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Patent- und Rechtsanwälte

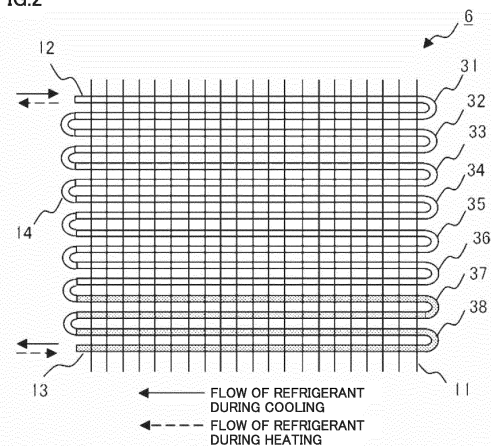
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(54) **HEAT EXCHANGER AND AIR CONDITIONER**

(57) A heat exchanger for an air conditioner for which a zeotropic refrigerant mixture is used is obtained, and the heat exchanger, when used as an evaporator, enables reduction of the amount of required refrigerant without deteriorating the heat transfer performance. The heat exchanger includes: a plurality of fins 11 stacked together at predetermined intervals therebetween; first heat transfer pipes 31 to 36 which extend through the plurality of fins 11, in which a heat medium flows, and which have a plurality of grooves in the inner surface of the pipes; and second heat transfer pipes 37, 38 extending through the plurality of fins 11, having one end connected to one end of the first heat transfer pipes 31 to 36 to form one heat medium flow path, being smaller in pipe diameter than the first heat transfer pipes 31 to 36, and having an inner surface shape providing a pressure loss per unit length smaller than that of the first heat transfer pipes 31 to 36.

FIG.2



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Description

TECHNICAL FIELD

[0001] The present invention relates to a heat exchanger for an air conditioner.

BACKGROUND ART

[0002] It has been pointed out that chlorofluorocarbons used as refrigerants for many refrigerators and air conditioners have a global warming effect, and various regulations have been enacted globally in order to reduce emissions of chlorofluorocarbons. For example, the 2016 Kigali Amendment to the Montreal Protocol requires that industrialized countries including Japan reduce the total GWP value, which is determined by multiplying the GWP (Global Warming Potential) by the refrigerant usage, to 15% by 2036, compared to that in 2011 to 2013.

[0003] To comply with such regulations, it has been considered, in the refrigerator and air conditioner industry, to replace HFC refrigerants that are currently used widely, such as R410A (R32 : R125 = 50 wt% : 50 wt%, GWP = 2088) and R32 (GWP = 675), with refrigerants of lower GWP.

[0004] More specifically, it has been considered to apply HFO refrigerants such as 2-3-3-3-tetrafluoropropene (R1234yf, GWP = 4), trans-1-3-3-3-tetrafluoropropene (R1234ze(E), GWP = 6), and 1-1-2-trifluoroethylene (R1123, GWP = 4); refrigerant mixtures of HFC refrigerants such as difluoromethane (R32, GWP = 675), pentafluoromethane (R125, GWP = 3500), and 1-1-1-2-tetrafluoroethane (R134a, GWP = 1430), and the above-identified HFO refrigerants; or HC refrigerants such as propane (R290, GWP = 3) and isobutane (R600a, GWP = 4).

[0005] Among these substance candidates, the refrigerant mixture of the HFC refrigerant and the HFO refrigerant is superior in terms of refrigeration capacity, theoretical COP, flammability, and toxicity, for example, and may be applicable to a wide variety of refrigerators and air conditioners. It is known that a mixture of multiple refrigerants having different boiling points, which is so-called zeotropic refrigerant mixture, exhibits properties different from those of pure refrigerants and azeotropic refrigerant mixtures. For example, in an evaporation process of zeotropic refrigerant mixtures, a lower-boiling-point component is evaporated first, and subsequently a higher-boiling-point component is evaporated, and therefore, the concentration of the higher-boiling-point component is higher in a liquid phase in the vicinity of the gas-liquid interface, which suppresses further boiling of the lower-boiling-point component. When the zeotropic refrigerant mixture is used, it is necessary to recover from such degradation in evaporation heat transfer.

[0006] As a method for improving the heat exchange performance of an evaporator, a method is known that places an auxiliary heat exchanger at a refrigerant en-

trance side of a heat exchanger used as the evaporator, reduces the number of refrigerant flow paths of the auxiliary heat exchanger, and increases the pipe diameter thereof (PTL 1, for example).

CITATION LIST

PATENT LITERATURE

[0007] PTL 1: Japanese Patent Laying-Open No. 2004-332958

SUMMARY OF INVENTION

15 TECHNICAL PROBLEM

[0008] For such a heat exchanger configured like the above-cited patent literature, the auxiliary heat exchanger with the increased pipe diameter is located at a refrigerant exit side of the heat exchanger when used as a condenser. At the refrigerant exit side of the condenser, subcooled liquid flows, resulting in increase of the amount of refrigerant necessary for this refrigeration cycle due to the increased pipe diameter, and accordingly resulting in increase of the refrigerant usage.

[0009] The present invention has been made to solve the problems as described above, and thereby obtain a heat exchanger for an air conditioner for which a zeotropic refrigerant mixture is used, and this heat exchanger, when used as an evaporator, enables reduction of the amount of required refrigerant without deteriorating the heat transfer performance.

SOLUTION TO PROBLEM

[0010] To achieve the above object, a heat exchanger according to the present disclosure includes:

a first heat transfer pipe in which a heat medium flows and which has a plurality of grooves formed in an inner surface of the first heat transfer pipe; and a second heat transfer pipe having one end connected to one end of the first heat transfer pipe to form one heat medium flow path, the second heat transfer pipe being smaller in pipe diameter than the first heat transfer pipe, and having an inner surface shape providing a pressure loss per unit length smaller than that of the first heat transfer pipe.

50 ADVANTAGEOUS EFFECTS OF INVENTION

[0011] With the heat exchanger according to the present disclosure for which a zeotropic refrigerant mixture is used, the amount of required refrigerant can be reduced, without deteriorating the heat exchange performance. Moreover, the manufacture cost can also be reduced.

BRIEF DESCRIPTION OF DRAWINGS

[0012]

Fig. 1 is a refrigerant circuit diagram of an air conditioner including a heat exchanger according to Embodiment 1.

Fig. 2 is a front view of the heat exchanger according to Embodiment 1.

Fig. 3 is a cross-sectional view of heat transfer pipes to be used for the heat exchanger according to Embodiment 1.

Fig. 4 is a characteristics plot showing an example of the evaporation heat transfer performance relative to the dryness fraction of refrigerant in a general grooved pipe.

Fig. 5 is a characteristic plot showing an example of the pressure loss relative to the dryness fraction of refrigerant in a general grooved pipe.

Fig. 6 is a Ph chart showing a refrigeration cycle operation of an air conditioner equipped with the heat exchanger according to Embodiment 1.

Fig. 7 is an example of a side view of one refrigerant flow path portion extracted from the heat exchanger according to Embodiment 1.

Fig. 8 is another example of a side view of one refrigerant flow path portion extracted from a heat exchanger according to Embodiment 2.

Fig. 9 is an external view of an air conditioner to which the heat exchanger according to Embodiment 1 or 2 is applied.

DESCRIPTION OF EMBODIMENTS

[0013] A heat exchanger and an air conditioner according to embodiments of the present disclosure are described hereinafter based on the drawings. It should be noted that the present invention is not limited by the embodiments.

Embodiment 1

[0014] Fig. 1 is a refrigerant circuit diagram showing an example of an air conditioner including a heat exchanger according to Embodiment 1. The direction of refrigerant flow is indicated by solid and broken lines. In Fig. 1, an air conditioner 100 includes an outdoor unit 1 and an indoor unit 2 that are connected to each other by a gas pipe 3 and a liquid pipe 4 to form a single refrigerant circuit. In this refrigerant circuit, a refrigerant mixture made up of two or more types of refrigerants that are different from each other in boiling point is enclosed.

[0015] Outdoor unit 1 is equipped with a compressor 5, an outdoor heat exchanger 6, an expansion valve 7, and a four-way valve 9, and indoor unit 2 is equipped with an indoor heat exchanger 8. During cooling operation in which indoor heat exchanger 8 acts as an evaporator, refrigerant discharged from compressor 5 flows

through four-way valve 9 into outdoor heat exchanger 6, is reduced in pressure by expansion valve 7, and then flows out of outdoor unit 1. The refrigerant flowing through liquid pipe 4 into indoor unit 2 is evaporated in indoor heat exchanger 8 and flows out of indoor unit 2. The refrigerant then flows through gas pipe 3, returns to outdoor unit 1, and is sucked again into compressor 5.

[0016] During heating operation in which indoor heat exchanger 8 acts as a condenser, refrigerant discharged from compressor 5 flows into indoor unit 2 through gas pipe 3 following a flow path setting for four-way valve 9. The refrigerant condensed by indoor heat exchanger 8 flows through liquid pipe 4, returns to outdoor unit 1, and is reduced in pressure in expansion valve 7. The refrigerant with the reduced pressure exchanges, in outdoor heat exchanger 6, heat with outdoor air, and the refrigerant is accordingly evaporated and sucked again into compressor 5 through four-way valve 9.

[0017] Outdoor heat exchanger 6 and indoor heat exchanger 8 are each equipped with a fan (not shown), to force outdoor air and indoor air to flow to outdoor heat exchanger 6 and indoor heat exchanger 8 and thereby increase the efficiency in exchanging heat between refrigerant and air. As the fan, for example, cross flow fan, propeller fan, turbo fan, or sirocco fan may be used. A single heat exchanger may be equipped with a plurality of fans, or a plurality of heat exchangers may be equipped with a single fan. Air conditioner 100 according to Embodiment 1 has a minimum configuration required for enabling cooling operation and heating operation, and a gas-liquid separator, a receiver, an accumulator, and/or an inner heat exchanger, for example, may appropriately be added in the refrigerant circuit.

[0018] Fig. 2 is a front view showing an example of outdoor heat exchanger 6 according to Embodiment 1. Outdoor heat exchanger 6 is made up of a plurality of fins 11 stacked together at intervals of about 1.5 mm therebetween, and heat transfer pipes 31 to 38 extending through these fins 11. Heat transfer pipes 31 to 38 are formed in a hairpin shape and closely fit in fins 11 to allow heat transfer. Heat transfer pipes 31 to 38 have one end or both ends connected by a plurality of U-shaped pipes 14 to form a single refrigerant flow path having a gas-side exit/entrance 12 and a liquid-side exit/entrance 13. During heating operation in which outdoor heat exchanger 6 acts as an evaporator, liquid-side exit/entrance 13 is an entrance of the refrigerant flow path while gas-side exit/entrance 12 is an exit of the refrigerant flow path. As also shown in Fig. 1, the refrigerant flow direction is the opposite direction during cooling operation, and therefore, when outdoor heat exchanger 6 acts as a condenser, liquid-side exit/entrance 13 is an exit of the refrigerant flow path while gas-side exit/entrance 12 is an entrance of the refrigerant flow path.

[0019] Fig. 3 is a cross-sectional view of the heat transfer pipes used for the heat exchanger according to the embodiment. Heat transfer pipes 31 to 38 forming outdoor heat exchanger 6 shown in Fig. 2 include first heat

transfer pipes 31 to 36, and the first heat transfer pipes are grooved pipes having peaks and valleys on the pipe inner surface as shown for example in Fig. 3 (a), have one end located at gas-side exit/entrance 12, and extend through fins 11 to form a first heat exchanger portion. Heat transfer pipes 37, 38 are second heat transfer pipes that are smooth pipes as shown in Fig. 3 (b), have one end located at liquid-side exit/entrance 13, and extend through fins 11 to form a second heat exchanger portion. Heat transfer pipes 37, 38 have an inner diameter D2 smaller than an inner diameter D1 of the grooved pipes used as heat transfer pipes 31 to 36 ($D1 > D2$).

[0020] The shape of the grooves in heat transfer pipes 31 to 36 is not limited. Specifically, there is no particular limitation on the inner diameter, the number of fins in the pipes (hereinafter intra-pipe fins), the height of the intra-pipe fins, the helix angle of the intra-pipe fins, and the area extension ratio, for example.

[0021] The type of the zeotropic refrigerant mixture (hereinafter referred to as "refrigerant" as long as it is not necessary in terms of context to distinguish between zeotropic refrigerant mixture, pure refrigerant, and azeotropic refrigerant mixture) to be enclosed in air conditioner 100 is not particularly limited. For example, the refrigerant to be used may be a refrigerant mixture of an HFC refrigerant such as difluoromethane (R32, GWP = 675), pentafluoromethane (R125, GWP = 3500), or 1-1-1-2-tetrafluoromethane (R134a, GWP = 1430), and an HFO refrigerant such as 2-3-3-3-tetrafluoropropene (R1234yf, GWP = 4), trans-1-3-3-3-tetrafluoropropene (R1234ze(E), GWP = 6), 1-1-2-trifluoroethylene (R1123, GWP = 4), difluoroethylene (R1132a, GWP = 1), trans-difluoroethylene (R1132(E), GWP = 1), or 1-1-1-4-4-4-hexafluoro-2-butene (R1336mzz(Z), GWP = 2), or a refrigerant mixture of an HFCO refrigerant such as trans-1-chloro-3-3-3-trifluoropropene (R1233zd, GWP = 1), or cis-1-chloro-2-3-3-3-tetrafluoropropene (R1224yd(Z), GWP = 1), and an HC refrigerant such as propane (R290, GWP = 3), or isobutane (R600a, GWP = 4), and the like.

[0022] Fig. 4 is a characteristic plot showing an example of the intra-pipe evaporation heat transfer performance relative to the dryness fraction of refrigerant in a general grooved pipe. The vertical axis indicates the evaporation heat transfer coefficient of the grooved pipe, represented by a relative value with respect to the evaporation heat transfer coefficient of a smooth pipe. As for the refrigerant, respective characteristics of two different refrigerants, i.e., a single refrigerant and a zeotropic refrigerant mixture, are plotted by a broken line and a solid line, respectively.

[0023] As shown in Fig. 4, for the single refrigerant, the grooved pipe exhibits an evaporation heat transfer coefficient of three or more times higher than that of the smooth pipe, regardless of the refrigerant dryness fraction, and thus significantly contributes to improvement of the heat exchange performance. In contrast, when the zeotropic refrigerant mixture is used, improvement of the evaporation heat transfer coefficient relative to the

smooth pipe is not significantly large, unlike the one achieved for the single refrigerant. In particular, in the region of a low refrigerant dryness fraction of 0.4 or less, the evaporation heat transfer coefficient of the grooved pipe is substantially identical to the evaporation heat transfer coefficient of the smooth pipe, and thus fails to contribute to improvement of the heat exchange performance.

[0024] Fig. 5 is a characteristic plot showing an example of the pressure loss relative to the dryness fraction of refrigerant in a general grooved pipe. The vertical axis indicates the pressure loss of the grooved pipe, represented by a relative value with respect to the pressure loss of a smooth pipe. The broken line represents the pressure loss for a single refrigerant, and the solid line represents the pressure loss for a zeotropic refrigerant mixture.

[0025] As shown in Fig. 5, the pressure loss of the grooved pipe is large relative to the pressure loss of the smooth pipe, regardless of the refrigerant dryness fraction, and particularly large in the region of a refrigerant dryness fraction of 0.3 to 0.5. This phenomenon is substantially the same for both the single refrigerant and the zeotropic refrigerant mixture. For the zeotropic refrigerant mixture, however, the rate of increase of the pressure loss is larger. It is seen from Figs. 4 and 5 that although use of the grooved pipe for the heat exchanger improves the heat transfer performance, the heat transfer performance is not improved and only the pressure loss is increased for a refrigerant dryness fraction of 0.4 or less.

[0026] Fig. 6 is a Ph chart showing a refrigeration cycle operation of air conditioner 100 according to Embodiment 1. The vertical axis indicates the pressure, the horizontal axis indicates the specific enthalpy, and XO is a saturation line connecting points where refrigerant is saturated liquid or saturated gas. State A, State B, State C, and State D are respective entrance states of a process of compression, condensation, expansion, and evaporation that form a refrigeration cycle. While the refrigeration cycle shown in Fig. 6 is not limited to cooling operation or heating operation, the refrigeration cycle operation is described first for the heating operation in the following.

[0027] Low-temperature low-pressure gas refrigerant (State A) at a suction position of compressor 5 is increased in pressure by compressor 5 into high-temperature high-pressure discharged gas (State B). The discharged gas is condensed in indoor heat exchanger 8 acting as a condenser into high-pressure subcooled liquid (State C). The refrigerant is subsequently reduced in pressure by expansion valve 7 into low-pressure gas-liquid two-phase refrigerant (State D).

[0028] In the chart, X1 is a line of constant dryness fraction where the refrigerant dryness fraction is 0.2. It is known that, at the entrance of the evaporator, the refrigerant (State D) has a dryness fraction of approximately 0.2, for a condensation temperature in a range of $40^{\circ}\text{C} \pm 10^{\circ}\text{C}$ and an evaporation temperature in a range of $0^{\circ}\text{C} \pm 10^{\circ}\text{C}$ that are general operating conditions of air

conditioning. In other words, in an evaporation process from State D to State A in a general air conditioner, the refrigerant dryness fraction changes from 0.2 to approximately 1.0 under most operating conditions. In the present embodiment, in outdoor heat exchanger 6 shown in Fig. 2, the low-pressure gas-liquid two-phase refrigerant in State D absorbs heat from outdoor air until being superheated slightly, and returns to State A to thereby complete a single refrigeration cycle.

[0029] As set forth above, the heat transfer coefficient improvement effect to be produced by the grooved pipe is not exhibited for a dryness fraction change from 0.2 to 0.4 in a dryness fraction change of 0.8 (= 1.0 - 0.2) in this evaporation process. In other words, when the heat exchanger is used as an evaporator, it is unnecessary to employ the grooved pipe, which is means for improving the heat exchange performance, for a length of 25% (= 0.2/0.8) from liquid-side exit/entrance 13 serving as a refrigerant entrance. Therefore, in Embodiment 1 as shown in Fig. 2, heat transfer pipes 37, 38 leading to liquid-side exit/entrance 13 of outdoor heat exchanger 6 are configured in the form of smooth pipes. The smooth pipe is lower in cost than the grooved pipe, and therefore, the manufacture cost of outdoor heat exchanger 6 can be reduced.

[0030] Moreover, if it is used under an extremely low evaporation temperature condition, refrigerator oil dissolved in the liquid refrigerant may separate from the refrigerant and stay in the vicinity of the wall of the heat transfer pipe. Stay of the refrigerator oil may deteriorate the reliability of compressor 5, and should therefore be avoided as much as possible. Thus, for the second heat exchanger portion located near liquid-side exit/entrance 13 where a large amount of liquid refrigerant is present, smooth pipes in which less friction occurs can be employed to reduce the amount of staying refrigerator oil, and thereby improve the reliability of the air conditioner.

[0031] Next, cooling operation is described. During cooling operation, indoor heat exchanger 8 acts as an evaporator and outdoor heat exchanger 6 acts as a condenser. High-temperature high-pressure gas refrigerant in State B is discharged from compressor 5, flows into outdoor heat exchanger 6 to exchange heat with outdoor air, and is then condensed into subcooled liquid refrigerant in State C. In an SC portion which is the last stage of this condensation process, i.e., SC portion that is a region after refrigerant becomes saturated liquid, most of the amount of refrigerant necessary for this refrigeration cycle is concentrated.

[0032] In outdoor heat exchanger 6 in Embodiment 1, heat transfer pipes 37, 38 forming the second heat exchanger portion located at the refrigerant exit side when the outdoor heat exchanger is used as a condenser, have a smaller diameter than that of the other heat transfer pipes, and therefore, the amount of refrigerant present in the SC portion is reduced. Accordingly, the amount of refrigerant enclosed in air conditioner 100 is also reduced, which can contribute to reduction of the total GWP

value and can lessen the environmental load.

[0033] Moreover, the smaller diameter of heat transfer pipes 37, 38 increases the refrigerant flow rate in the second heat exchanger portion to promote convection heat transfer, and therefore, it is possible to recover from the deterioration of the heat transfer performance due to the smooth pipe, and to suppress deterioration of the heat exchange performance.

[0034] Fig. 7 is an example of a side view of one refrigerant flow path portion extracted from the heat exchanger according to Embodiment 1. While Fig. 2 shows the heat exchanger arranged in a single line, Fig. 7 shows that heat transfer pipes 31 to 38 forming one refrigerant flow path are arranged in two lines in the direction of air flow. Of eight heat transfer pipes 31 to 38, six heat transfer pipes 31 to 36 are grooved pipes and two heat transfer pipes 37, 38 are smooth pipes thinner than the grooved pipes. Namely, 25% of the total length of the refrigerant flow path that is located relatively closer to liquid-side exit/entrance 13 is formed by the smooth pipes. In Fig. 7, a first heat exchanger portion formed by heat transfer pipes 31 to 36 and a second heat exchanger portion formed by heat transfer pipes 37, 38 are constituted in the form of a single unit, which reduces the number of process steps required for manufacture to thereby enable reduction of the manufacture cost.

[0035] As seen from the above, in the heat exchanger according to Embodiment 1, heat transfer pipes leading to gas-side exit/entrance 12 of a single refrigerant flow path are grooved pipes, while heat transfer pipes leading to liquid-side exit/entrance 13 are smooth pipes thinner than the grooved pipes, and the ratio of the length of the smooth pipes is less than or equal to 25% of the total length. Therefore, when a zeotropic refrigerant mixture is used, the amount of required refrigerant can be reduced without deteriorating the heat transfer performance. The manufacture cost can also be reduced.

Embodiment 2

[0036] Fig. 8 is another example of a side view of one refrigerant flow path portion extracted from outdoor heat exchanger 6 according to Embodiment 2. Heat transfer pipes 31 to 36 are arranged in an upper portion of outdoor heat exchanger 6 to form a first heat exchanger portion, and heat transfer pipes 37, 38 are arranged in a lower portion of outdoor heat exchanger 6 to form a second heat exchanger portion. As shown in Fig. 8, respective fins 11 for the first heat exchanger portion and the second heat exchanger portions are separate from each other, and therefore, the first heat exchanger portion and the second heat exchanger portion can be adjusted independently of each other, in terms of the intervals between the heat transfer pipes and the gap between fins 11.

[0037] As seen from the above, for the heat exchanger according to Embodiment 2, the first heat exchanger portion of the grooved pipes and the second heat exchanger portion of the smooth pipes can be manufactured sepa-

rately from each other, and therefore, the fin pitch and the interval between heat transfer pipes can be set appropriately depending on respective heat exchanging characteristics.

Embodiment 3

[0038] Fig. 9 is an external view showing an example of an air conditioner equipped with the heat exchanger according to Embodiment 1 or 2. Air conditioner 100 is formed by connecting outdoor unit 1 and indoor unit 2 by gas pipe 3 and liquid pipe 4. For both outdoor heat exchanger 6 housed in outdoor unit 1 and indoor heat exchanger 9 housed in indoor unit 2, the heat exchanger shown in connection with Embodiment 1 or 2 is used (not shown).

[0039] As seen from the above, for air conditioner 100 illustrated in connection with Embodiment 3, the heat exchanger according to Embodiment 1 or 2 can be used as outdoor heat exchanger 6 and indoor heat exchanger 8, and therefore, the amount of refrigerant enclosed in air conditioner 100 can be reduced without deteriorating the heat exchange performance, which can contribute to reduction of the total GWP value and lessen the environmental load.

[0040] According to Embodiments 1 and 2, eight heat transfer pipes form a single refrigerant flow path, of which two pipes located near liquid-side exit/entrance 13 are smooth pipes. However, if four heat transfer pipes form a single refrigerant flow path, for example, it is one heat transfer pipe located near liquid-side exit/entrance 13 that is a smooth pipe and, if six heat transfer pipes form a single refrigerant flow path, it is also one heat transfer pipe located near liquid-side exit/entrance 13 that is a smooth pipe. As long as the length of the refrigerant flow path formed by the smooth pipe(s) is at least less than or equal to 25% of the total length, the effect of enhancing the heat transfer performance by the grooved pipes is not deteriorated. Moreover, these advantageous effects are achieved not only for outdoor heat exchanger 6 but also for indoor heat exchanger 8.

[0041] The features illustrated in connection with the above embodiments are an example of the details of the present disclosure, and may be combined with other known techniques, or may partially be omitted or changed without going beyond the scope of the present disclosure.

REFERENCE SIGNS LIST

[0042] 1 outdoor unit; 2 indoor unit; 3 gas pipe; 4 liquid pipe; 5 compressor; 6 outdoor heat exchanger; 7 expansion valve; 8 indoor heat exchanger; 9 four-way valve; 11 fin; 12 gas-side exit/entrance; 13 liquid-side exit/entrance; 14 U-shaped pipe; 31-36 grooved pipe; 37, 38 smooth pipe; 100 air conditioner

Claims

1. A heat exchanger comprising:

5 a first heat transfer pipe in which a heat medium flows and which has a plurality of grooves formed in an inner surface of the first heat transfer pipe; and
10 a second heat transfer pipe having one end connected to one end of the first heat transfer pipe to form one heat medium flow path, the second heat transfer pipe being smaller in pipe diameter than the first heat transfer pipe, and having an inner surface shape providing a pressure loss per unit length smaller than that of the first heat transfer pipe.

2. The heat exchanger according to claim 1, wherein

20 when the heat exchanger acts as an evaporator, another end of the second heat transfer pipe is an entrance for the heat medium, and
25 when the heat exchanger acts as a condenser, another end of the first heat transfer pipe is an entrance for the heat medium.

3. The heat exchanger according to claim 2, wherein the heat medium is a zeotropic refrigerant mixture.

30 4. The heat exchanger according to claim 3, wherein the second heat transfer pipe has a length of less than or equal to 25% of a length of the heat medium flow path.

35 5. The heat exchanger according to any one of claims 1 to 4, comprising a first heat exchanger portion formed by the first heat transfer pipe, and a second heat exchanger portion formed by the second heat transfer pipe and separate from the first heat exchanger portion.

40 6. An air conditioner comprising the heat exchanger according to any one of claims 1 to 5, the heat exchanger being used either as an outdoor heat exchanger or an indoor heat exchanger.

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FIG.1

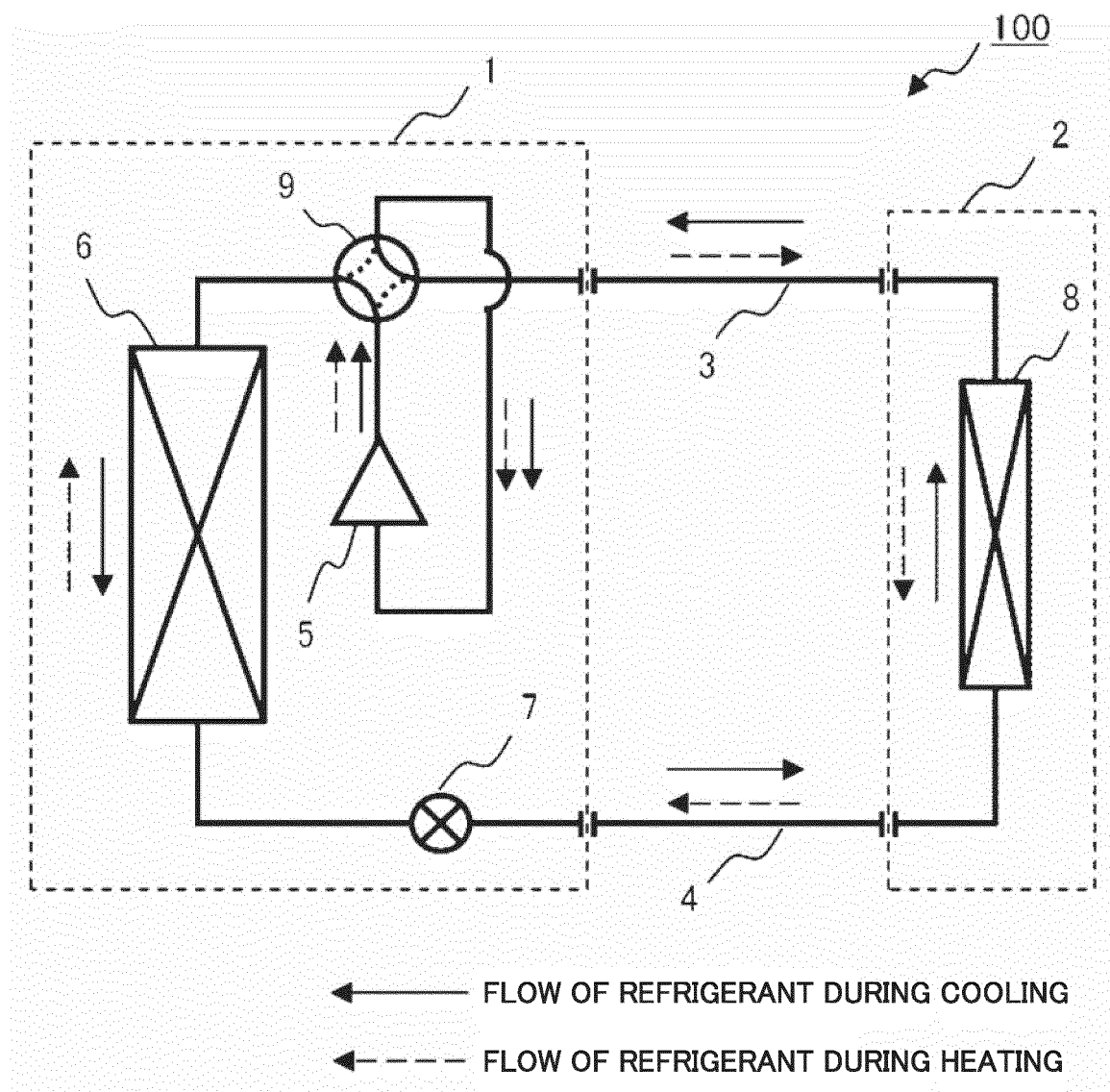


FIG.2

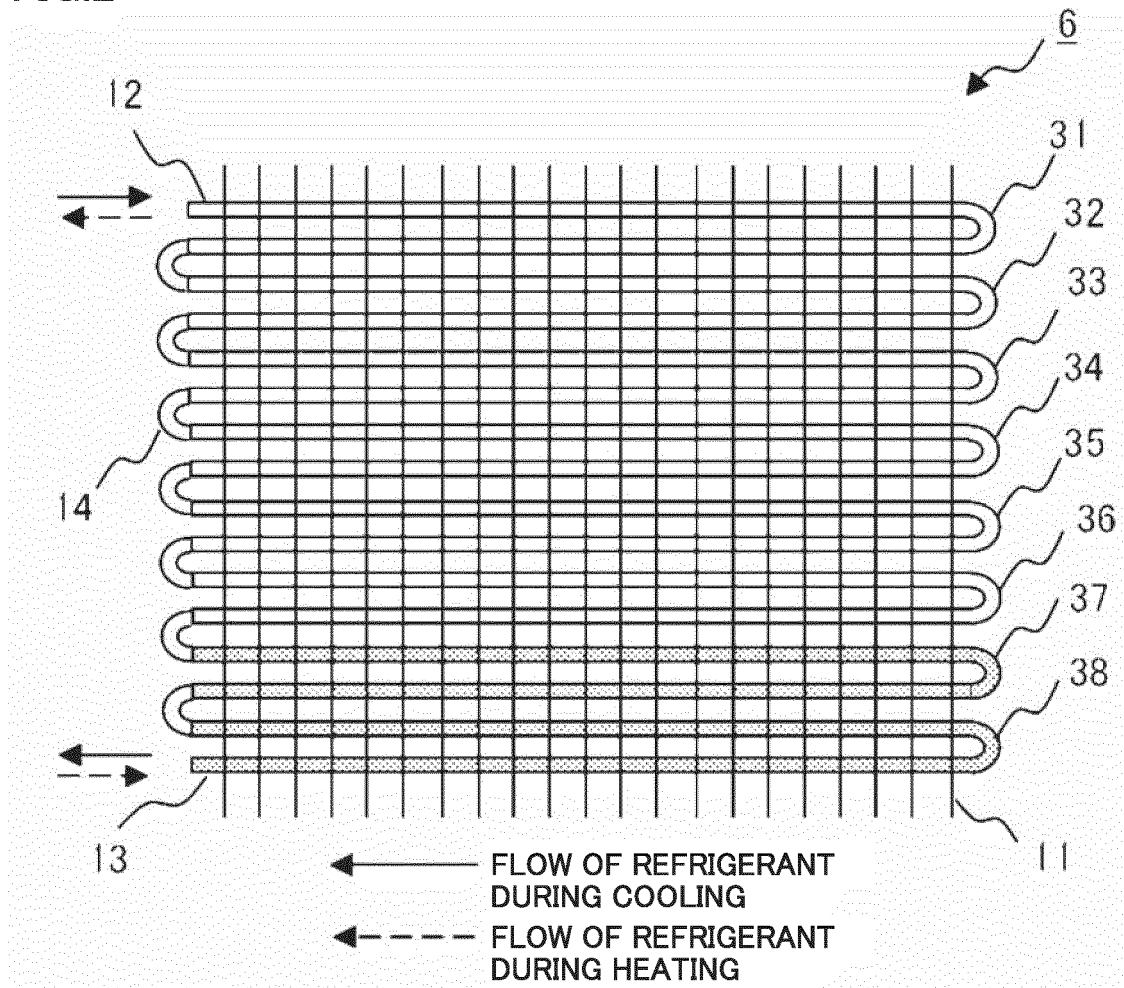


FIG.3

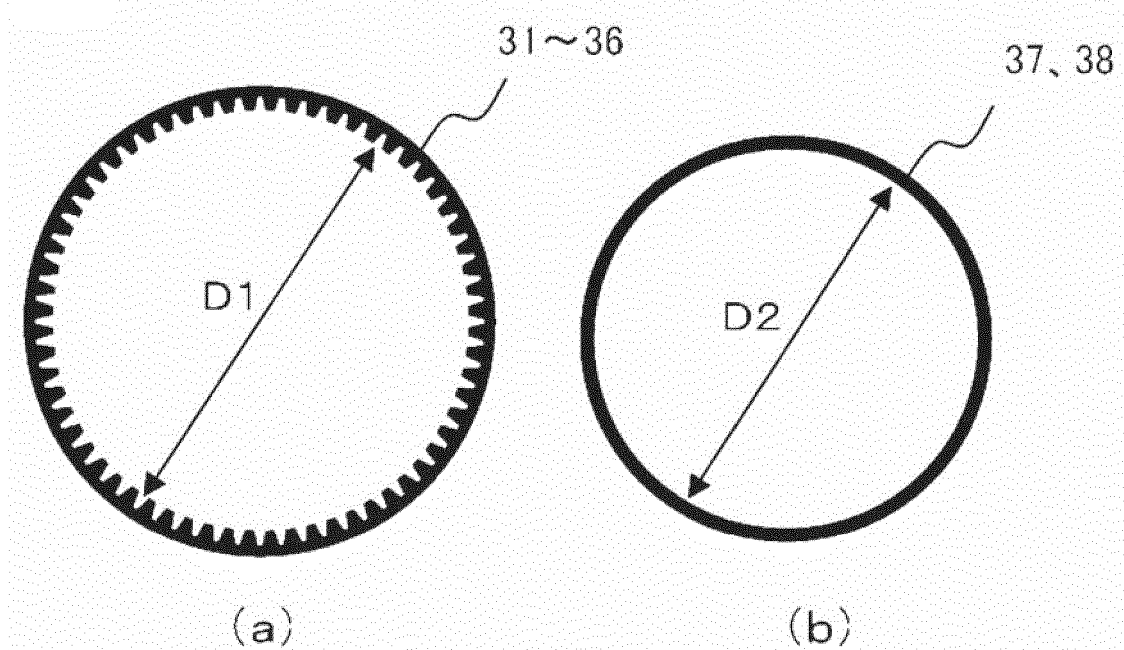


FIG.4

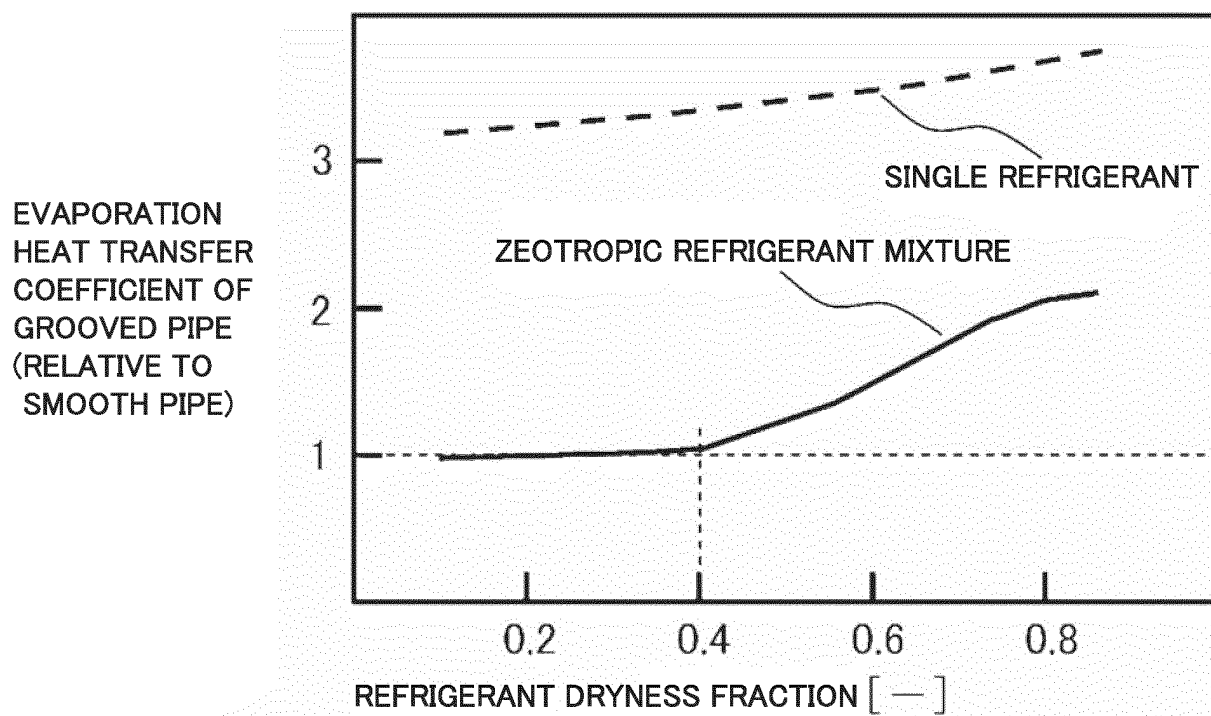


FIG.5

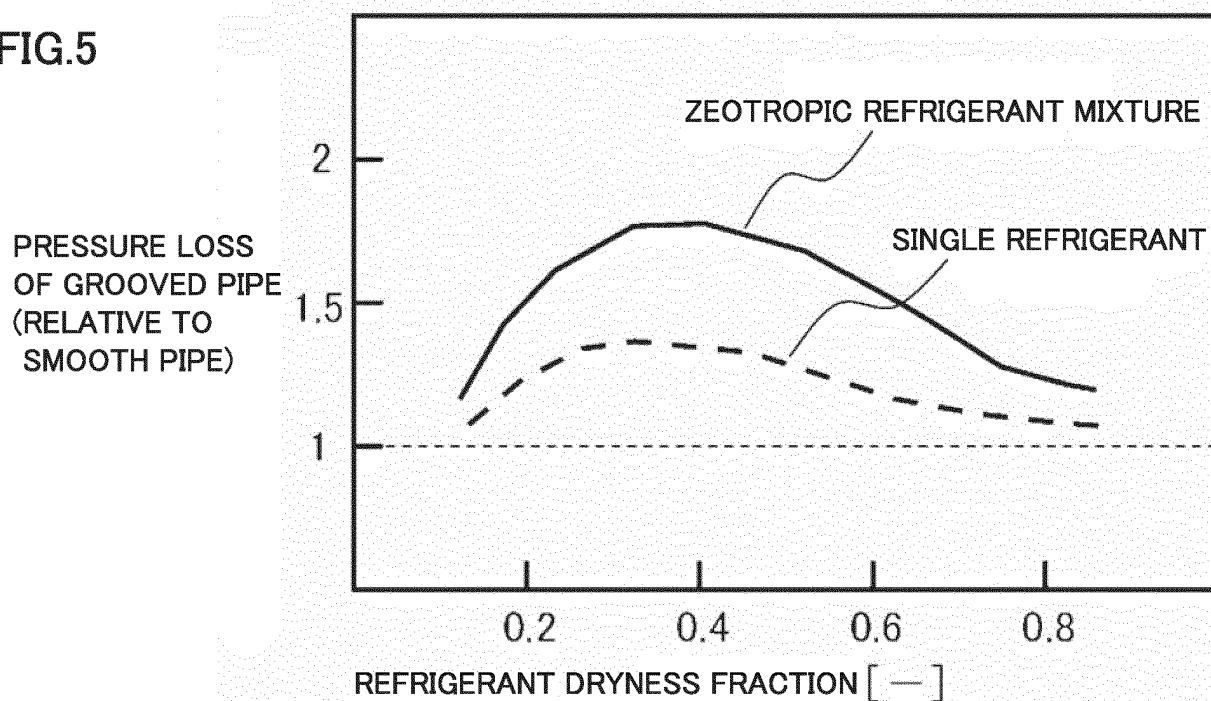


FIG.6

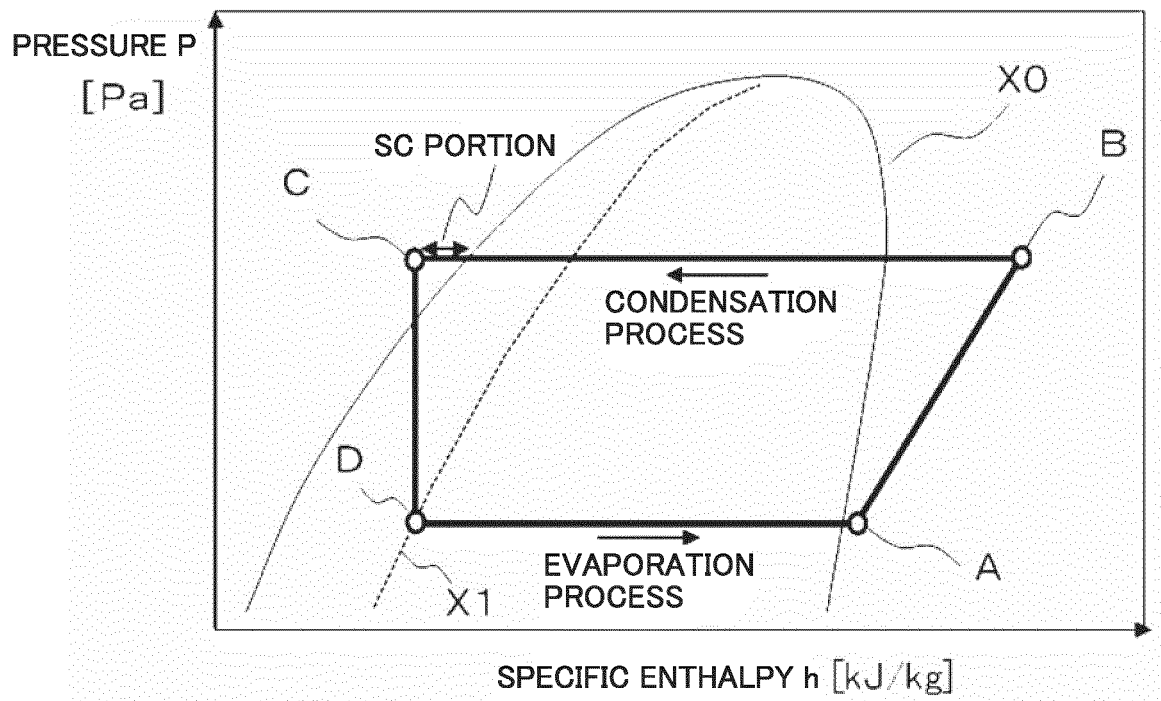


FIG.7

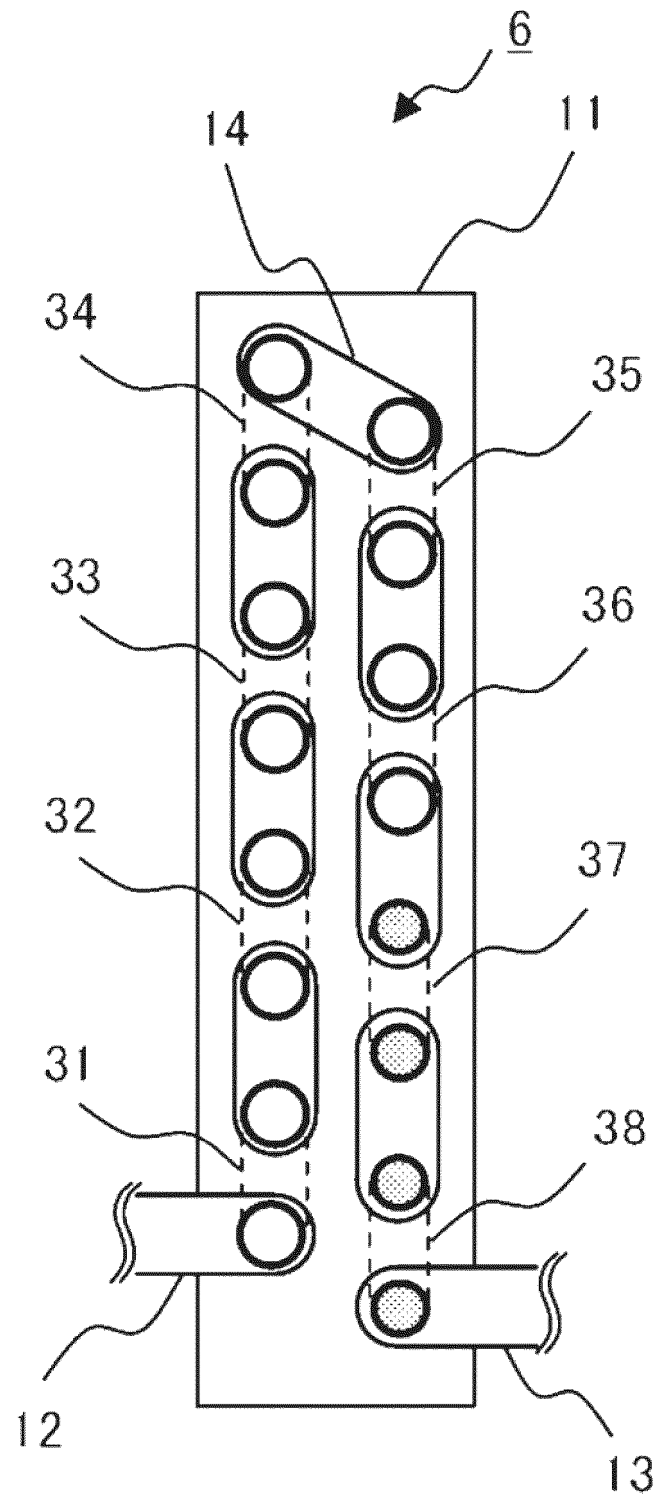


FIG.8

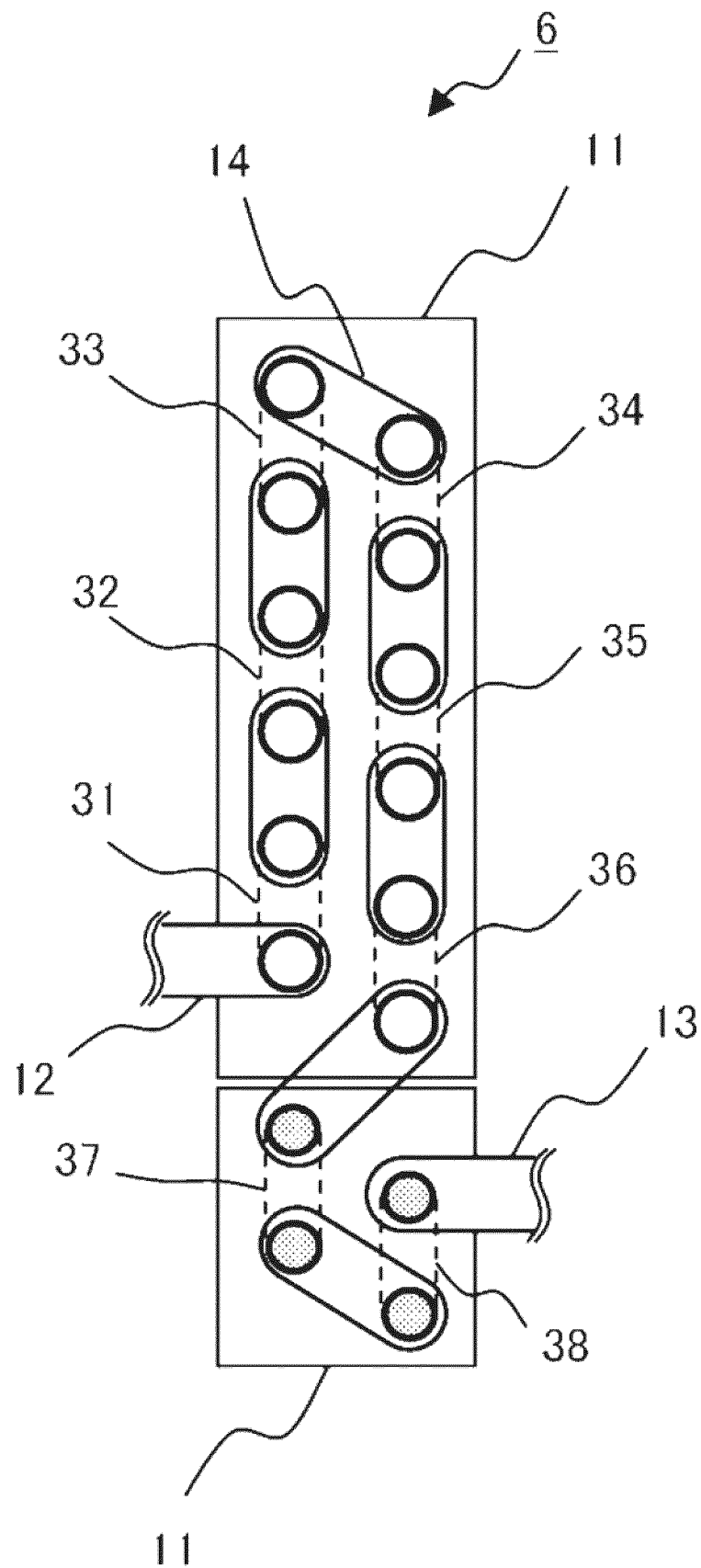
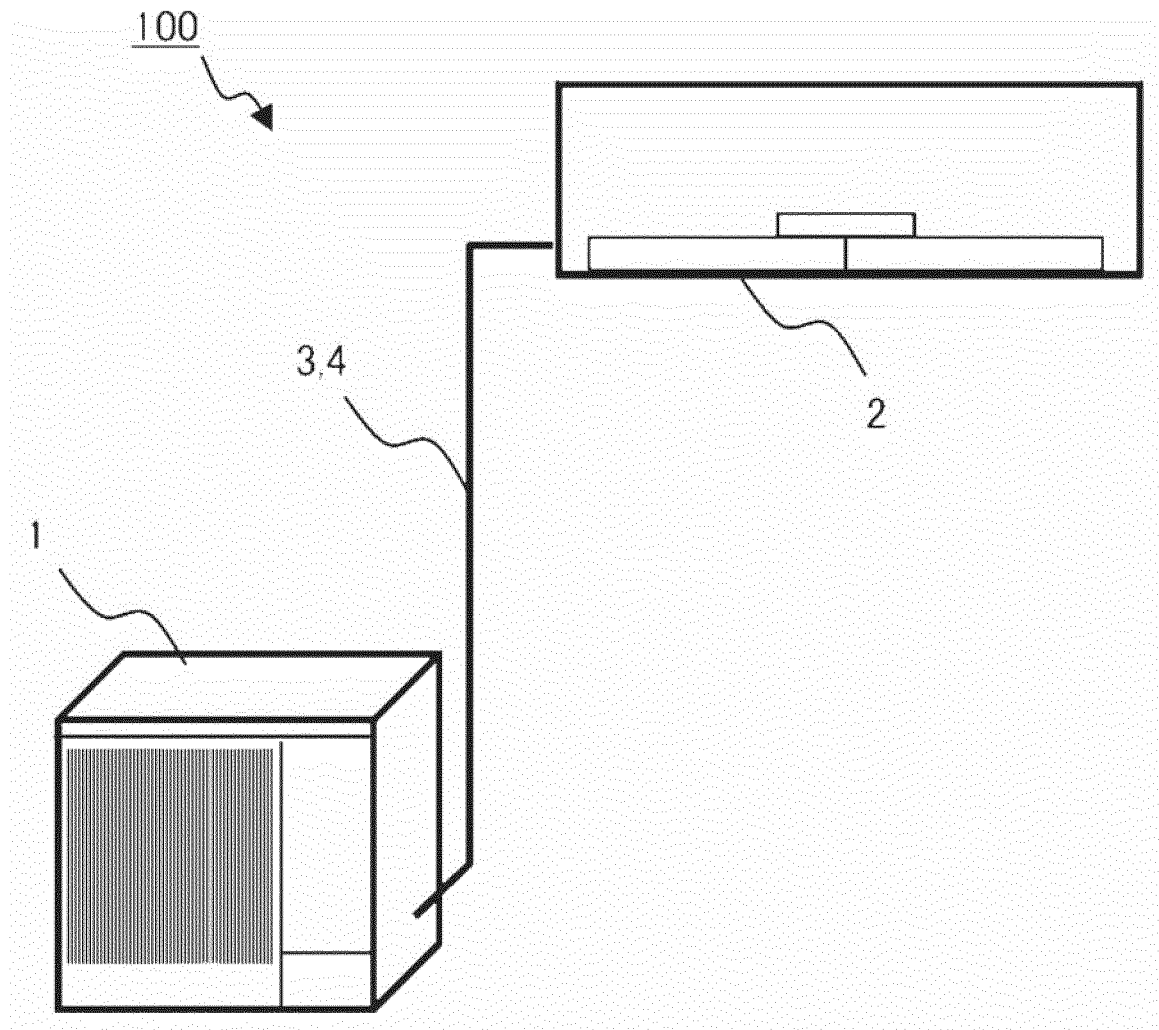


FIG.9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/009421

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. F25B39/02(2006.01) i, F25B39/04(2006.01) i, F28F13/02(2006.01) i,
F28F13/06(2006.01) i, F25B1/00(2006.01) i

FI: F28F13/02 B, F28F13/06, F25B1/00 396B, F25B39/02 W, F25B39/04 U

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl. F25B39/02, F25B39/04, F28F13/02, F28F13/06, F25B1/00

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2020

Registered utility model specifications of Japan 1996-2020

Published registered utility model applications of Japan 1994-2020

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 8-145593 A (SANYO ELECTRIC CO., LTD.) 07 June 1996, paragraphs [0001]-[0026], fig. 1-3	1-6
Y	JP 6-281293 A (TOSHIBA CORP.) 07 October 1994, paragraphs [0001]-[0045], fig. 1-18	1-6
A	JP 2009-257740 A (DAIKIN INDUSTRIES, LTD.) 05 November 2009, paragraphs [0001]-[0157], fig. 1-32	1-6
A	JP 8-75384 A (HITACHI, LTD.) 19 March 1996, paragraphs [0001]-[0050], fig. 1-20	1-6
A	JP 7-113555 A (HITACHI, LTD.) 02 May 1995, paragraphs [0001]-[0051], fig. 1-11	1-6



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search
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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2020/009421
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2015/125525 A1 (MITSUBISHI ELECTRIC CORP.) 27 August 2015, paragraphs [0001]-[0044], fig. 1-12	1-6

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/JP2020/009421

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 8-145593 A	07.06.1996	(Family: none)	
JP 6-281293 A	07.10.1994	(Family: none)	
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JP 8-75384 A	19.03.1996	US 6018963 A column 1, line 7 to column 11, line 22, fig. 1-20	
		KR 10-0300640 B1	
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JP 7-113555 A	02.05.1995	US 5542271 A column 1, line 5 to column 11, line 16, fig. 1-11	
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WO 2015/125525 A1	27.08.2015	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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