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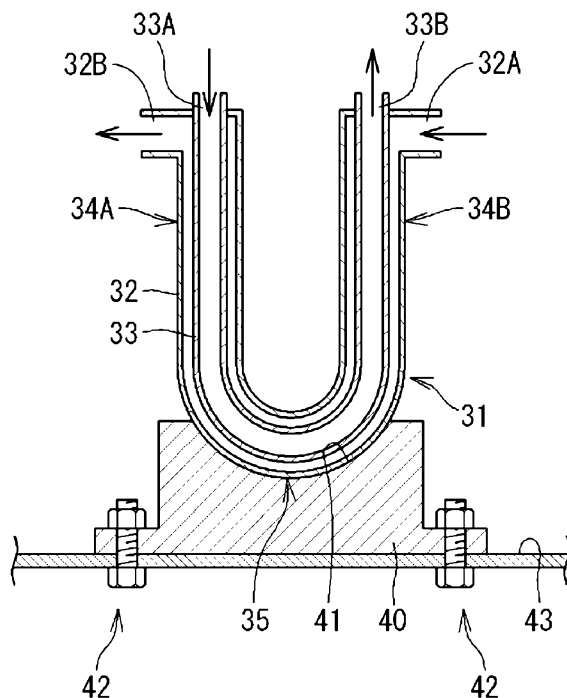
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— 国際調査報告 (条約第 21 条(3))

(54) Title: DOUBLE-PIPE HEAT EXCHANGER AND AIR CONDITIONER USING SAME

(54) 発明の名称: 二重管式熱交換器及びこれを備えた空気調和装置



(57) Abstract: Provided is a double-pipe heat exchanger that can be compactly configured, but is capable of restraining the outflow of a liquid refrigerant contained in a gas-liquid two-phase refrigerant from an inner pipe, and is capable of preventing the occurrence of refrigerant flood back. The double-pipe heat exchanger (31) is provided with: an outer pipe (32) that allows a high-pressure liquid refrigerant to flow therethrough; and an inner pipe (33) having an inlet-side end (33A), which allows a low-pressure gas-liquid two-phase refrigerant, which is obtained by reducing the pressure of the high-pressure liquid refrigerant, to flow in, and an outlet-side end (33B) connected to the suction-side of a compressor. The double-pipe heat exchanger (31) comprises a plurality of vertical pipes (34A, 34B) arranged in a vertical direction, and a curved pipe (35) that connects the ends of the plurality of vertical pipes (34A, 34B). The outlet-side end (33B) of the inner pipe (33) is provided to the upper end of one vertical pipe (34B), and the inlet-side end (33A) of the inner pipe (33) is provided to the upper end of the other vertical pipe (34A).

(57) 要約:

[続葉有]



コンパクトに構成することが可能でありながら、気液二相冷媒に含まれる液冷媒が内管から流出するのを抑制し、液バック現象の発生を防止することができる二重管式熱交換器を提供する。二重管式熱交換器（３１）は、高圧液冷媒を流動させる外管（３２）と、前記高圧液冷媒を減圧して得られる低圧の気液二相冷媒を流入させる入口側端部（３３Ａ）、及び圧縮機の吸引側に接続される出口側端部（３３Ｂ）を有する内管（３３）と、を備えている。二重管式熱交換器（３１）は、上下方向に配設された複数の縦管（３４Ａ、３４Ｂ）と、複数の縦管（３４Ａ、３４Ｂ）の端部同士を接続する曲管（３５）とからなり、内管（３３）の出口側端部（３３Ｂ）が、一の縦管（３４Ｂ）の上端部に設けられ、内管（３３）の入口側端部（３３Ａ）が、他の縦管（３４Ａ）の上端部に設けられている。

DESCRIPTION

TITLE OF INVENTION: DOUBLE-PIPE HEAT EXCHANGER AND AIR
CONDITIONER USING SAME

TECHNICAL FIELD

[0001] The present invention relates to a double-pipe heat exchanger and an air conditioner using same.

BACKGROUND ART

[0002] There is a known refrigerant circuit including a supercooling heat exchanger for supercooling a high pressure liquid refrigerant before flowing into an expansion valve in an air conditioner. As this supercooling heat exchanger, as disclosed in Patent Literature 1 below, there is a double-pipe heat exchanger including an outer pipe through which a high pressure liquid refrigerant flows, and an inner pipe through which a low pressure gas-liquid two-phase refrigerant obtained by reducing pressure of the high pressure liquid refrigerant flows. Specifically, Patent Literature 1 discloses a double-pipe heat exchanger of a vertical pipe shape arranged in the up and down direction, and a double-pipe heat exchanger of an inverted U shape.

CITATION LIST

[PATENT LITERATURE]

[0003] Patent Literature 1: Japanese Unexamined Patent Publication No. 2003-75026

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004] In the double-pipe heat exchanger of the vertical pipe shape, there is a need for ensuring an arrangement space which is wide in the up and down direction in a casing of an outdoor unit in an air conditioner, and a refrigerant pipe has to be connected to each of an upper end and a lower end of the double-pipe heat exchanger. Thus, at the time of a task of connecting this refrigerant pipe, there is a need for a step of inverting the double-pipe heat exchanger upside down. Thus, there is a disadvantage that the task becomes troublesome.

[0005] Meanwhile, the double-pipe heat exchanger of the inverted U shape can be arranged compactly in the up and down direction, and both ends are arranged on the same side (lower side). Thus, there is an advantage that a task of connecting a refrigerant pipe is easily performed. However, a gas-liquid two-phase refrigerant flowing in from one end (inlet side end) of an inner pipe flows upward and then flows downward through a U shape curved portion, and flows out from the other end (outlet side end). Thus, in a case where the gas-liquid two-phase refrigerant is not sufficiently evaporated inside the inner pipe, and when a liquid component (liquid refrigerant) contained in the gas-liquid two-phase refrigerant gets over the curved portion, there is a possibility that the liquid component flows downward in the inner pipe and easily flows out from the outlet side end, so as to flow into a compressor. Such a phenomenon is called as a "liquid-back phenomenon" which unfavorably causes a decrease in a performance of the

compressor.

[0006] The present invention is achieved in consideration with the situation described above, and an object thereof is to provide a double-pipe heat exchanger and an air conditioner capable of achieving a compact configuration, and suppressing a liquid refrigerant contained in a gas-liquid two-phase refrigerant from flowing out from an inner pipe so as to prevent generation of a liquid-back phenomenon.

[0006A] Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

[0006B] Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present disclosure as it existed before the priority date of each claim of this application.

SOLUTION TO PROBLEM

[0007] (1) The present invention is a double-pipe heat exchanger including an outer pipe through which a high pressure liquid refrigerant flows, and an inner pipe having an inlet side end into which a low pressure gas-liquid two-phase refrigerant obtained by reducing pressure of the high pressure liquid refrigerant flows, and an outlet side end connected to a suction side part of a compressor, wherein the double-pipe heat exchanger includes a plurality of vertical pipes arranged in the up and down direction, and a curve pipe connecting ends of the plurality of vertical pipes, the outlet side end of the inner pipe is provided in an upper end of one vertical pipe, and the inlet side end of the inner pipe is provided in an upper end of the other vertical pipe.

[0008] With this configuration, while flowing through the inner pipe, the gas-liquid two-phase refrigerant flowing in from the inlet side end of the inner pipe performs heat exchange with the high pressure liquid refrigerant flowing through the outer pipe, and is evaporated to become a gas refrigerant, and then flows out from the outlet side end of the inner pipe. At this time,

the outlet side end of the inner pipe is provided in the upper end of the one vertical pipe. Thus, even in a case where the gas-liquid two-phase refrigerant is not sufficiently evaporated and a liquid component (liquid refrigerant) remains, this liquid component does not easily go up in the inner pipe of the one vertical pipe, and hence does not easily flow out from the outlet side end. Therefore, a "liquid-back phenomenon" in which the liquid refrigerant comes into a compressor can be prevented.

Both the inlet side end and the outlet side end of the inner pipe are provided in the upper ends of the vertical pipes. Thus, without inverting the double-pipe heat exchanger, the refrigerant pipe can be connected, so that a pipe connecting task can be easily performed.

[0009] (2) Preferably, in the above configuration, the two vertical pipes are provided, and lower ends of the vertical pipes are connected by the curve pipe.

With such a configuration, the double-pipe heat exchanger can achieve a simple configuration, and by reducing a curve pipe part, a pressure loss of the refrigerant can be decreased.

[0010] (3) An air conditioner of the present invention includes a compressor, a condenser for condensing a high pressure gas refrigerant compressed by the compressor, a pressure reduction mechanism for reducing pressure of the condensed high pressure liquid refrigerant, an evaporator for evaporating the low pressure refrigerant after pressure reduction, and the double-pipe heat exchanger according to (1) or (2) described above, the double-pipe heat exchanger for supercooling the high pressure liquid refrigerant condensed by the condenser before reducing the pressure of the

refrigerant by the pressure reduction mechanism.

[0011] (4) Preferably, in the above air conditioner, the curve pipe connected to lower ends of the plurality of vertical pipes in the double-pipe heat exchanger is supported on a bottom frame of a casing in the air conditioner via a support member.

With such a configuration, in a part of the curve pipe where strength is relatively high, the double-pipe heat exchanger can be stably supported.

ADVANTAGEOUS EFFECTS OF INVENTION

[0012] According to the present invention, while the double-pipe heat exchanger can achieve a compact configuration, the liquid refrigerant contained in the gas-liquid two-phase refrigerant can be suppressed from flowing out from the inner pipe so as to prevent generation of the liquid-back phenomenon.

BRIEF DESCRIPTION OF DRAWINGS

[0013] [FIG. 1] FIG. 1 is a pattern diagram showing a refrigerant circuit of an air conditioner according to a first embodiment of the present invention.

[FIG. 2] FIG. 2 is a schematic view of a double-pipe heat exchanger provided in the refrigerant circuit of the air conditioner shown in FIG. 1.

[FIG. 3] FIG. 3 is a schematic view showing a modified example of a double-pipe heat exchanger according to a second embodiment of the present invention.

[FIG. 4] FIG. 4 is a pattern diagram showing a modified example of the refrigerant circuit of the air conditioner.

DESCRIPTION OF EMBODIMENTS

[0014] FIG. 1 is a pattern diagram showing a refrigerant circuit of an air conditioner according to a first embodiment of the present invention.

An air conditioner 1 is for example a multiple type air conditioner for a building in which a refrigerant circuit 10 is formed in such a manner that a plurality of indoor units 3 is connected in parallel to one or a plurality of outdoor unit 2 so as to circulate a refrigerant.

[0015] In the outdoor unit 2, compressors 11, a four way valve 12, an outdoor heat exchanger 13, an outdoor expansion valve 14, a supercooling heat exchanger 31, and the like are provided. These parts are connected by a refrigerant pipe so as to form the refrigerant circuit. A fan 23 is provided in the outdoor unit 2. In the indoor unit 3, an indoor expansion valve 15, an indoor heat exchanger 16, and the like are provided. The four way valve 12 and the indoor heat exchanger 16 are connected by a gas side refrigerant communication pipe 17a, and the outdoor expansion valve 14 and the indoor expansion valve 15 are connected by a liquid side refrigerant communication pipe 17b. A gas side stop valve 18 and a liquid side stop valve 19 are provided in terminal portions of the inside refrigerant circuit of the outdoor unit 2. The gas side stop valve 18 is arranged on the side of the four way valve 12, and the liquid side stop valve 19 is arranged on the side of the outdoor expansion valve 14. The gas side refrigerant communication pipe

17a is connected to the gas side stop valve 18, and the liquid side refrigerant communication pipe 17b is connected to the liquid side stop valve 19.

[0016] In a case where a cooling operation is performed in the air conditioner 1 with the above configuration, the four way valve 12 is retained in a state shown by solid lines in FIG. 1. A high temperature and high pressure gas refrigerant discharged from the compressors 11 flows into the outdoor heat exchanger (condenser) 13 via the four way valve 12, and performs heat exchange with the outdoor air by actuation of the fan 23 so as to be condensed and liquefied. The liquefied refrigerant passes through the outdoor expansion valve 14 in a fully open state, and flows into the indoor units 3 through the liquid side refrigerant communication pipe 17b. In the indoor unit 3, pressure of the refrigerant is reduced to predetermined low pressure by the indoor expansion valve (pressure reduction mechanism) 15, and further, the refrigerant performs the heat exchange with the indoor air in the indoor heat exchanger (evaporator) 16 so as to be evaporated. The indoor air cooled by evaporation of the refrigerant is blown out to an interior by an indoor fan (not shown) so as to cool the interior. The refrigerant evaporated in the indoor heat exchanger 16 is returned to the outdoor unit 2 through the gas side refrigerant communication pipe 17a, and suctioned into the compressors 11 via the four way valve 12.

[0017] On the other hand, in a case where a heating operation is performed, the four way valve 12 is retained in a state shown by broken lines in FIG. 1. A high temperature and high pressure gas refrigerant discharged from the compressors 11 flows into the indoor heat exchanger (condenser) 16 of the indoor unit 3 via the four way valve 12, and performs

the heat exchange with the indoor air so as to be condensed and liquefied. The indoor air heated by condensation of the refrigerant is blown out to the interior by the indoor fan so as to heat the interior. The refrigerant liquefied in the indoor heat exchanger 16 is returned to the outdoor unit 2 from the indoor expansion valve 15 in a fully open state through the liquid side refrigerant communication pipe 17b. The pressure of the refrigerant returned to the outdoor unit 2 is reduced to predetermined low pressure by the outdoor expansion valve (pressure reduction mechanism) 14, and further, the refrigerant performs the heat exchange with the outdoor air in the outdoor heat exchanger (evaporator) 13 so as to be evaporated. The refrigerant evaporated in the outdoor heat exchanger 13 is suctioned into the compressors 11 via the four way valve 12.

[0018] The supercooling heat exchanger 31 of the present embodiment is used for supercooling the high pressure liquid refrigerant flowing out from the outdoor heat exchanger 13 before reducing the pressure by the indoor expansion valve 15 at the time of the cooling operation as described above. In the present embodiment, the supercooling heat exchanger 31 is provided in a part of the refrigerant pipe (called as a main refrigerant pipe 25) between the outdoor expansion valve 14 and the liquid side stop valve 19.

The refrigerant circuit has a bypass refrigerant circuit 26 in which a part of the refrigerant condensed in the outdoor heat exchanger 13 (high pressure liquid refrigerant) is diverted from the main refrigerant pipe 25, the cooling refrigerant serving as a cooling source is supplied to the supercooling heat exchanger 31, and then the cooling refrigerant is returned to a suction

side part of the compressors 11. Specifically, the bypass refrigerant circuit 26 has a diverting pipe 27 by which the refrigerant is diverted from a part of the main refrigerant pipe 25 between the outdoor expansion valve 14 and the supercooling heat exchanger 31, the diverting pipe 27 being connected to an inlet of the cooling refrigerant in the supercooling heat exchanger 31, and a joining pipe 28 extending from an outlet of the cooling refrigerant in the supercooling heat exchanger 31 and joining a pipe of the suction side part of the compressors 11.

[0019] A bypass expansion valve 29 for reducing the pressure of the refrigerant is provided in the diverting pipe 27. The bypass expansion valve 29 is formed by an electric valve or the like for reducing the pressure of the high pressure liquid refrigerant flowing through the diverting pipe 27 so as to make the refrigerant a low pressure gas-liquid two-phase refrigerant. The high pressure liquid refrigerant flowing from the outdoor heat exchanger 13 toward the indoor expansion valve 15 is supercooled by the low pressure gas-liquid two-phase refrigerant in the supercooling heat exchanger 31. A liquid component (liquid refrigerant) contained in the gas-liquid two-phase refrigerant is evaporated by the heat exchange with the high pressure liquid refrigerant to become a gas refrigerant, and suctioned by the compressors 11.

[0020] FIG. 2 is a schematic view of the supercooling heat exchanger (double-pipe heat exchanger) provided in the refrigerant circuit of the air conditioner shown in FIG. 1. The supercooling heat exchanger 31 of the present embodiment is a double-pipe heat exchanger. That is, as shown in FIGS. 1 and 2, the supercooling heat exchanger 31 is formed by double pipes

including an outer pipe 32 connected to the main refrigerant pipe 25 of the refrigerant circuit, the outer pipe 32 through which the high temperature and high pressure liquid refrigerant flowing out from the outdoor heat exchanger 13 flows, and an inner pipe 33 connected to the bypass refrigerant circuit 26, the inner pipe 33 through which the cooling refrigerant after pressure reduction by the bypass expansion valve 29 flows. More specifically, the inner pipe 33 has one end (inlet side end) 33A connected to the diverting pipe 27, and the other end (outlet side end) 33B connected to the joining pipe 28. By the heat exchange between the high pressure liquid refrigerant flowing through the outer pipe 32 and the gas-liquid two-phase refrigerant flowing through the inner pipe 33, the high pressure liquid refrigerant is supercooled, and the gas-liquid two-phase refrigerant becomes the gas refrigerant by evaporation of the liquid component.

[0021] The supercooling heat exchanger 31 is formed in a U curved structure. Specifically, the supercooling heat exchanger 31 includes two vertical pipes 34A and 34B, and a curve pipe 35 connecting ends of the two vertical pipes 34A and 34B. The curve pipe 35 connects lower ends of the two vertical pipes 34A and 34B. Therefore, inlet side ends 32A and 33A and outlet side ends 32B and 33B of the refrigerant are provided in upper ends of the two vertical pipes 34A and 34B.

[0022] The gas-liquid two-phase cooling refrigerant after the pressure reduction by the bypass expansion valve 29 flows into the inner pipe 33 of the supercooling heat exchanger 31 from the inlet side end 33A, performs the heat exchange with the high pressure liquid refrigerant flowing through the outer pipe 32 while flowing through the inner pipe 33 to become

the gas refrigerant, and flows out from the outlet side end 33B. However, in a case where the liquid component of the gas-liquid two-phase refrigerant is not completely evaporated by the heat exchange with the high pressure liquid refrigerant, and when the liquid component flows out from the outlet side end 33B, the liquid component is suctioned by the compressors 11 and a liquid-back phenomenon is generated, so as to cause a decrease in a performance of the compressors 11.

[0023] In the present embodiment, the outlet side end 33B of the inner pipe 33 is provided in the upper end of the vertical pipe 34B. Thus, even when the liquid component of the gas-liquid two-phase refrigerant remains unevaporated, the liquid component does not easily go up toward the outlet side end 33B of the inner pipe 33, and does not easily flow out from the end 33B. Therefore, the liquid-back phenomenon to the compressors 11 can be suppressed. The liquid component of the gas-liquid two-phase refrigerant performs the heat exchange with the high pressure liquid refrigerant in the outer pipe 32 while remaining in the curve pipe 35 to become the gas refrigerant, and then flows out from the outlet side end 33B. Meanwhile, since the two vertical pipes 34A and 34B are connected by the curve pipe 35 having no horizontal part, drift (up-down separation of the liquid component and a gas component) of the gas-liquid two-phase refrigerant between the two vertical pipes 34A and 34B can be suppressed as far as possible.

[0024] Both the inlet side end 32A and the outlet side end 32B of the outer pipe 32, and the inlet side end 33A and the outlet side end 33B of the inner pipe 33 in the supercooling heat exchanger 31 are provided on the

same side (upper side) in the up and down direction. Thus, the refrigerant pipe can be connected to these parts without inverting the supercooling heat exchanger 31 upside down. Therefore, a task of connecting the refrigerant pipe to the supercooling heat exchanger 31 can be performed with favorable workability.

[0025] The supercooling heat exchanger 31 is attached onto a bottom frame 43 in a casing of the outdoor unit 2 via a support member 40. This support member 40 is made of rubber, synthetic resin, or the like, and fixed to the bottom frame 43 by fixing tools 42 including bolts, nuts, and the like. A fitting recessed portion 41 recessed in a curved shape is formed on an upper surface of the support member 40. The supercooling heat exchanger 31 is supported by the support member 40 by fitting the curve pipe 35 into the fitting recessed portion 41 and fixing the support member 40 and the curve pipe 35 by a fastening band or the like. The supercooling heat exchanger 31 has relatively high strength in a part of the curve pipe 35. Thus, the supercooling heat exchanger 31 can be stably supported by the support member 40.

[0026] FIG. 3 is a schematic view showing a supercooling heat exchanger (double-pipe heat exchanger) according to a second embodiment.

A supercooling heat exchanger 31 shown in FIG. 3 includes four vertical pipes 34A to 34D, and three curve pipes 35A to 35C. Ends of the adjacent vertical pipes 34A to 34D are respectively connected by the curve pipes 35A to 35C, so as to be formed in a substantially W form as a whole. Inlet side ends 32A and 33A and outlet side ends 32B and 33B of an outer pipe 32 and an inner pipe 33 are provided in upper ends of the vertical pipes

34A and 34D. The curve pipes 35A and 35C arranged on the lower part side of the supercooling heat exchanger 31 are supported by a bottom frame 43 of a casing via a support member 40. Therefore, the supercooling heat exchanger 31 of the present embodiment exerts the same operations and effects as the supercooling heat exchanger 31 shown in FIG. 2. Further, in comparison to the supercooling heat exchanger 31 of the first embodiment, the supercooling heat exchanger 31 of the present embodiment can be formed more compactly in the up and down direction in a case where pipe length is the same. However, since the number of the curve pipes 35A to 35C is higher in the present embodiment, a pressure loss of the refrigerant is more easily generated. Thus, in this point, the first embodiment is more advantageous.

[0027] The present invention is not limited to the above embodiments but can be appropriately changed within the scope of the invention described in the claims.

For example, the supercooling heat exchanger (double-pipe heat exchanger) 31 of the present invention can also be applied to a refrigerant circuit shown in FIG. 4. In this refrigerant circuit, the supercooling heat exchanger 31 performs the heat exchange between the high pressure liquid refrigerant flowing out from the outdoor heat exchanger 13 and the gas-liquid two-phase refrigerant after the pressure reduction by the indoor expansion valve 15, a part of the gas-liquid two-phase refrigerant being evaporated in the indoor heat exchanger 16. It should be noted that in this refrigerant circuit, the high pressure liquid refrigerant can be favorably supercooled by the supercooling heat exchanger 31 even at the time of the

heating operation.

[0028] In the supercooling heat exchanger 31 shown in FIG. 3, the pluralities of vertical pipes 34A to 34D and curve pipes 35A to 35C are arranged on one straight line in a plan view. However, for example, the pipes may be arranged in a square form or a substantially Z form in a plan view. The supercooling heat exchanger 31 may include six or more vertical pipes (and five or more curve pipes).

REFERENCE SIGNS LIST

[0029] 1: AIR CONDITIONER
2: OUTDOOR UNIT
10: REFRIGERANT CIRCUIT
11: COMPRESSOR
12: FOUR WAY VALVE
13: OUTDOOR HEAT EXCHANGER
14: OUTDOOR EXPANSION VALVE
15: INDOOR EXPANSION VALVE
16: INDOOR HEAT EXCHANGER
31: SUPERCOOLING HEAT EXCHANGER (DOUBLE-PIPE
HEAT EXCHANGER)
32: OUTER PIPE
33: INNER PIPE
33A: INLET SIDE END
33B: OUTLET SIDE END
34A to 34D: VERTICAL PIPE

35: CURVE PIPE

35A to 35C: CURVE PIPE

40: SUPPORT MEMBER

43: BOTTOM FRAME

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. An air conditioner comprising:
 - a casing having a bottom frame;
 - a double-pipe heat exchanger comprising an outer pipe through which a high pressure liquid refrigerant flows, and an inner pipe having an inlet side end into which a low pressure gas-liquid two-phase refrigerant obtained by reducing pressure of the high pressure liquid refrigerant flows, and an outlet side end connected to a suction side part of a compressor; and
 - a support member for supporting the double-pipe heat exchanger,wherein
 - the double-pipe heat exchanger includes a plurality of vertical pipes arranged in the up and down direction, and a curve pipe connecting ends of the plurality of vertical pipes,
 - the outlet side end of the inner pipe is provided in an upper end of one vertical pipe,
 - the inlet side end of the inner pipe is provided in an upper end of the other vertical pipe, and
 - the curve pipe connected to lower ends of the plurality of vertical pipes in the double-pipe heat exchanger is supported on the bottom frame of the casing in the air conditioner via the support member.

2. The air conditioner according to claim 1,
 - wherein
 - the support member is made of rubber or synthetic resin,

a fitting recessed portion for fitting the curve pipe is formed on an upper surface of the support member.

3. The air conditioner according to claim 1 or 2,
wherein

the double-pipe heat exchanger includes the two vertical pipes,
lower ends of the vertical pipes are connected by the curve pipe.

FIG. 1

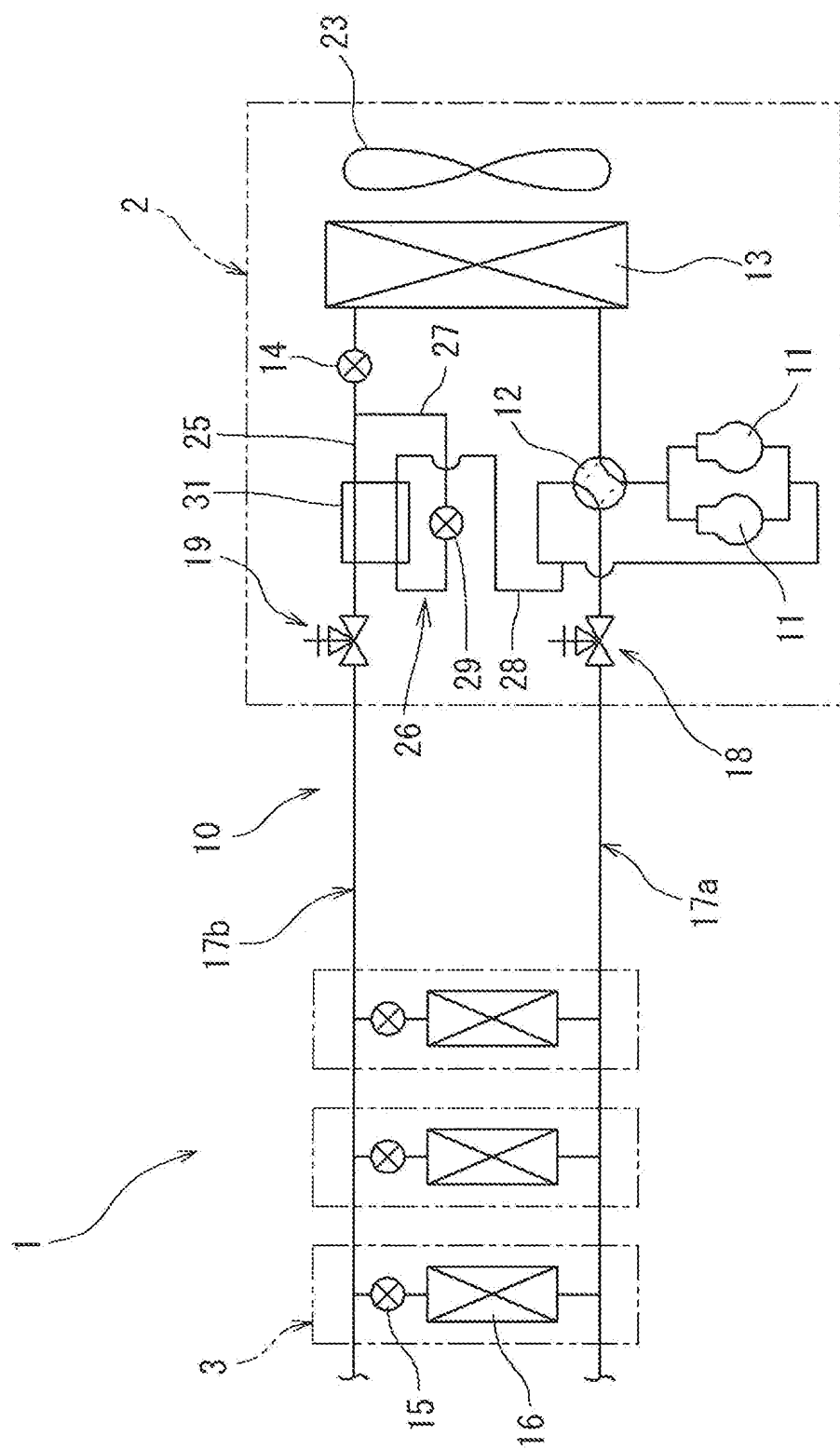


FIG. 2

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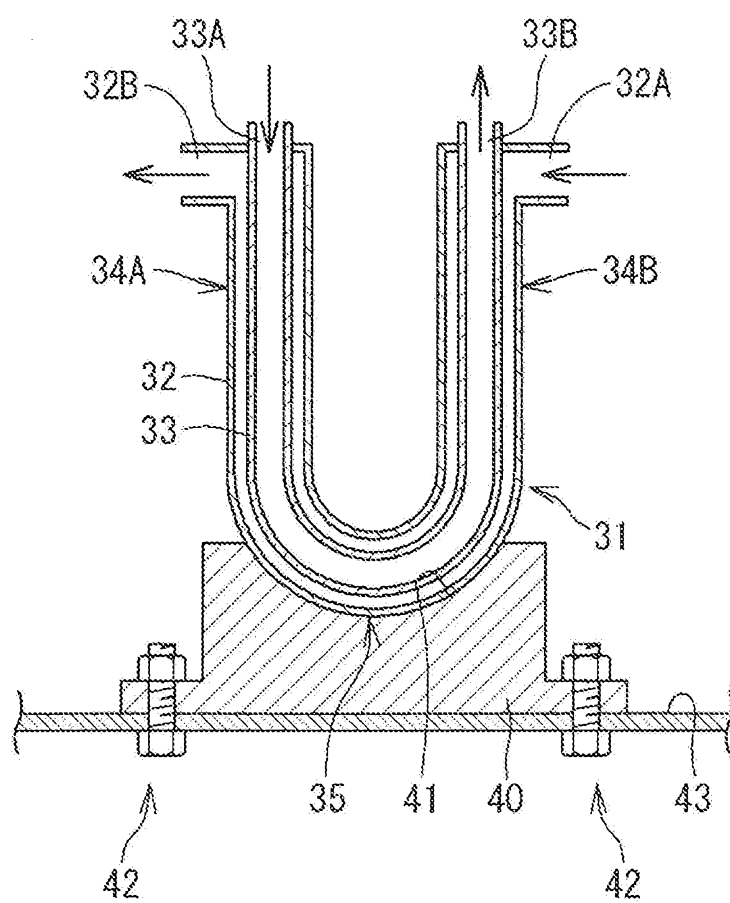


FIG. 3

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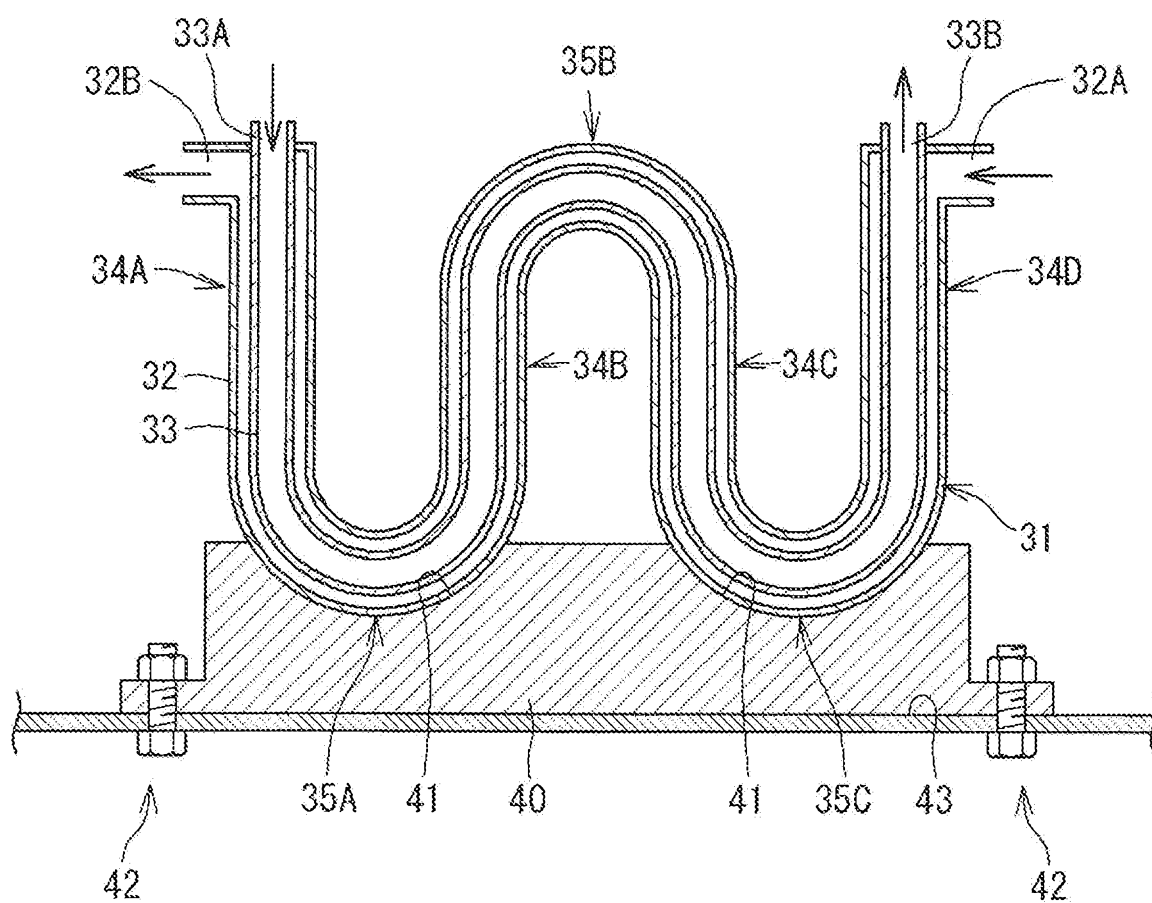


FIG. 4

