the one end side of the fourth refrigerant flow path 26d, then reverses and extends downward, and is connected to the upper end of the flow distributor body 65a. The fifth capillary tube 64e extends upward from the one end side of the fifth refrigerant flow path 26e, then reverses and extends downward, and is connected to the upper end of the flow distributor body 65a. In the sixth capillary tube 64f serving as the lowermost stage capillary tube, there is formed a horizontal U-shaped portion 68 having a shape that extends upward from the one end side of the sixth refrigerant flow path

26f, then extends in a horizontal direction and then reverses, and a vertical U-shaped portion 69 having a shape that extends in the vertical direction and then reverses is formed after the horizontal U-shaped portion 68. Here, the horizontal U-shaped portion 68 extends in the direction of the right side surface of the unit casing 51. In this manner, because the horizontal U-shaped portion 68 and the vertical U-shaped portion 69 are formed in the sixth capillary tube 64f, the height distance from the lower end of the sixth refrigerant flow path 26f serving as the refrigerant flow path of the lowermost stage to the upper end of the refrigerant flow distributor 65 can be made smaller. Here, a height h1 from the lower end of the sixth refrigerant flow path 26f serving as the refrigerant flow path of the lowermost stage to the upper end of the refrigerant flow distributor 65 is equal to or less than 1/4 times a height H from the lower end of the sixth refrigerant flow path 26f to the upper end of the first refrigerant flow path 26a serving as the refrigerant flow path of the uppermost stage. Further, a height h2 from the lower end of the sixth refrigerant flow path 26f to the upper end of the sixth capillary tube 64f is equal to or less than 1/2 times the height H. Further, a length L6 of the sixth capillary tube 64f is equal to or greater than 2/5 times a length Lx of the longest capillary tube of the other capillary tubes 64a to 64e excluding the sixth capillary tube 64f.

(3) Operation of Outdoor Unit

[0057] Next, operation of the outdoor unit 2 that includes the outdoor heat exchanger 26 will be described.

[0058] First, operation of the outdoor unit 2 during cooling operation and heating operation will be described.

[0059] During cooling operation, the four-way switch valve 24 of the refrigerant circuit 10 is in the state indicated by the solid lines in FIG. 1, that is, a state where the discharge pipe 23 is connected to the first gas refrigerant pipe 25 and where the suction pipe 21 is connected to the second gas refrigerant pipe 30. Further, the liquid close valve 29 and the gas close valve 31 are opened, and the opening of the expansion valve 28 is adjusted to depressurize the refrigerant.

[0060] Operation of the outdoor fans 32 and the compressor 22 is performed in this state of the refrigerant circuit 10. Then, because of the operation of the outdoor fans 32, a flow of outdoor air is formed where outdoor air is taken inside the unit casing 51 from the suction openings 55a and 55b in the left side surface and the rear surface of the unit casing 51, is utilized as a heat source as a result of passing through the outdoor heat exchanger 26, and is blown out from the blowout opening 54a in the front surface of the unit casing 51. Further, because of the operation of the compressor 22, low pressure gas refrigerant is sucked into the compressor 22 through the suction pipe 21, is compressed into high pressure gas refrigerant, and is thereafter discharged into the discharge pipe 23.

[0061] The high pressure gas refrigerant that has been

discharged into the discharge pipe 23 is sent to the outdoor heat exchanger 26 through the four-way switch valve 24 and the first gas refrigerant pipe 25, is cooled and condensed by heat exchange with outdoor air, becomes high pressure liquid refrigerant, and is sent to the liquid refrigerant pipe 27. More specifically, the high pressure gas refrigerant flowing into the header 67 from the first gas refrigerant pipe 25 is distributed to each of the refrigerant flow paths 26a to 26f of the outdoor heat exchanger 26 via the header communication pipes 66a to 66f. Then, this high pressure gas refrigerant is cooled and condensed by heat exchange with outdoor air inside each of the refrigerant flow paths 26a to 26f, becomes high pressure liquid refrigerant, merges in the refrigerant flow distributor 65 via the capillary tubes 64a to 64f, and is sent to the liquid refrigerant pipe 27.

[0062] Here, as mentioned above, the horizontal U-shaped portion 68 and the vertical U-shaped portion 69 are formed in the sixth capillary tube 64f, whereby the height h1 from the lower end of the sixth refrigerant flow path 26f serving as the refrigerant flow path of the lowermost stage to the upper end of the refrigerant flow distributor 65 becomes smaller (specifically, equal to or less than 1/4 times the height H), so it becomes easier for the refrigerant inside the refrigerant flow path of the lowermost stage to flow. For this reason, a situation where the liquid refrigerant accumulates in the sixth refrigerant flow path 26a and the subcooling degree becomes excessively large can be prevented. Further, the height h2 from the lower end of the sixth refrigerant flow path 26f to the upper end of the sixth capillary tube 64f is equal to or less than 1/2 times the height H, so it becomes even easier for the refrigerant inside the refrigerant flow path of the lowermost stage to flow.

[0063] Then, the high pressure liquid refrigerant that has been sent to the liquid refrigerant pipe 27 is depressurized in the expansion valve 28, becomes refrigerant in a low pressure gas-liquid two-phase state, and is sent to the indoor heat exchanger 41 through the liquid refrigerant pipe 27, the liquid close valve 29 and the liquid refrigerant communication pipe 5. The refrigerant in the low pressure gas-liquid two-phase state that has been sent to the indoor heat exchanger 41 is heated and evaporated by heat exchange with indoor air, becomes low pressure gas refrigerant, is returned to the suction pipe 21 through the gas refrigerant communication pipe 6, the gas close valve 31, the second gas refrigerant pipe 30 and the four-way switch valve 24, and is again sucked into the compressor 22.

[0064] Next, during heating operation, the four-way switch valve 24 of the refrigerant circuit 10 is in the state indicated by the dotted lines in FIG. 1, that is, a state where the discharge pipe 23 is connected to the second gas refrigerant pipe 30 and where the suction pipe 21 is connected to the first gas refrigerant pipe 25. Further, the liquid close valve 29 and the gas close valve 31 are opened, and the opening of the expansion valve 28 is adjusted to depressurize the refrigerant.

[0065] Operation of the outdoor fans 32 and the compressor 22 is performed in this state of the refrigerant circuit 10. Then, because of the operation of the outdoor fans 32, a flow of outdoor air is formed where outdoor air is taken inside the unit casing 51 from the suction openings 55a and 55b in the left side surface and the rear surface of the unit casing 51, is utilized as a heat source as a result of passing through the outdoor heat exchanger 26, and is blown out from the blowout opening 54a in the front surface of the unit casing 51. Further, because of the operation of the compressor 22, low pressure gas refrigerant is sucked into the compressor 22 through the suction pipe 21, is compressed into high pressure gas refrigerant, and is thereafter discharged into the discharge pipe 23. The high pressure gas refrigerant that has been discharged into the discharge pipe 23 is sent to the indoor heat exchanger 41 through the four-way switch valve 24, the second gas refrigerant pipe 30, the gas close valve 31 and the gas refrigerant communication pipe 6, is cooled and condensed by heat exchange with the indoor air, becomes high pressure liquid refrigerant, and is sent to the expansion valve 28 through the liquid refrigerant communication pipe 5, the liquid close valve 29 and the liquid refrigerant pipe 27. The high pressure liquid refrigerant that has been sent to the expansion valve 28 is depressurized in the expansion valve 28, becomes refrigerant in a low pressure gas-liquid two-phase state, and is sent to the outdoor heat exchanger 26 through the liquid refrigerant pipe 27. The refrigerant in the low pressure gas-liquid two-phase state that has been sent to the outdoor heat exchanger 26 is heated and evaporated by heat exchange with the outdoor air, becomes low pressure gas refrigerant, and is sent to the first gas refrigerant pipe 25. More specifically, the refrigerant in the low pressure gas-liquid two-phase state flowing into the refrigerant flow distributor 65 from the liquid refrigerant pipe 27 is distributed to each of the refrigerant flow paths 26a to 26f of the outdoor heat exchanger 26 via the capillary tubes 64a to 64f. Then, the refrigerant in the low pressure gas-liquid two-phase state is heated and evaporated by heat exchange with outdoor air inside each of the refrigerant flow paths 26a to 26f, becomes low pressure gas refrigerant, merges in the header 67 via the header communication pipes 66a to 66f, and is sent to the first gas refrigerant pipe 25.

[0066] Here, as mentioned above, the length L6 of the sixth capillary tube 64f is equal to or greater than 2/5 times the length Lx of the longest capillary tube of the other capillary tubes 64a to 64e, so pressure loss of the refrigerant flowing from the refrigerant flow distributor 65 into the sixth refrigerant flow path 26f via the sixth capillary tube 64f can be secured as much as possible and maldistribution of the refrigerant between the sixth refrigerant flow path 26f and the other refrigerant flow paths 26a to 26e can be controlled. That is, a structure is realized where, in consideration of when the outdoor heat exchanger 26 is caused to function as an evaporator of refrigerant, the length of the sixth capillary tube 64f is

ensured, and, in consideration of when the outdoor heat exchanger 26 is caused to function as a condenser of refrigerant, the height h1 of the refrigerant flow distributor 65 is made smaller.

[0067] Then, the low pressure gas refrigerant that has been sent to the first gas refrigerant pipe 25 is returned to the suction pipe 21 through the four-way switch valve 24 and is again sucked into the compressor 22.

(4) Characteristics of Outdoor Heat Exchanger

[0068] The outdoor heat exchanger 26 of the present embodiment has the following characteristics.

(A) In the outdoor heat exchanger 26 of the present embodiment, the sixth capillary tube 64f serving as the lowermost stage capillary tube includes the horizontal U-shaped portion 68 and the vertical U-shaped portion 69, so the height distance from the lower end of the sixth refrigerant flow path 26f serving as the refrigerant flow path of the lowermost stage to the upper end of the refrigerant flow distributor 65 can be made smaller. Thus, it becomes easier for the refrigerant inside the sixth refrigerant flow path 26f to flow when the outdoor heat exchanger 26 is caused to function as a condenser of the refrigerant, so a situation where the liquid refrigerant accumulates in the sixth refrigerant flow path 26f and the subcooling degree ends up becoming excessively large can be prevented.

(B) Further, the height h2 from the lower end of the sixth refrigerant flow path 26f to the upper end of the sixth capillary tube 64f is made equal to or less than 1/2 times the height H from the lower end of the sixth refrigerant flow path 26f to the upper end of the first refrigerant flow path 26a, so the refrigerant inside the sixth refrigerant flow path 26f can be made even easier to flow when the outdoor heat exchanger 26 is caused to function as a condenser of the refrigerant.

(C) Moreover, the length L6 of the sixth capillary tube 64f is made equal to or greater than 2/5 times the length Lx of the longest capillary tube, so when the outdoor heat exchanger 26 is caused to function as an evaporator of the refrigerant, pressure loss of the refrigerant flowing from the refrigerant flow distributor 65 into the sixth refrigerant flow path 26f via the sixth capillary tube 64f can be secured as much as possible and maldistribution of the refrigerant between the sixth refrigerant flow path 26f and the other refrigerant flow paths 26a to 26e can be controlled.

(5) Modification 1

[0069] In the preceding embodiment (see FIG. 4 and FIG. 5), the height distance from the lower end of the sixth refrigerant flow path 26f serving as the refrigerant flow path of the lowermost stage to the upper end of the

refrigerant flow distributor 65 was made smaller by forming the horizontal U-shaped portion 68 and the vertical U-shaped portion 69 in the sixth capillary tube 64f, but as shown in FIG. 6, instead of the horizontal U-shaped portion 68 and the vertical U-shaped portion 69, a coil portion 70 having a shape formed by coiling part of the sixth capillary tube 64f may be formed to thereby make the height h1 from the lower end of the sixth refrigerant flow path 26f to the upper end of the refrigerant flow distributor 65 equal to or less than 1/4 times the height H from the lower end of the sixth refrigerant flow path 26f to the upper end of the first refrigerant flow path 26a serving as the refrigerant flow path of the uppermost stage.

[0070] In this case also, basically effects that are the same as those of the preceding embodiment are obtained. Moreover, in the present modification, the length L6 of the sixth capillary tube 64f can be varied by adjusting the number of coils of the coil portion 70, so it is easy to make the length L6 equal to or greater than 2/5 times the length Lx of the longest capillary tube, and it is also possible, for example, to make the length L6 the same length as the length Lx of the longest capillary tube. Thus, when the outdoor heat exchanger 26 is caused to function as an evaporator of the refrigerant, the effect of securing, as much as possible, pressure loss of the refrigerant flowing from the refrigerant flow distributor 65 into the sixth refrigerant flow path 26f via the sixth capillary tube 64f and controlling maldistribution of the refrigerant between the sixth refrigerant flow path 26f and the other refrigerant flow paths 26a to 26e can also be improved even more.

(6) Modification 2

[0071] In the preceding embodiment and modification 1 (see FIG. 4 to FIG. 6), the height distance from the lower end of the sixth refrigerant flow path 26f serving as the refrigerant flow path of the lowermost stage to the upper end of the refrigerant flow distributor 65 was made smaller by forming the horizontal U-shaped portion 68 and the vertical U-shaped portion 69 or by forming the coil portion 70 in the sixth capillary tube 64f, but as shown in FIG. 7, the height h1 from the lower end of the sixth refrigerant flow path 26f to the upper end of the refrigerant flow distributor 65 may also be made equal to or less than 1/4 times the height H from the lower end of the sixth refrigerant flow path 26f to the upper end of the first refrigerant flow path 26a serving as the refrigerant flow path of the uppermost stage without disposing the horizontal U-shaped portion 68.

[0072] In this case, the height h2 from the lower end of the sixth refrigerant flow path 26f to the upper end of the sixth capillary tube 64f becomes larger than the height h2 in the preceding embodiment and modification 1, so the effect of making it easier for the refrigerant inside the sixth refrigerant flow path 26f to flow becomes somewhat smaller, but basically effects that are the same as those of the preceding embodiment and modification 1 are obtained. Further, as long as a situation where the height

h2 in the present modification becomes somewhat larger than the height h2 in the preceding embodiment can be allowed, it is also possible to make the length L6 of the sixth capillary tube 64f equal to or greater than 2/5 times the length Lx of the longest capillary tube; thus, similar to the preceding embodiment and modification 1, when the outdoor heat exchanger 26 is caused to function as an evaporator of the refrigerant, the effect of securing, as much as possible, pressure loss of the refrigerant flowing from the refrigerant flow distributor 65 into the sixth refrigerant flow path 26f via the sixth capillary tube 64f and controlling maldistribution of the refrigerant between the sixth refrigerant flow path 26f and the other refrigerant flow paths 26a to 26e can also be obtained.

(7) Other Embodiments

[0073] Embodiments of the present invention have been described above on the basis of the drawings, but the basic configuration is not limited to these embodiments and can be altered in a range that does not depart from the gist of the invention.

[0074] For example, in the preceding embodiment where the horizontal U-shaped portion 68 and the vertical U-shaped portion 69 were formed in the sixth capillary tube 64f, one each of the horizontal U-shaped portion 68 and the vertical U-shaped portion 69 were formed, but the invention is not limited to this, and the horizontal U-shaped portion 68 and the vertical U-shaped portion 69 may also be plurally formed.

[0075] Further, the invention may also have a configuration where the preceding embodiment and modification 1 are combined -- that is, where the horizontal U-shaped portion 68, the vertical U-shaped portion 69 and the coil portion 70 are disposed in the sixth capillary tube 64f.

INDUSTRIAL APPLICABILITY

[0076] By utilizing the present invention, there can be prevented, in a heat exchanger for an outdoor unit that has a structure where plural mutually independent refrigerant flow paths are arranged in multiple stages in a vertical direction and where one end of each of these plural refrigerant flow paths is connected to a refrigerant flow distributor via a capillary tube, a situation where liquid refrigerant accumulates in the refrigerant flow path of the lowermost stage and the subcooling degree ends up becoming excessively large when the heat exchanger is caused to function as a condenser of refrigerant.

Claims

1. A heat exchanger (26) for an outdoor unit comprising:

plural refrigerant flow paths (26a to 26f) that are

- mutually independent and arranged in multiple stages in a vertical direction;
capillary tubes (64a to 64f) that are respectively connected to one end side of the plural refrigerant flow paths; and
a refrigerant flow distributor (65) with which the plural capillary tubes merge, wherein the heat exchanger functions as a condenser of refrigerant to condense gas refrigerant flowing in from the other end side of the plural refrigerant flow paths and thereafter discharge liquid refrigerant via the capillary tubes and the refrigerant flow distributor from the one end side of the plural refrigerant flow paths, and
the lowermost stage capillary tube that is the capillary tube connected to the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths includes a horizontal U-shaped portion having a shape that extends in a horizontal direction and then reverses and a vertical U-shaped portion having a shape that extends in the vertical direction and then reverses.
2. The heat exchanger (26) for an outdoor unit of claim 1, wherein a height (h2) from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths (26a to 26f) to the upper end of the lowermost stage capillary tube (64f) is equal to or less than 1/2 times a height (H) from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the refrigerant flow path of the uppermost stage.
 3. The heat exchanger (26) for an outdoor unit of claim 1 or 2, wherein a length (L6) of the lowermost stage capillary tube (64f) is equal to or greater than 2/5 times a length (Lx) of the longest capillary tube of the other capillary tubes (64a to 64e) excluding the lowermost stage capillary tube.
 4. A heat exchanger (26) for an outdoor unit comprising:

plural refrigerant flow paths (26a to 26f) that are mutually independent and arranged in multiple stages in a vertical direction;
capillary tubes (64a to 64f) that are respectively connected to one end side of the plural refrigerant flow paths; and
a refrigerant flow distributor (65) with which the plural capillary tubes merge, wherein the heat exchanger functions as a condenser of refrigerant to condense gas refrigerant flowing in from the other end side of the plural refrigerant flow paths and thereafter discharge liquid refrigerant via the capillary tubes and the refrigerant flow distributor from the one end side of the plural
 5. The heat exchanger (26) for an outdoor unit of claim 4, wherein a height (h2) from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths (26a to 26f) to the upper end of the lowermost stage capillary tube (64f) is equal to or less than 1/2 times a height (H) from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the refrigerant flow path of the uppermost stage.
 6. The heat exchanger (26) for an outdoor unit of claim 4 or 5, wherein a length (L6) of the lowermost stage capillary tube (64f) is equal to or greater than 2/5 times a length (Lx) of the longest capillary tube of the other capillary tubes (64a to 64e) excluding the lowermost stage capillary tube.
 7. A heat exchanger (26) for an outdoor unit comprising:

plural refrigerant flow paths (26a to 26f) that are mutually independent and arranged in multiple stages in a vertical direction;
capillary tubes (64a to 64f) that are respectively connected to one end side of the plural refrigerant flow paths; and
a refrigerant flow distributor (65) with which the plural capillary tubes merge, wherein the heat exchanger functions as a condenser of refrigerant to condense gas refrigerant flowing in from the other end side of the plural refrigerant flow paths and thereafter discharge liquid refrigerant via the capillary tubes and the refrigerant flow distributor from the one end side of the plural refrigerant flow paths, and
a height (h1) from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the refrigerant flow distributor is equal to or less than 1/4 times a height (H) from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the refrigerant flow path of the uppermost stage of the plural refrigerant flow paths.
 8. The heat exchanger (26) for an outdoor unit of claim 7, wherein a height (h2) from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths (26a to 26f) to the upper end of the lowermost stage capillary tube (64f) is

equal to or less than $1/2$ times a height (H) from the lower end of the refrigerant flow path of the lowermost stage of the plural refrigerant flow paths to the upper end of the refrigerant flow path of the uppermost stage.

5

9. The heat exchanger (26) for an outdoor unit of claim 7 or 8, wherein a length (L6) of the lowermost stage capillary tube (64f) is equal to or greater than $2/5$ times a length (Lx) of the longest capillary tube of the other capillary tubes (64a to 64e) excluding the lowermost stage capillary tube.

10

15

20

25

30

35

40

45

50

55

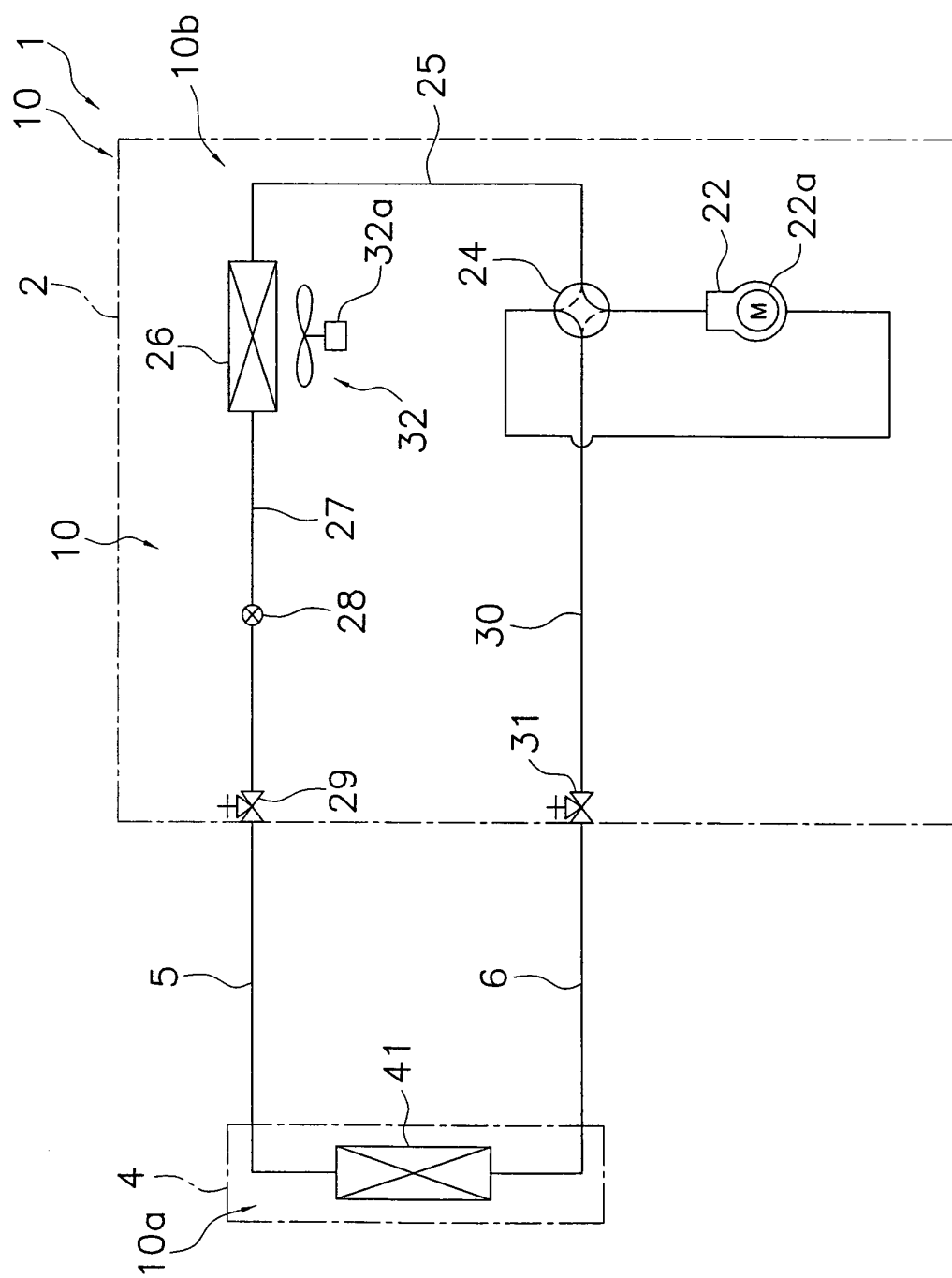


Fig. 1

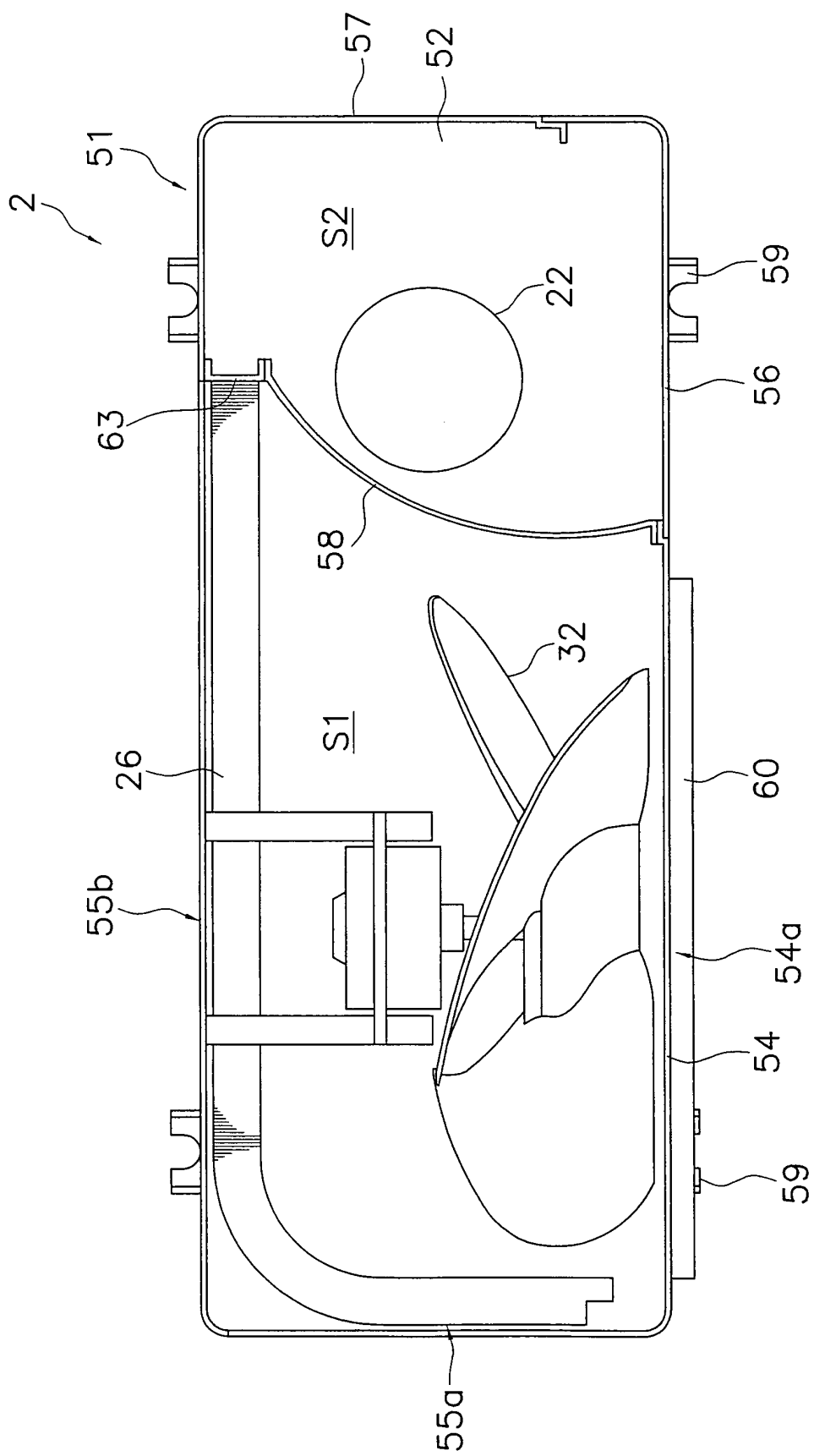


Fig. 2

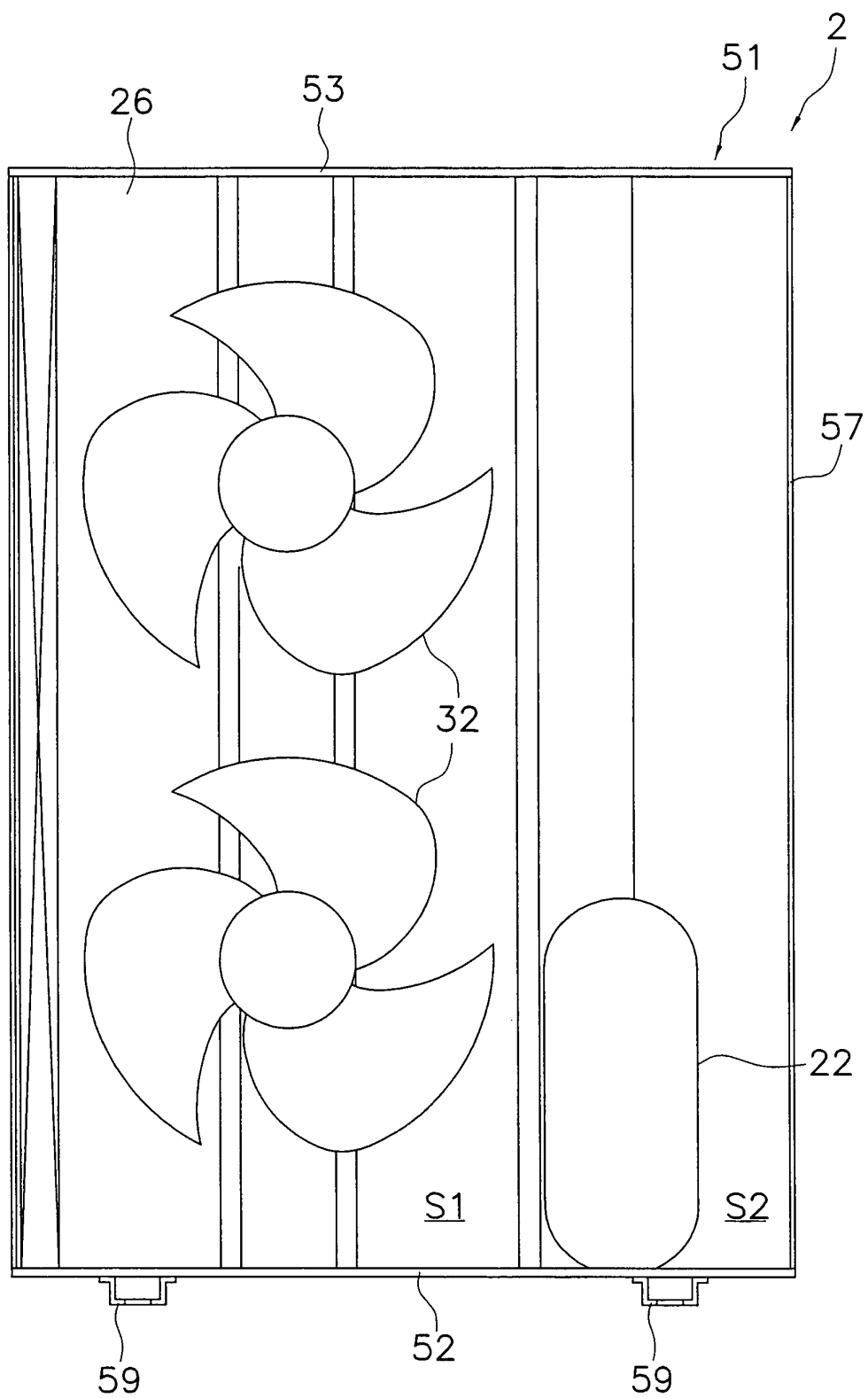


Fig. 3

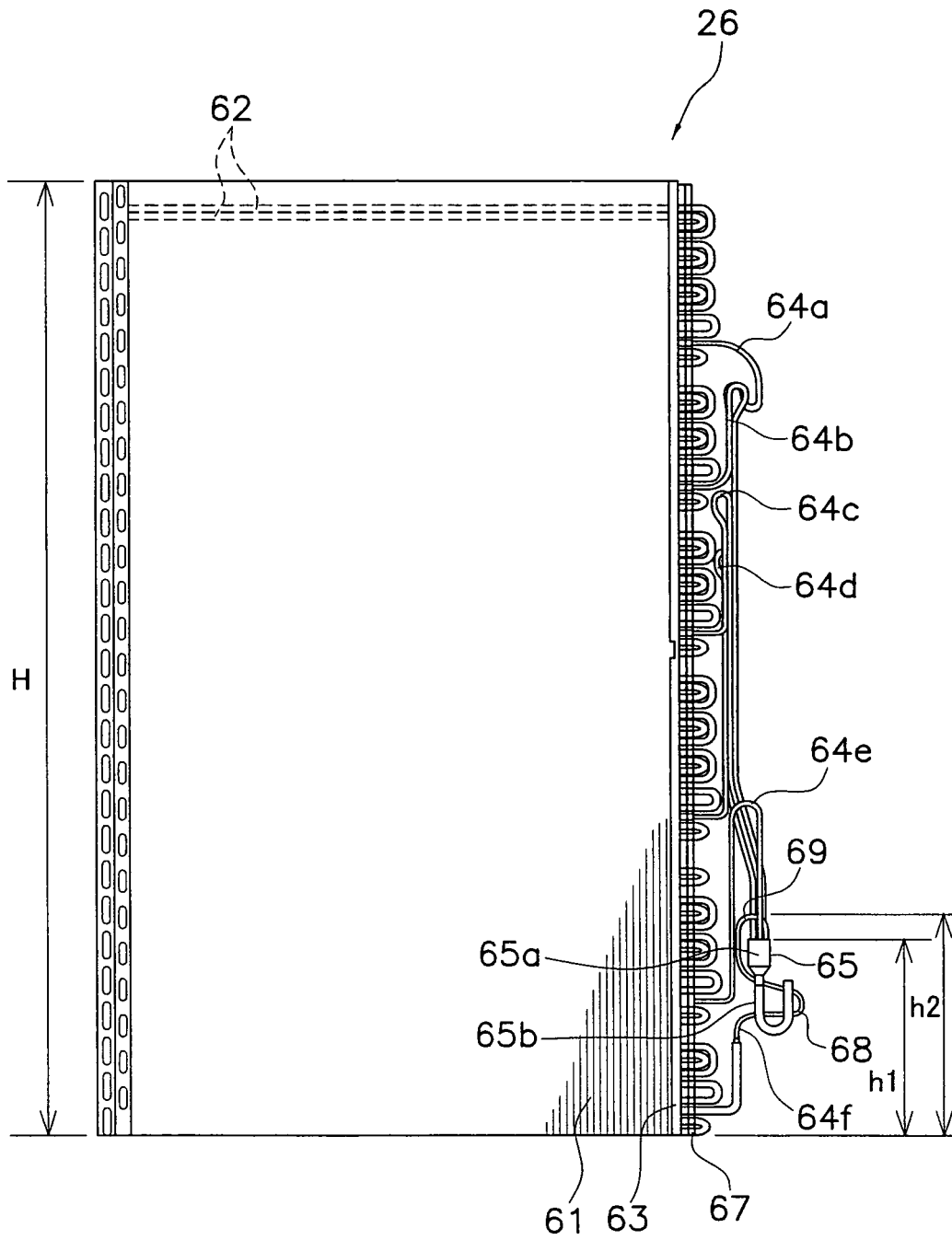


Fig. 4

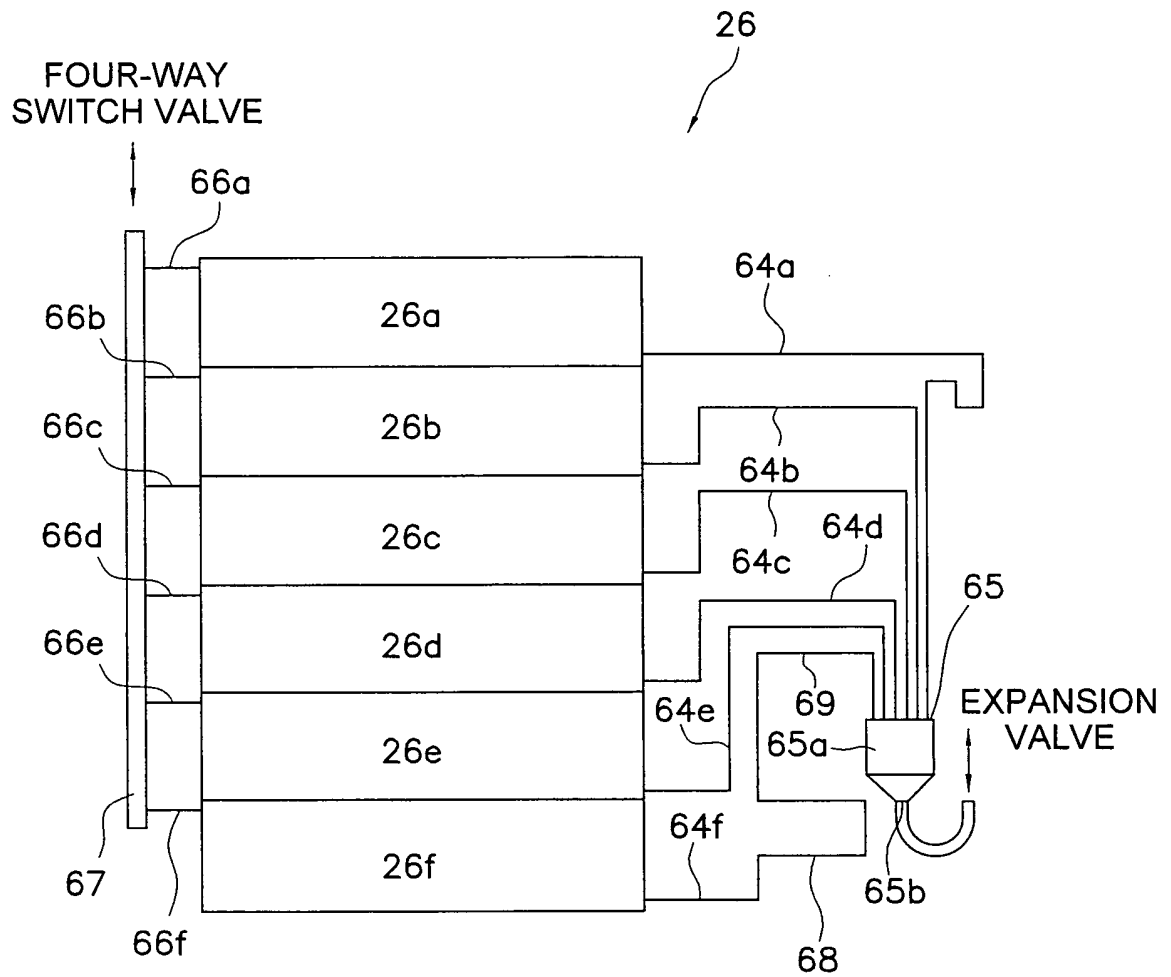


Fig. 5

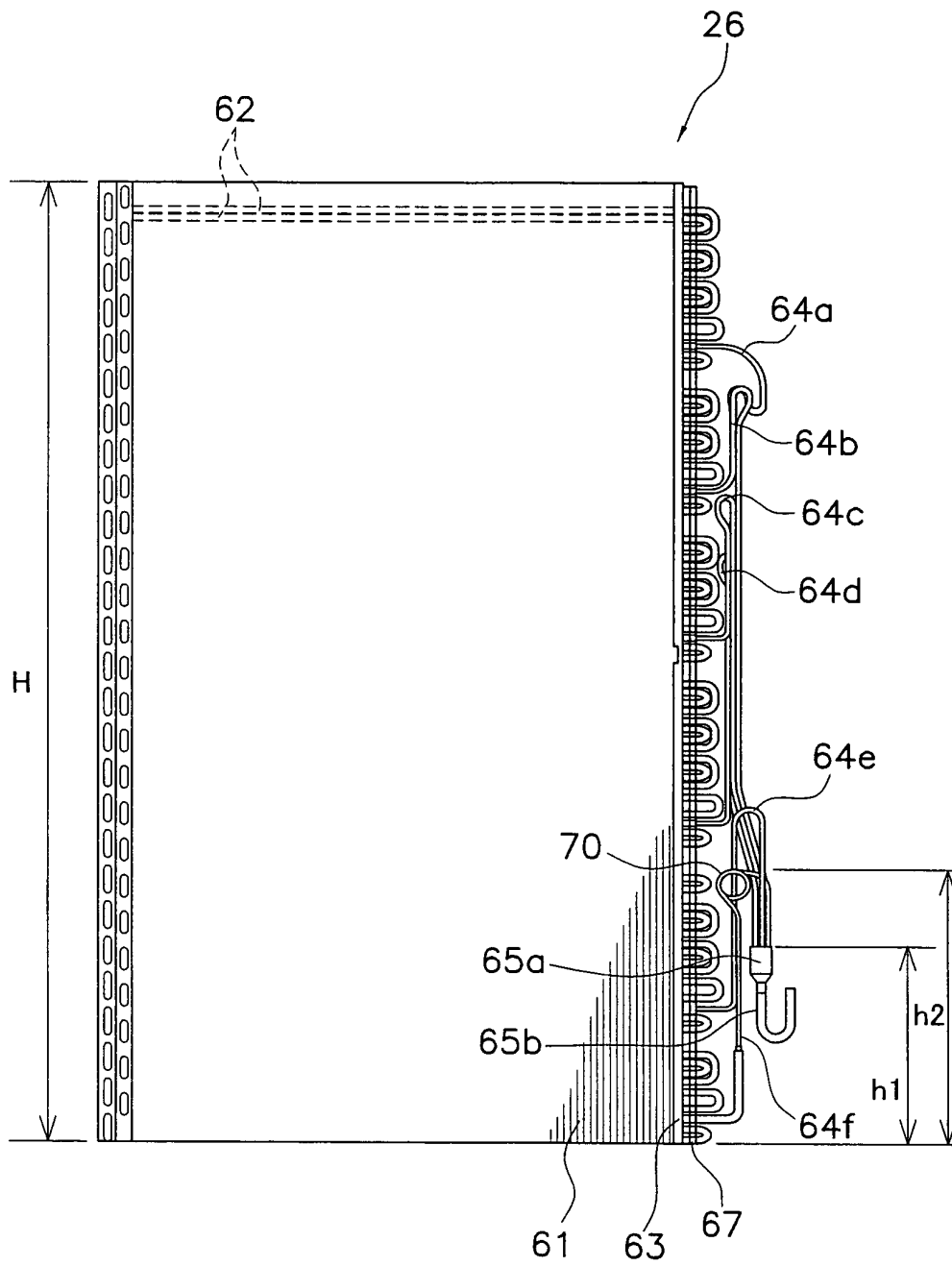


Fig. 6

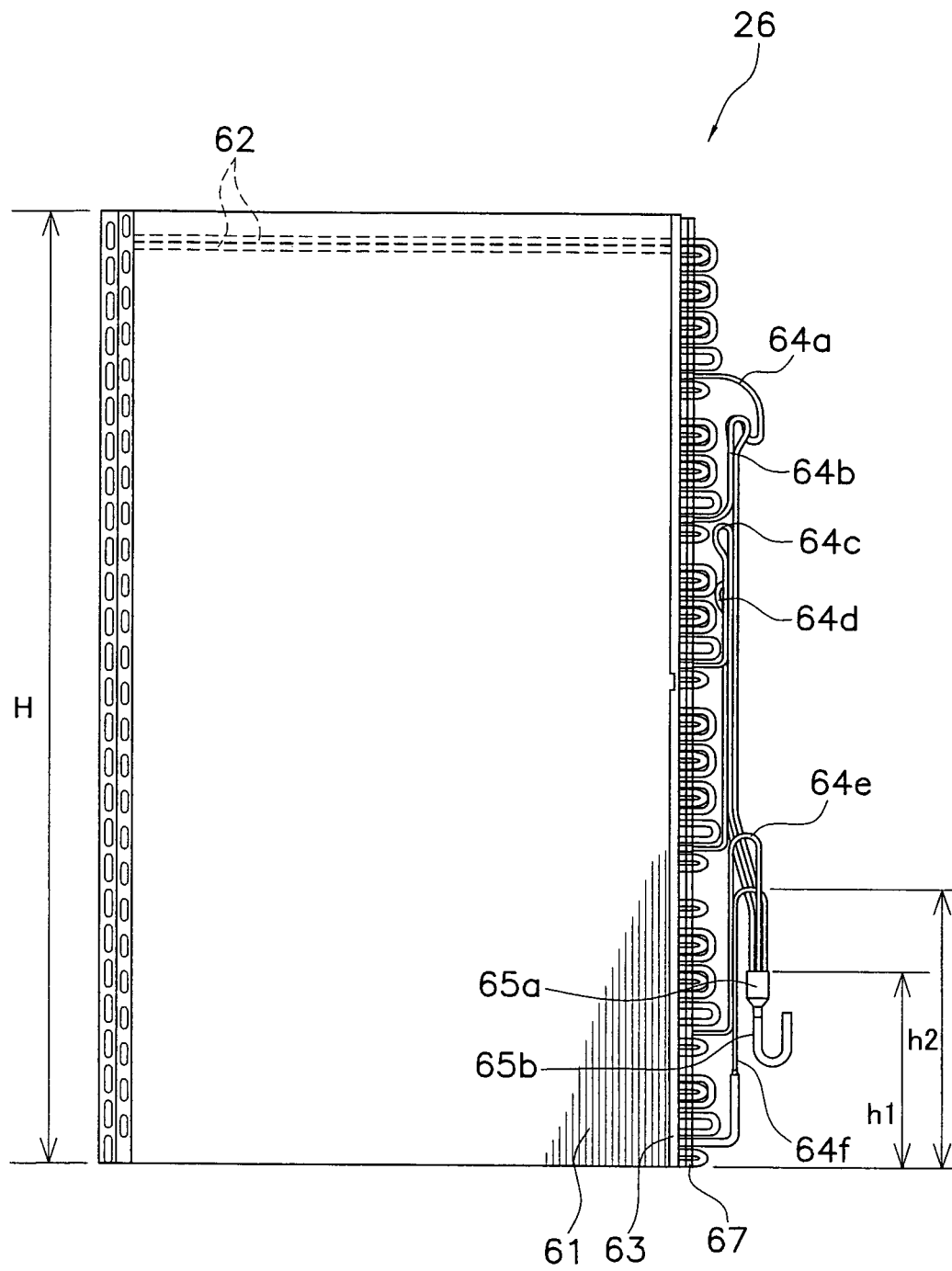


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/321283

A. CLASSIFICATION OF SUBJECT MATTER

F25B39/04(2006.01) i, F24F5/00(2006.01) 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)

F25B39/04, F24F5/00, 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 1996-2006

Kokai Jitsuyo Shinan Koho 1971-2006 Toroku Jitsuyo Shinan Koho 1994-2006

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	JP 10-267469 A (Daikin Industries, Ltd.), 09 October, 1998 (09.10.98), Claim 1; Fig. 3 (Family: none)	1-9
Y	JP 9-145198 A (Sanyo Electric Co., Ltd.), 06 June, 1997 (06.06.97), Par. No. [0003]; Fig. 4 (Family: none)	1-9
Y	JP 9-292135 A (Sanyo Electric Co., Ltd.), 11 November, 1997 (11.11.97), Par. No. [0003]; Fig. 6 (Family: none)	4-6

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"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
21 November, 2006 (21.11.06)Date of mailing of the international search report
28 November, 2006 (28.11.06)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 9236284 A [0003]