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(54) **AIR CONDITIONER**

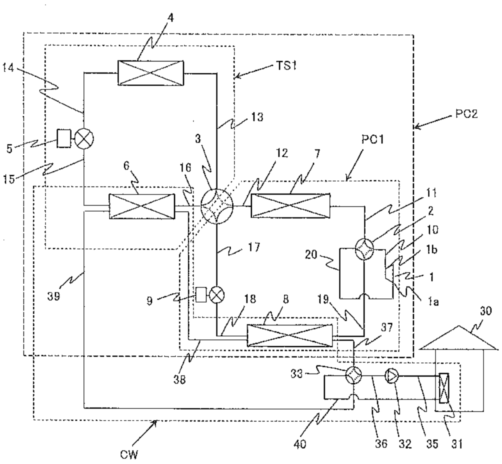
(57) [Purpose]

To display cooling and heating capabilities by using a heat exchanger for a natural circulation type cycle as a heat exchanger for a vapor compression cycle.

[Solution]

An air conditioning device according to the present invention is configured to be capable of forming at least three refrigeration cycles including: a natural circulation type cycle (TS1) formed into a circular shape by sequentially connecting a first heat source side heat exchanger (4), a first expansion valve (5), and a first user side heat exchanger (6) with refrigerant pipes; a first vapor compression cycle (PC1) formed into a circular shape by sequentially connecting a discharge port (1b) of a compressor (1), a flow path switching valve (2), a second heat source side heat exchanger (7), a second expansion valve (9), a second user side heat exchanger (8), and a suction port (1a) of the compressor (1) with refrigerant pipes; and a second vapor compression cycle (PC2) formed into a circular shape by sequentially connecting the discharge port (1b) of the compressor (1), the flow path switching valve (2), the second heat source side heat exchanger (7), the first heat source side heat exchanger (4), the first expansion valve (5), the first user side heat exchanger (6), the second user side heat exchanger (8), and the suction port (1a) of the compressor with refrigerant pipes.

FIG. 1



EP 2 541 168 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to an air conditioning device installed in, for example, a house or an office building, and more specifically to an air conditioning device provided with both a natural circulation type cycle in which a refrigerant is naturally circulated by a density difference and a vapor compression cycle in which the refrigerant is forcibly circulated by a compressor, and also capable of selectively using these two refrigeration cycles.

BACKGROUND ART

[0002] As related art selectively using two refrigeration cycles including a natural circulation type cycle and a vapor compression cycle, for example, disclosed in Patent Literature 1 is a technology provided, for the purpose of cooling air in a box body, with both a refrigeration cycle (vapor compression cycle) formed by sequentially connecting a compressor, a reheating condenser, and a cooler with refrigerant pipes and a natural circulation cooling device (natural circulation type cycle) formed by connecting a natural circulation cooling condenser and a natural circulation cooling cooler with a refrigerant pipe. According to this Patent Literature 1, the air in the box body can be cooled by the natural circulation cooling cooler (natural circulation type cycle), thus reducing a load of cooling by the refrigeration cycle (vapor compression cycle). Therefore, according to the technology described in Patent Literature 1, power consumption can be reduced, and operation costs of the entire cooling system can be controlled at a low level.

[0003] Moreover, disclosed in Patent Literature 2 is a refrigerant natural circulation cooling and dehumidification device provided with an indoor heat exchanger, an outdoor heat exchanger, a refrigerant pipe, an expansion valve, and a refrigerant compression and forcible circulation device corresponding to a compression freezer of another device. This refrigerant natural circulation cooling and dehumidification device has: a natural circulation type cycle formed into a circular shape by connecting the outdoor heat exchanger, the indoor heat exchanger located at position lower than the outdoor heat exchanger, and the expansion valve with refrigerant pipes; and a vapor compression cycle provided by the refrigerant compression and forcible circulation device, and is configured such that an evaporation heat exchanger for the vapor compression cycle is closely coupled to the outdoor heat exchanger for the natural circulation type cycle. With this configuration, the evaporation heat exchanger can efficiently take heat from the outdoor heat exchanger, so that, even in a case where the cooling and dehumidification capabilities have deteriorated due to no temperature difference between the room inside and the outside, deterioration in cooling and dehumidification capabilities of the refrigerant natural circulation cooling and dehumidification device can be compensated by activating the refrigerant compression and forcible circulation device.

[0004] Further, disclosed in Patent Literature 2 is an air conditioning device having a refrigerant natural circulation cooling and dehumidification device (natural circulation type cycle) which uses refrigerant natural circulation and which is provided in a refrigerant compression and forcible circulation both cooling and heating device (vapor compression cycle) using a refrigerant compression and forcible circulation system. According to this air conditioning device, a high-quality dry operation mode can be performed in which heating is performed by the refrigerant compression and forcible circulation both cooling and heating device while performing dehumidification by the refrigerant natural circulation cooling and dehumidification device, which can improve comfortability.

CITATION LIST

PATENT LITERATURE

[0005]

PATENT LITERATURE 1: JP-A No. 2003-121072
PATENT LITERATURE 2: JP-A No. H10-300128

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0006] However, in each related art described above, the natural circulation type cycle and the vapor compression cycle form mutually independent refrigeration cycles, and thus it has been impossible to use a heat exchanger for the natural circulation type cycle as a heat exchanger for the vapor compression cycle, for example, in an event in which cooling and heating are at a peak. Thus, there has arisen a problem that heat exchange function of the heat exchanger for the natural circulation type cycle is not effectively used.

[0007] Moreover, the natural circulation type cycle is a cycle in which a refrigerant is naturally circulated by a difference of statical head due to a difference in height between the two heat exchangers and a density difference between the gas refrigerant ant the liquid refrigerant, thus raising a problem that, in a case where outside air temperature is equal to or lower than indoor temperature and when a difference between the outside air temperature and the indoor temperature is small, dehumidification capabilities cannot be provided even by performing cooling operation using the natural circulation type cycle.

SOLUTION TO PROBLEM

[0008] In view of the circumstances described above, the present invention has been made, and it is an object of the invention to, in an air conditioning device provided with both a vapor compression cycle and a natural circulation type cycle, use a heat exchanger for the natural circulation type cycle as a heat exchanger for the vapor compression cycle to display cooling and heating capabilities. Moreover, it is also an object of the invention to provide an air conditioning device capable of, in a case where outside air temperature is equal to or lower than indoor temperature, improving dehumidification capabilities by using both the natural circulation type cycle and the vapor compression cycle even when a difference between the outside air temperature and the indoor temperature is small.

ADVANTAGEOUS EFFECT OF INVENTION

[0009] To address the above-mentioned object, an air conditioning device of the present invention includes: a compressor; first and second heat source side heat exchangers making heat exchange between a heat source side heat transfer medium and a refrigerant; first and second user side heat exchangers making heat exchange between a user side heat transfer medium and a refrigerant; a flow path switching valve switching a flow path direction of the refrigerant; and first and second expansion valves. The air conditioning device is capable of forming at least three refrigeration cycles including: a natural circulation type cycle being formed into a circular shape by sequentially connecting the first heat source side heat exchanger, the first expansion valve, and the first user side heat exchanger installed at a position lower than the first heat source side heat exchanger with refrigerant pipes, wherein the refrigerant is naturally circulated by a density difference; a first vapor compression cycle being formed into a circular shape by sequentially connecting a discharge port of the compressor, the flow path switching valve, the second heat source side heat exchanger, the second expansion valve, the second user side heat exchanger, and a suction port of the compressor with refrigerant pipes, wherein the refrigerant is forcibly circulated by the compressor; and a second vapor compression cycle being formed into a circular shape by sequentially connecting the discharge port of the compressor, the flow path switching valve, the second heat source side heat exchanger, the first heat source side heat exchanger, the first expansion valve, the first user side heat exchanger, the second user side heat exchanger, and the suction port of the compressor with refrigerant pipes, wherein the refrigerant is forcibly circulated by the compressor. The air conditioning device further includes cycle switching means adapted to switch the refrigeration cycle between a first state in which the natural circulation type cycle and the first vapor compression cycle are formed independently and a second state in which the second vapor compression cycle is formed.

[0010] According to the present invention, as a result of operating the cycle switching means to make switching to the second vapor compression cycle, a heat exchanger for the natural circulation type cycle can be used as a heat exchanger for the second vapor compression cycle, thus permitting an improvement in cooling and heating capabilities, which consequently displays great effect when cooling and heating are at a peak.

[0011] In the aforementioned configuration, the present invention is characterized in that the first user side heat exchanger, the second user side heat exchanger, and an indoor heat exchanger installed in a cooled space are sequentially connected with user side heat transfer medium pipes to form a circular-shaped user side heat transfer medium circulation circuit, and water or brine as the user side heat transfer medium is forcibly circulated through the user side heat transfer medium circulation circuit.

[0012] According to the present invention, configuration is such that the user side heat transfer medium circulation circuit is provided and air in a cooled space is subjected to, for example, cooling and heating via the indoor heat exchanger installed in the cooled space, so that a refrigerant pipe connecting together an indoor unit and an outdoor unit as in conventional air is no longer required and also only a small amount of refrigerant is required. Moreover, to form a natural circulation type cycle in the configuration such that indoor and outdoor units are connected together with a refrigerant pipe as in the past, the outdoor unit needs to be set at position higher than the indoor unit, which results in layout limitations. However, according to the invention, configuration is such that the user side heat transfer medium circulation circuit is provided, thus providing advantage that a degree of freedom in layout increases.

[0013] In the aforementioned configuration, the present invention is characterized in that the second user side heat exchanger is halved into a first divided heat exchanger and a second divided heat exchanger, and a third expansion valve is provided at a coupling refrigerant pipe linking together the first divided heat exchanger and the second divided heat exchanger.

[0014] According to the present invention, reheating and dehumidification operation can be performed by which dehumidification is performed while heating the air in the cooled space by the first divided heat exchanger, the second divided heat exchanger, and the third expansion valve. In addition, both the natural circulation type cycle and the first vapor compression cycle can be used, which can therefore improve dehumidification capabilities even in a case where outside air temperature is equal to or lower than indoor temperature and when a difference between the outside air temperature and the indoor temperature is small. In addition, it provides advantage that a range of temperature and humidity control is widened.

[0015] In the aforementioned configuration, the present invention is characterized in that the second heat source side heat exchanger and a heat storage tank are connected together with a heat source side heat transfer medium pipe to form a circular-shaped heat source side heat transfer medium circulation circuit, and water as the heat source side heat transfer medium is forcibly circulated through the heat source side heat transfer medium circulation circuit.

[0016] According to the present invention, heat discharged by the heat source side heat exchanger can be used to produce intermediate hot water, so that this intermediate hot water can be used for, for example, hot water supply to thereby achieve efficiency improvement. Further, in the present invention, the heat discharged by the heat source side heat exchanger can be stored by the heat storage tank, thus also making it possible to resolve, for example, a time zone difference between an air conditioning load and a hot water supply load.

[0017] In the aforementioned configuration, the present invention is characterized in that a hot water supply compressor, a hot water supply user side heat exchanger, a hot water supply expansion valve, and the second heat source side heat exchanger are sequentially connected with hot water supply refrigerant pipes to form a circular-shaped hot water supply cycle, and a hot water supply refrigerant as the heat source side heat transfer medium is forcibly circulated through the hot water supply cycle by the hot water supply compressor.

[0018] According to the present invention, hot water whose temperature is higher than that of the intermediate hot water can be produced.

[0019] In the aforementioned configuration, the present invention is characterized in that, further included are: a bypass pipe bypassing the suction port and the discharge port of the compressor; and bypass opening and closing means adapted to switch a refrigerant flow path between a flow path extending through the compressor and a flow path extending through the bypass pipe.

[0020] According to the present invention, the natural circulation type cycle using the two heat source side heat exchangers and the two user side heat exchangers can be formed, thus making it possible to achieve operation by a natural circulation cycle with high heat exchange efficiency and permitting power saving to be achieved.

EFFECT OF THE INVENTION

[0021] According to the present invention, the heat exchanger for the natural circulation type cycle can be used as the heat exchanger for the vapor compression cycle, so that, compared to use of only the heat exchanger for the vapor compression cycle, an area of heat transmission of the heat exchanger widens, heat exchange efficiency improves, and can achieve power saving. Moreover, both the natural circulation type cycle and the vapor compression cycle can be used, which can improve the dehumidification capabilities even in a case where the outside air temperature is equal to or lower than the indoor temperature and when a difference between the outside air temperature and the indoor temperature is small.

BRIEF DESCRIPTION OF DRAWINGS

[0022]

[FIG. 1] Fig. 1 is a basic configuration diagram showing components forming an air conditioning device and their connection relationship according to a first embodiment of the present invention.

[FIG. 2] Fig. 2 is a sequence diagram showing flows of a refrigerant and a heat transfer medium in an operation mode No. 1 of the air conditioning device according to the first embodiment of the present invention.

[FIG. 3] Fig. 3 is a sequence diagram showing the flows of the refrigerant and the heat transfer medium in an operation mode No. 2 of the air conditioning device according to the first embodiment of the present invention.

[FIG. 4] Fig. 4 is a sequence diagram showing the flows of the refrigerant and the heat transfer medium in an operation mode No. 3 of the air conditioning device according to the first embodiment of the present invention.

[FIG. 5] Fig. 5 is a sequence diagram showing the flows of the refrigerant and the heat transfer medium in an operation mode No. 4 of the air conditioning device according to the first embodiment of the present invention.

[FIG. 6] Fig. 6 is a basic configuration diagram showing components forming an air conditioning device and their connection relationship according to a second embodiment of the present invention.

[FIG. 7] Fig. 7 is a sequence diagram showing flows of a refrigerant and a heat transfer medium in an operation mode No. 5 of the air conditioning device according to the second embodiment of the present invention.

[FIG. 8] Fig. 8 is a basic configuration diagram showing components forming an air conditioning device and their connection relationship according to a third embodiment of the present invention.

[FIG. 9] Fig. 9 is a sequence diagram showing flows of a refrigerant and a heat transfer medium in an operation mode No. 6 of the air conditioning device according to the third embodiment of the present invention.

[FIG. 10] Fig. 10 is a sequence diagram showing the flows of the refrigerant and the heat transfer medium in an operation mode No. 7 of the air conditioning device according to the third embodiment of the present invention.

[FIG. 11] Fig. 11 is a sequence diagram showing the flows of the refrigerant and the heat transfer medium in an operation mode No. 8 of the air conditioning device according to the third embodiment of the present invention.

[FIG. 12] Fig. 12 is a sequence diagram showing the flows of the refrigerant and the heat transfer medium in an operation mode No. 9 of the air conditioning device according to the third embodiment of the present invention.

[FIG. 13] Fig. 13 is a sequence diagram showing the flows of the refrigerant and the heat transfer medium in an operation mode No. 10 of the air conditioning device according to the third embodiment of the present invention.

[FIG. 14] Fig. 14 is a sequence diagram showing the flows of the refrigerant and the heat transfer medium in an operation mode No. 11 of the air conditioning device according to the third embodiment of the present invention.

[FIG. 15] Fig. 15 is a basic configuration diagram showing components forming an air conditioning device and their connection relationship according to a fourth embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[First Embodiment of the Present Invention]

[0023] Configuration, functions, and operation of an air conditioning device according to a first embodiment of the present invention will be described with reference to FIGS. 1 to 5. Arrows provided to heat exchangers in FIGS. 2 to 5 show heat flows. In FIG. 1, "1" denotes a variable displacement compressor for a refrigerant, "2" denotes a vapor compression cycle four-way valve (flow path switching valve), "3" denotes a cycle switching four-way valve (cycle switching means), "4" denotes a first heat source side heat exchanger that performs heat exchange between air (heat source side heat transfer medium) and a refrigerant, "5" denotes a first expansion valve, "6" denotes a first user side heat exchanger that performs heat exchange between water (user side heat transfer medium) and the refrigerant, "7" denotes a second heat source side heat exchanger that performs heat exchange between the air (heat source side heat transfer medium) and the refrigerant, "8" denotes a second user side heat exchanger that performs heat exchange between the water (user side heat transfer medium) and the refrigerant, and "9" denotes a second expansion valve. Note that the first user side heat exchanger 6 is installed at a position lower than the first heat source side heat exchanger 4. That is, a head difference is provided between the first user side heat exchanger 6 and the first heat source side heat exchanger 4. Moreover, in this embodiment, R410A is used as the refrigerant.

[0024] A natural circulation type cycle TS1 is a refrigeration cycle formed into a circular shape by connecting together the first heat source side heat exchanger 4 and the first expansion valve 5 with a refrigerant pipe 14, connecting together the first expansion valve 5 and the first user side heat exchanger 6 with a refrigerant pipe 15, connecting together the first user side heat exchanger 6 and the cycle switching four-way valve 3 with a refrigerant pipe 16, and connecting together the cycle switching four-way valve 3 and the first heat source side heat exchanger 4 with a refrigerant pipe 13. Then in this natural circulation type cycle, the refrigerant is naturally circulated by a density difference.

[0025] A first vapor compression cycle PC1 is a refrigeration cycle formed into a circular shape by connecting together a discharge port 1b of the compressor 1 and the vapor compression cycle four-way valve 2 with a refrigerant pipe 10, connecting together the vapor compression cycle four-way valve 2 and the second heat source side heat exchanger 7 with a refrigerant pipe 11, connecting together the second heat source side heat exchanger 7 and the cycle switching four-way valve 3 with a refrigerant pipe 12, connecting together the cycle switching four-way valve 3 and the second expansion valve 9 with a refrigerant pipe 17, connecting together the second expansion valve 9 and the second user side heat exchanger 8 with a refrigerant pipe 18, connecting together the second user side heat exchanger 8 and the vapor compression cycle four-way valve 2 with a refrigerant pipe 19, and connecting together the vapor compression cycle four-way valve 2 and a suction port 1a of the compressor 1 with a refrigerant pipe 20. Then by the compressor 1, the refrigerant is forcibly circulated in the first vapor compression cycle PC1.

[0026] A second vapor compression cycle PC2 is a refrigeration cycle formed into a circular shape by connecting together the discharge port 1b of the compressor 1 and the vapor compression cycle four-way valve 2 with the refrigerant pipe 10, connecting together the vapor compression cycle four-way valve 2 and the second heat source side heat exchanger 7 with the refrigerant pipe 11, connecting together the second heat source side heat exchanger 7 and the cycle switching four-way valve 3 with the refrigerant pipe 12, connecting together the cycle switching four-way valve 3 and the first heat source side heat exchanger 4 with the refrigerant pipe 13, connecting together the first heat source side heat exchanger 4 and the first expansion valve 5 with the refrigerant pipe 14, connecting together the first expansion valve 5 and the first user side heat exchanger 6 with the refrigerant pipe 15, connecting together the first user side heat exchanger 6 and the cycle switching four-way valve 3 with the refrigerant pipe 16, connecting together the cycle switching four-way valve 3 and the second expansion valve 9 with the refrigerant pipe 17, connecting together the second expansion valve 9 and the second user side heat exchanger 8 with the refrigerant pipe 18, connecting together the second user side heat exchanger 8 and the vapor compression cycle four-way valve 2 with the refrigerant pipe 19, and connecting together the vapor compression cycle four-way valve 2 and the suction port la of the compressor 1 with the refrigerant pipe 20. Then by the compressor 1, the refrigerant is forcibly circulated in the second vapor compression cycle PC2.

[0027] Cycle switching between the natural circulation type cycle TS1, the first vapor compression cycle PC1, and the second vapor compression cycle PC2 is performed by operating the cycle switching four-way valve 3. Describing it in more detail, the cycle switching four-way valve 3 is operated to provide a first state in which the refrigerant pipe 13 and the refrigerant pipe 16 are communicated to each other and also the refrigerant pipe 12 and the refrigerant pipe 17 are communicated to each other, thereby forming the two independent refrigeration cycles, i.e., the natural circulation type cycle TS1 and the first vapor compression cycle PC1. That is, the two refrigeration cycles, the natural circulation type cycle TS1 and the first vapor compression cycle PC1, are formed at the same time. On the contrary, the cycle switching four-way valve 3 is operated to provide a second state in which the refrigerant pipe 12 and the refrigerant pipe 13 are communicated to each other and also the refrigerant pipe 16 and the refrigerant pipe 17 are communicated to each other, thereby forming only the second vapor compression cycle PC2. As described above, in the air conditioning device according to the first embodiment, the cycle switching four-way valve 4 is operated to thereby create the two states including the state in which the natural circulation type cycle TS1 and the first vapor compression cycle PC1 can be used at the same time and the state in which only the second vapor compression cycle PC2 can be used.

[0028] Moreover, "30" denotes a house, "31" denotes an indoor heat exchanger installed in a room (cooled space) of the house, "32" denotes a circulation pump, and "33" denotes a cooled and heated water circuit four-way valve. A cooled and heated water circulation circuit (user side heat transfer medium circulation circuit) CW is a circuit formed into a circular shape by connecting together the indoor heat exchanger 31 and the circulation pump 32 with a cooled and heated water pipe (user side heat transfer medium pipe) 35, connecting together the circulation pump 32 and the cooled and heated water circuit four-way valve 33 with a cooled and heated water pipe 36, connecting together the cooled and heated water circuit four-way valve 33 and the second user side heat exchanger 8 with a cooled and heated water pipe 37, connecting together the second user side heat exchanger 8 and the first user side heat exchanger 6 with a cooled and heated water pipe 38, connecting together the first user side heat exchanger 6 and the cooled and heated water circuit four-way valve 33 with a cooled and heated water pipe 39, and connecting together the cooled and heated water circuit four-way valve 33 and the indoor heat exchanger 31 with a cooled and heated water pipe 40. Then by the circulation pump 32, water is forcibly circulated in the cooled and heated water circulation circuit CW.

[0029] Next, operation modes that can be performed in the air conditioning device according to the first embodiment will be described. In the air conditioning device according to the first embodiment, as shown below, the four operation modes No. 1 to No. 4 can be performed. Note that "hs" is an abbreviation of heat source, "app" is an abbreviation of application, and "H" is an abbreviation of Humidity in the description below.

"Operation mode No. 1 (FIG. 2)"

[0030] The operation mode No. 1 is a cooling operation mode solely using the second vapor compression cycle PC2, and is an operation mode used in a case where outside air temperature is high and a cooling load is great in, for example, summer daytime. This operation mode No. 1 is a mode adopted in a case where "outside temperature Ths-set temperature Tusker≥0" and also "indoor temperature Tapp-the set temperature Tuser≥0", for example, a case where the outside temperature Ths is 35 degrees Celsius, the set temperature Tuser is 23 degrees Celsius, and the indoor temperature Tapp is 27 degrees Celsius. Note that, in this operation mode No. 1, a refrigerant circulation path is directions of the arrows of FIG. 2.

[0031] In this operation mode, first by the vapor compression cycle four-way valve 2, the refrigerant pipe 10 and the refrigerant pipe 11 are communicated to each other and the refrigerant pipe 19 and the refrigerant pipe 20 are communicated to each other. Moreover, by the cycle switching four-way valve 3, the refrigerant pipe 12 and the refrigerant pipe 13 are communicated to each other and the refrigerant pipe 16 and the refrigerant pipe 17 are communicated to each other. Switching between the vapor compression cycle four-way valve 2 and the cycle switching four-way valve 3 in this manner forms the second vapor compression cycle PC2. Here, in the operation mode No. 1, the first expansion valve 5 is adjusted at a predetermined degree of opening, and the second expansion valve 9 is fully open.

[0032] A high-temperature/high-pressure gas refrigerant discharged from the discharge port 1b of the compressor 1 flows into the second heat source side heat exchanger 7 through the vapor compression cycle four-way valve 2, and while flowing through the second heat source side heat exchanger 7, dissipates heat to air to be condensed. Further, the refrigerant exiting from the second heat source side heat exchanger 7 flows into the first heat source side heat exchanger 4 through the cycle switching four-way valve 3, and while flowing through the first heat source side heat exchanger 4, dissipates heat to the air to be condensed, and then finally liquidized. The liquidized refrigerant is depressurized and expanded by the first expansion valve 5, which is adjusted at the predetermined degree of opening, and flows into the first user side heat exchanger 6 in a low-temperature/low-pressure vapor-liquid two-phase.

[0033] This refrigerant in the vapor-liquid two-phase state absorbs heat from water circulating in the cooled and heated water circulation circuit CW to be evaporated while flowing through the first user side heat exchanger 6, further sequentially passes through the cycle switching four-way valve 3 and the second expansion valve 9, and flows into the second user side heat exchanger 8. Then the refrigerant flowing into the second user side heat exchanger 8, while flowing through the second user side heat exchanger 8, absorbs heat from the water circulating in the cooled and heated water circulation circuit CW to be thereby evaporated and finally gasified. The gasified refrigerant flows into the suction port 1a of the compressor 1 through the vapor compression cycle four-way valve 2, and is compressed again by the compressor 1, turning into a high-temperature/high-pressure gas refrigerant.

[0034] In this operation mode No. 1, by the first user side heat exchanger 6 and the second user side heat exchanger 8, the water in the cooled and heated water circulation circuit CW is cooled, so that the air in the house 30 is cooled by the indoor heat exchanger 31. That is, the operation mode No. 1 is a cooling operation mode. In this operation mode No. 1, the refrigerant discharges heat to the air by the two heat source side heat exchangers 4 and 7 and absorbs heat from the water by the two user side heat exchangers 6 and 8, which can therefore improve cooling capabilities by effective use of the heat exchangers.

"Operation mode No. 2 (FIG. 3)"

[0035] The operation mode No. 2 is a heating operation mode solely using the second vapor compression cycle PC2, and is an operation mode used in a case where a heating load in the room is great, for example, at winter nights. This operation mode No. 2 is a mode adopted in a case where "the outside temperature Ths-the set temperature Tuser≤0" and "the indoor temperature Tapp-the set temperature Tuser≤0", for example, a case where the outside temperature Ths is seven degrees Celsius, the set temperature Tuser is 23 degrees Celsius, and the indoor temperature Tapp is 18 degrees Celsius. Note that a refrigerant circulation path in the operation mode No. 2 is directions of the arrows of FIG. 3, and as is clear from comparison between FIGS. 2 and 3, the refrigerant circulation path in the operation mode No. 2 is opposite to the refrigerant circulation path in the operation mode No. 1.

[0036] In this operation mode, first by the vapor compression cycle four-way valve 2, the refrigerant pipe 10 and the refrigerant pipe 19 are communicated to each other and the refrigerant pipe 11 and the refrigerant pipe 20 are communicated to each other. Moreover, by the cycle switching four-way valve 3, the refrigerant pipe 12 and the refrigerant pipe 13 are communicated to each other and the refrigerant pipe 16 and the refrigerant pipe 17 are communicated to each other. Switching between the vapor compression cycle four-way valve 2 and the cycle switching four-way valve 3 in this manner forms the second vapor compression cycle PC2. Here, in the operation mode No. 2, the first expansion valve 5 is adjusted at a predetermined degree of opening, and the second expansion valve 9 is fully open.

[0037] A high-temperature/high-pressure gas refrigerant discharged from the discharge port 1b of the compressor 1 flows into the second user side heat exchanger 8 through the vapor compression cycle four-way valve 2, and dissipates heat to the water circulating in the cooled and heated water circulation circuit CW to be condensed while flowing through the second user side heat exchanger 8. Furthermore, the refrigerant exiting from the second user side heat exchanger 8 sequentially passes through the second expansion valve 9 and the cycle switching four-way valve 3 and flows into the first user side heat exchanger 6, while flowing through the first user side heat exchanger 6, dissipates heat to the water circulating in the cooled and heated water circulation circuit CW to be condensed and finally liquidized. The liquidized refrigerant is depressurized and expanded by the first expansion valve 5 which is adjusted at the predetermined degree of opening, and flows into the first heat source side heat exchanger 4 in a low-temperature/low-pressure vapor-liquid two-phase state.

[0038] This refrigerant in the vapor-liquid two-phase state absorbs heat from the air to be evaporated while flowing through the first heat source side heat exchanger 4, and while passing through the cycle switching four-way valve 3 and flowing through the second heat source side heat exchanger 7, further absorbs heat from the air to be evaporated and is finally gasified. The gasified refrigerant flows into the suction port 1a of the compressor 1 through the vapor compression cycle four-way valve 2, and is compressed again by the compressor 1, turning into a high-temperature/high-pressure gas refrigerant.

[0039] In this operation mode No. 2, by the first user side heat exchanger 6 and the second user side heat exchanger 8, the water in the cooled and heated water circulation circuit CW is heated, so that the air in the house 30 is heated by the indoor heat exchanger 31. That is, the operation mode No. 2 is a heating operation mode. In this operation mode No. 2, the refrigerant absorbs heat from the air by the two heat source side heat exchangers 4 and 7 and dissipates the heat to the water by the two user side heat exchangers 6 and 8, which can therefore improve heating capabilities by effective use of the heat exchangers.

"Operation mode No. 3 (FIG. 4)"

[0040] The operation mode No. 3 is a cooling operation mode using both the natural circulation type cycle TS1 and the first vapor compression cycle PC1, and is a mode used in a case where the outside air temperature is lower than the indoor temperature by some degrees and a cooling load is present, particularly in a case where dehumidification is required (for example, at night during a rainy season). This operation mode No. 3 is a mode adopted in a case where "the outside temperature Ths-the set temperature Tuser≤-5" and also "the indoor temperature Tapp-the set temperature Tusker≥0", for example, a case where the outside temperature Ths is 16 degrees Celsius, the set temperature Tuser is 23 degrees Celsius, and the indoor temperature Tpp is 25 degrees Celsius. Note that in this operation mode No. 3, a refrigerant circulation path is directions of the arrows of FIG. 4.

[0041] In this operation mode, first by the vapor compression cycle four-way valve 2, the refrigerant pipe 10 and the refrigerant pipe 11 are communicated to each other and the refrigerant pipe 19 and the refrigerant pipe 20 are communicated to each other. Moreover, by the cycle switching four-way valve 3, the refrigerant pipe 12 and the refrigerant pipe 17 are communicated to each other and the refrigerant pipe 13 and the refrigerant pipe 16 are communicated to each other. Switching between the vapor compression cycle four-way valve 2 and the cycle switching four-way valve 3 in this manner forms the natural circulation type cycle TS1 and the first vapor compression cycle PC1 independently from each other. Here, in the operation mode No. 3, the first expansion valve 5 is adjusted at a predetermined degree of opening in accordance with an amount of exchanged heat to be obtained by the first user side heat exchanger 6, and the second expansion valve 9 is also adjusted at a predetermined degree of opening.

[0042] On a side of the first vapor compression cycle PC1, a high-temperature/high-pressure gas refrigerant discharged from the discharge port 1b of the compressor 1 flows into the second heat source side heat exchanger 7 through the vapor compression cycle four-way valve 2. The gas refrigerant, while flowing through the second heat source side heat exchanger 7, dissipates heat to the air to be condensed and then liquidized. The liquidized refrigerant is depressurized and expanded by the second expansion valve 9 adjusted at the predetermined degree of opening and flows into the second user side heat exchanger 8 in a low-temperature/low-pressure vapor-liquid two-phase state. This refrigerant in the vapor-liquid two-phase state, while flowing through the second user side heat exchanger 8, absorbs heat from the water circulating in the cooled and heated water circulation circuit CW to be evaporated and then gasified. The gasified refrigerant flows into the suction port 1a of the compressor 1 through the vapor compression cycle four-way valve 2, and is compressed again by the compressor 1, turning into a high-temperature/high-pressure gas refrigerant.

[0043] On the other hand, on a side of the natural circulation type cycle TS1, the refrigerant remaining in the first heat source side heat exchanger 4 dissipates heat to the air to be condensed and then liquidized. The liquidized refrigerant with great density falls down under the influence of gravitational force, passes through the first expansion valve 5, and while flowing through the first user side heat exchanger 6, absorbs heat from the water circulating in the cooled and heated water circulation circuit CW to be evaporated and then gasified. At this point, a pressure gradient due to a refrigerant density difference is provided, so that the evaporated refrigerant flows toward the first heat source side heat exchanger 4.

[0044] In this operation mode No. 3, by the first user side heat exchanger 6 and the second user side heat exchanger 8, the water in the cooled and heated water circulation circuit CW is cooled, so that the air in the house 30 is cooled by the indoor heat exchanger 31. That is, the operation mode No. 3 is a cooling operation mode. According to this operation mode No. 3, the natural circulation type cycle TS1 and the first vapor compression cycle PC1 are both used, and thus, compared to the operation mode No. 1 using the second vapor compression cycle PC2, power consumption can be reduced.

[0045] Further, in a case where the outside air temperature is equal to or lower than the indoor temperature of the house 30 and a difference between the outside air temperature and the indoor temperature is small, natural circulation of the refrigerant using the natural circulation type cycle TS1 is difficult, thus making it difficult to ensure the cooling capabilities. Moreover, in a case where the outside air temperature is equal to or higher than dew-point temperature of the room air, it is difficult to perform dehumidification only by the natural circulation system operation. However, according to the operation mode No. 3, the first vapor compression cycle PC1 is used to forcibly perform the cooling operation, and thus heat exchange is performed between the water circulating in the cooled and heated water circulation circuit CW and the refrigerant flowing through the second user side heat exchanger 8, and cool and hot water supplied to the indoor heat exchanger 31 can be set at desired temperature, making it possible to perform cooling and dehumidification of room air. At this point, the water in the cooled and heated water circulation circuit CW is heat-exchanged with the room air of the house 30 via the indoor heat exchanger 31, turns into water whose temperature is lower than the indoor temperature but higher than the outside air temperature, and returns to the first user side heat exchanger 6, and drains heat by refrigerant evaporation, and water temperature lowers closely to the outside air temperature. The water whose temperature has been lowered closely to the outside air temperature is transmitted to the second user side heat exchanger 2 to be cooled down to desired temperature. That is, operation of the first vapor compression cycle PC assists for insufficient cooling capabilities of the natural circulation type cycle TS1. As described above, particularly even in a case where the difference between the outside air temperature and the indoor temperature is small, the operation mode No. 3 can use both the natural circulation type cycle TS1 and the first vapor compression cycle PC1 to perform efficient cooling operation.

"Operation mode No. 4 (FIG. 5)"

[0046] The operation mode 4 is a cooling operation mode using only the natural circulation type cycle TS1, and is a mode used in a case where the outside air temperature is considerably lower than the indoor temperature and a dehumidification load is small (the indoor temperature has risen due to solar radiation or an internal load, for example, in winter daytime). This operation mode No. 4 is a mode adopted in a case where "the outside temperature Ths-the set temperature Tuser≤-10" and also "the indoor temperature Tapp-the set temperature Tusker≥0", for example, a case where the outside temperature Ths is 10 degrees Celsius, the set temperature Tuser is 23 degrees Celsius, and the indoor temperature Tapp is 25 degrees Celsius. This operation mode No. 4 is the same as the operation mode No. 3 in a point that the natural circulation type cycle TS1 and the first vapor compression cycle PC1 are formed, but is different from the operation mode No. 3 in a point that the operation of the compressor 1 is stopped. That is, a difference between the operation mode No. 3 and the operation mode No. 4 lies in whether or not the compressor 1 is operated. Note that, in this operation mode 4, a refrigerant circulation path is directions of the arrows of FIG. 5.

[0047] In this operation mode No. 4, for example, in a case where the outside air temperature is higher than the indoor temperature, the water in the cooled and heated water circulation circuit CW can be cooled only by the natural circulation type cycle TS1 and heat exchange between the cooled water and the room air of the house 30 can be performed by the indoor heat exchanger 31 to cool the room. As described above, the operation mode No. 4 can cool the room even in a state in which the compressor 1 is stopped, thus permitting dramatic reduction in the power consumption.

[0048] Here, in the embodiment described above, as the refrigerant in the refrigerant pipes, 410a as a fluorocarbon-based refrigerant is used, but instead of this substance, R134a, HFO1234yf, HFO1234ze, or CO2 can also be used. Moreover, in the embodiment described above, water is used as a heat transfer medium to be circulated in the cooled and heated water circulation circuit CW, but instead of this substance, brine such as ethylene glycol may be used. Moreover, in the embodiment described above, configuration such that the cooled and heated water circulation circuit CW is provided by using water as a user side heat transfer medium is adopted, but instead of this configuration, it is also possible to use the air in the house 30 as the user side heat transfer medium to directly perform heat exchange between the user side heat exchangers 6 and 8 and the air in the house 30.

[0049] Moreover, in the embodiment described above, the cycle switching four-way valve 3 is used as cycle switching means, but instead of this configuration, configuration such that two three-way valves are combined together to provide the same function as that of the four-way valve and configuration such that four two-way valves are combined together to provide the same function as that of the four-way valve can be adopted. Here, in a case where the cycle switching four-way valve 3 is used as the cycle switching means, the refrigeration cycle can be switched between a first state in which the natural circulation type cycle TS1 and the first vapor compression cycle PC1 are formed independently from each other only by the single cycle switching four-way valve 3 and a second state in which the second vapor compression cycle PC2 is formed, thus providing advantage that the number of components can be reduced. Adopting the configuration such that the two three-way valves are combined together to provide the same function as that of the four-way valve provides advantage that control for switching the refrigeration cycle is facilitated. Moreover, adopting the configuration such that the four two-way valves are combined together to provide the same function as that of the four-way valve provides advantage that cost reduction can be achieved since the two-way valves are inexpensive.

[Second Embodiment of the Present Invention]

[0050] Next, an air conditioning device according to the second embodiment of the present invention will be described with reference to FIGS. 6 and 7, but for configuration same as that of the air conditioning device according to the first embodiment, the same reference signs are provided and their description will be omitted. In FIG. 7, arrows provided to heat exchangers indicate heat flows. The air conditioning device according to the second embodiment, as shown in FIG. 6, incorporates a first bypass three-way valve (bypass opening and closing means) 41 in the refrigerant pipe 11 which connects together the vapor compression cycle four-way valve 2 and the second heat source side heat exchanger 7, incorporates a second bypass three-way valve (bypass opening and closing means) 42 in the refrigerant pipe 19, which connects together the second user side heat exchanger 8 and the vapor compression cycle four-way valve 2, and connects together the first bypass three-way valve 41 and the second bypass three-way valve 42 with a bypass refrigerant pipe (bypass pipe) 43 to thereby provide a flow path through which the refrigerant bypasses the compressor 1, that is, configuration such that a bypass circuit is formed. The configuration such that the bypass circuit described above is provided is different from that of the first embodiment.

[0051] This difference permits formation of the natural circulation type cycle TS2 using the two heat source side heat exchangers 4 and 7 and the two user side heat exchangers 6 and 8, permitting operation by an operation mode No. 5 described below. Note that, for the formation of the natural circulation type cycle TS2, the heat source side heat exchanger 4 and the second heat source side heat exchanger 7 are installed at substantially the same height positions or the first user side heat exchanger 6 is installed at position lower than the second user side heat exchanger, the first user side heat exchanger 6 and the second user side heat exchanger 8 are installed at substantially the same heights, and also the first heat source side heat exchanger 4 and the second heat source side heat exchanger 7 are installed at the position higher than the first user side heat exchanger 6 and the second user side heat exchanger 8 to thereby provide a head difference.

[0052] To form the natural circulation type cycle TS2, the cycle switching four-way valve 3 is operated to connect together the refrigerant pipe 12 and the refrigerant pipe 13 and connect together the refrigerant pipe 16 and the refrigerant pipe 17. Further, the first bypass three-way valve 41 and the second bypass three-way valve 42 are operated to switch the refrigerant flow path so that the refrigerant flows through the bypass refrigerant pipe 43 without flowing into the compressor 1. This completes the natural circulation type cycle TS2 connecting together, into a circular shape, the second heat source side heat exchanger 7, the cycle switching four-way valve 3, the first heat source side heat exchanger 4, the first expansion valve 5, the first user side heat exchanger 6, the cycle switching four-way valve 3, the second expansion valve 9, the second user side heat exchanger 8, the second bypass three-way valve 42, the bypass refrigerant pipe 43, and a first bypass three-way valve 27. Next, the operation mode No. 5 will be described.

"Operation mode No. 5 (FIG. 7)"

[0053] The operation mode No. 5 is a cooling operation mode using only the natural circulation type cycle TS2, and, as is the case with the operation mode No. 4, is also used in a case where the outside air temperature is considerably lower than the indoor temperature and also a dehumidification load is small (for example, a case where the indoor temperature has risen, for example, in winter daytime due to solar radiation or an internal load). This operation mode No. 5 is a mode adopted in a case where "the outside temperature Ths-the set temperature Tuser≤-10" and also "the indoor temperature Tapp-the set temperature Tuser≥0", for example, Ths is 10 degrees Celsius, the set temperature Tuser is 23 degrees Celsius, and the indoor temperature Tapp is 25 degrees Celsius. In the operation mode No. 5, a refrigerant circulation path is directions of the arrows of FIG. 7.

[0054] In this operation mode, by the cycle switching four-way valve 3, the refrigerant pipe 12 and the refrigerant pipe 13 are communicated to each other and the refrigerant pipe 16 and the refrigerant pipe 17 are communicated to each other. Moreover, by the first bypass three-way valve 41 and the second bypass three-way valve 42, the refrigerant flows through the bypass refrigerant pipe 43 without flowing into the compressor 1. In the operation mode No. 5, the first expansion valve 5 is adjusted at a predetermined degree of opening in accordance with the amount of exchanged heat to be obtained by the first user side heat exchanger 6, and the second expansion valve 9 is fully open. In the operation mode No. 5, the compressor 1 is stopped.

[0055] The refrigerant remaining at the first heat source side heat exchanger 4 and the second heat source side heat exchanger 7 dissipates heat to the air to be condensed and liquidized. The liquidized refrigerant with great density flows toward the first user side heat exchanger 6 and the second user side heat exchanger 8 under the influence of gravitational force. The refrigerant flowing into the first user side heat exchanger 6 and the second user side heat exchanger 8 absorbs heat from the water circulating in the cooled and heated water circulation circuit CW to be evaporated while flowing through the user side heat exchangers 6 and 8, and is raised toward the second heat source side heat exchanger 7 by a pressure gradient provided by a refrigerant density difference. In this manner, the refrigerant is naturally circulated through the natural circulation type cycle TS2 by the density difference.

[0056] In this operation mode No. 5, the natural circulation type cycle TS2 can be formed by using the two heat source side heat exchangers 4 and 7 and the two user side heat exchangers 6 and 8, thus improving the cooling capabilities compared to the natural circulation type cycle TS1 described above. It is needless to say that since the operation by the compressor 1 is not required, high power saving effect is provided in a point that no power is consumed. Since the water in the cooled and heated water circulation circuit CW is cooled by the first user side heat exchanger 6 and the second user side heat exchanger 8, the air in the house 30 is cooled by the indoor heat exchanger 31. That is, the operation mode No. 5 is a cooling operation mode.

[0057] In this operation mode No. 5, the cycle switching four-way valve 3 can also be operated to connect together the refrigerant pipe 12 and the refrigerant pipe 17 and connect together the refrigerant pipe 13 and the refrigerant pipe 16 to thereby form the two natural circulation type cycles including the natural circulation type cycle TS1 and the natural circulation type cycle using the second heat source side heat exchanger 7 and the second user side heat exchanger 8. Listed as advantages in this case are: for example, that it is possible to ensure the cooling capabilities compared to a great circulation system (a system using natural circulation type cycle TS2) since a large temperature difference between the outside air and the water can be provided by the natural circulation type cycle formed by the first user side heat exchanger 6 and the first heat source side heat exchanger 4; or that it is easy to make switching to the operation mode No. 4 in accordance with the outside air temperature or load fluctuation.

[Third Embodiment of the Present Invention]

[0058] Next, an air conditioning device according to the third embodiment of the present invention will be described with reference to FIGS. 8 to 14, and the same configuration as that of the first embodiment will be provided with the same reference signs and thus their description will be omitted. Arrows provided to heat exchangers in FIGS. 9 to 14 indicate heat flows. The air conditioning device according to the third embodiment is configured to use the air in the house 30 as a user side heat transfer medium, halves a second user side heat exchanger 58 into a first divided heat exchanger 58a and a second divided heat exchanger 58b, and be provided with a dehumidification valve (third expansion valve) 51 between a coupling refrigerant pipe 52a and a coupling refrigerant pipe 52b linking together the first divided heat exchanger 58a and the second divided heat exchanger 58b. This configuration is a major difference from the first embodiment. With this configuration, the air conditioning device according to the third embodiment enables operation by a reheating and dehumidification operation mode in which the air in the house 30 is dehumidified while being warmed. Note that, although not shown, an air blower is provided which delivers the air in the house 30 to the first user side heat exchanger 1 and the second user side heat exchangers 58 (the first divided heat exchanger 58a and the second divided heat exchanger 58b).

[0059] The air conditioning device according to the third embodiment, as is the case with the first embodiment, can switch the refrigeration cycle by the cycle switching four-way valve 3 between a first state in which both a natural circulation type cycle TS3 described later and a first vapor compression cycle PC3 can be used and a second state in which a second vapor compression cycle PC4 can be used.

[0060] The natural circulation type cycle TS3 is a cycle formed into a circular shape by connecting together the first heat source side heat exchanger 4 and the first expansion valve 5 with the refrigerant pipe 14, connecting together the first expansion valve 5 and the first user side heat exchanger 6 with the refrigerant pipe 15, connecting together the first user side heat exchanger 6 and the cycle switching four-way valve 3 with the refrigerant pipe 16, and connecting together the cycle switching four-way valve 3 and the first heat source side heat exchanger 4 with the refrigerant pipe 13. Then the refrigerant is naturally circulated through inside of the natural circulation type cycle TS3 by a density difference.

[0061] The first vapor compression cycle PC3 is a cycle formed into a circular shape by connecting together the discharge port 1b of the compressor 1 and the vapor compression cycle four-way valve 2 with the refrigerant pipe 10, connecting together the vapor compression cycle four-way valve 2 and the second heat source side heat exchanger 7 with the refrigerant pipe 11, connecting together the second heat source side heat exchanger 7 and the cycle switching four-way valve 3 with the refrigerant pipe 12, connecting together the cycle switching four-way valve 3 and the second expansion valve 9 with the refrigerant pipe 17, connecting together the second expansion valve 9 and the first divided heat exchanger 58a with the refrigerant pipe 18, connecting together the first divided heat exchanger 58a and the dehumidification valve 51 with the coupling refrigerant pipe 52a, connecting together the dehumidification valve 51 and the second divided heat exchanger 58b with the coupling refrigerant pipe 52b, connecting together the second divided heat exchanger 58b and the vapor compression cycle four-way valve 2 with the refrigerant pipe 19, and connecting together the vapor compression cycle four-way valve 2 and the suction port 1a of the compressor 1 with the refrigerant pipe 20. Then by the compressor 1, the refrigerant is forcibly circulated through inside of the first vapor compression cycle PC3.

[0062] The second vapor compression cycle PC4 is a cycle formed into a circular shape by connecting together the discharge port 1b of the compressor 1 and the vapor compression cycle four-way valve 2 with the refrigerant pipe 10, connecting together the vapor compression cycle four-way valve 2 and the second heat source side heat exchanger 7 with the refrigerant pipe 11, connecting together the second heat source side heat exchanger 7 and the cycle switching four-way valve 3 with the refrigerant pipe 12, connecting together the cycle switching four-way valve 3 and the first heat source side heat exchanger 4 with the refrigerant pipe 13, connecting together the first heat source side heat exchanger 4 and the first expansion valve 5 with the refrigerant pipe 14, connecting together the first expansion valve 5 and the first user side heat exchanger 6 with the refrigerant pipe 15, connecting together the first user side heat exchanger 6 and the cycle switching four-way valve 3 with the refrigerant pipe 16, connecting together the cycle switching four-way valve 3 and the second expansion valve 9 with the refrigerant pipe 17, connecting together the second expansion valve 9 and the first divided heat exchanger 58a with the refrigerant pipe 18, connecting together the first divided heat exchanger 58a and the dehumidification valve 51 with the coupling refrigerant pipe 52a, connecting together the dehumidification valve 51 and the second divided heat exchanger 58b with the coupling refrigerant pipe 52b, connecting together the second divided heat exchanger 58b and the vapor compression cycle four-way valve 2 with the refrigerant pipe 19, and connecting together the vapor compression cycle four-way valve 2 and the suction port 1a of the compressor 1 with the refrigerant pipe 20. Then by the compressor 1, the refrigerant is forcibly circulated through inside of the second vapor compression cycle PC4.

[0063] Next, operations modes that can be performed by the air conditioning device according to the third embodiment will be described. In the air conditioning device according to the third embodiment, as shown below, the six operation modes No. 6 to No. 11 can be performed.

"Operation mode No. 6 (FIG. 9)"

[0064] The operation mode No. 6 is a reheating and dehumidification operation mode solely using the second vapour compression cycle PC4, and is a mode used for load condition that the indoor temperature is higher than the set temperature, the room humidity is slightly higher than set humidity, and heating and cooling and dehumidification are required. This operation mode No. 6 is a mode adopted in a case where "the indoor temperature

Tapp-the set temperature Tusker≥0", also "the room humidity Happ-the set humidity Huser≥0", and also "the outside temperature Ths-the set temperature Tusker≥0", for example, a case where the set humidity Huser is 50%, the room humidity Happ is 60%, the set temperature Tuser is 23 degrees Celsius, the indoor temperature Tapp is 25 degrees Celsius, and the outside temperature Ths is 27 degrees Celsius. Note that in this operation mode No. 6, a refrigerant circulation path is directions of arrows of FIG. 9.

[0065] In this operation mode, first by the vapor compression cycle four-way valve 2, the refrigerant pipe 10 and the refrigerant pipe 11 are communicated to each other and the refrigerant pipe 19 and the refrigerant pipe 20 are communicated to each other. Moreover, by the cycle switching four-way valve 3, the refrigerant pipe 12 and the refrigerant pipe 13 are communicated to each other and the refrigerant pipe 16 and the refrigerant pipe 17 are communicated to each other. Switching between the vapor compression cycle four-way valve 2 and the cycle switching four-way valve 3 in this manner forms the second vapor compression cycle PC4. Here, in the operation mode No. 6, the first expansion valve 5 and the second expansion valve 9 are fully open, and the dehumidification valve 51 is adjusted at a predetermined degree of opening.

[0066] A high-temperature/high-pressure gas refrigerant discharged from the discharge port 1b of the compressor 1, while sequentially flowing through the second heat source side heat exchanger 7 and the first heat source side heat exchanger 4, dissipates heat to the air as the heat source side heat transfer medium to be condensed, and flows into the first user side heat exchanger 6 in a vapor-liquid two-phase state. This refrigerant in the vapor-liquid two-phase state, while flowing through the first user side heat exchanger 6, dissipates heat to the air in the house 30 as the user side heat transfer medium to be thereby condensed, and then while flowing through the first divided heat exchanger 58a, similarly dissipates heat to the air in the house 30 to be further condensed and liquidized. The liquidized refrigerant is depressurized and expanded by the dehumidification valve 51, turning into a vapor-liquid two-phase state. The refrigerant in the vapor-liquid two-phase state, while flowing through the second divided heat exchanger 52b, absorbs heat from the air in the house 30 to be thereby evaporated and gasified. The gasified refrigerant flows into the suction port 1a of the compressor 1, and is compressed again by the compressor 1, turning into a high-temperature/high-pressure gas refrigerant.

[0067] In this operation mode No. 6, by the first user side heat exchanger 6 and the first divided heat exchanger 52a, the air in the house 30 is heated, and by the second divided heat exchanger 52b, the air in the house 30 is cooled and dehumidified.

"Operation mode No. 7 (FIG. 10)"

[0068] The operation mode No. 7 is a reheating and dehumidification operation mode solely using the second vapor compression cycle PC4, and is a mode used for load condition that the indoor temperature is higher than the set temperature, the room humidity is higher than the set humidity, and cooling and dehumidification and heating are required. This operation mode No. 7 is a mode adopted in a case where "the indoor temperature Tapp-the set temperature Tusker≥0", also "the room humidity Happ-the set humidity Huser≥15", and also "the outside temperature Ths-the set temperature Tusker≥0", for example, a case where the set humidity Huser is 50%, the room humidity Happ is 70%, the set temperature Tuser is 23 degrees Celsius, the indoor temperature Tapp is 25 degrees Celsius, and the outside temperature Ths is 27 degrees Celsius.

[0069] In this operation mode No. 7, as is clear through comparison between FIGS. 9 and 10, the refrigerant flows through the same circulation path as that in the operation mode No. 6. However, opening and closing states of the second expansion valve 9 and the dehumidification valve 51 differ between the operation mode No. 6 and the operation mode No. 7, and in the operation mode No. 7, the first expansion valve 5 is fully open, the second expansion valve 9 is adjusted at a predetermined degree of opening, and the dehumidification valve 51 is fully open.

[0070] A high-temperature/high-pressure gas refrigerant discharged from the discharge port 1b of the compressor 1, while sequentially flowing through the second heat source side heat exchanger 7 and the first heat source side heat exchanger 4, dissipates heat to the air as the heat source side heat transfer medium to be condensed, and flows into the first user side heat exchanger 6 in a vapor-liquid two-phase state. This refrigerant in the vapor-liquid two-phase state, while flowing through the first user side heat exchanger 6, dissipates heat to the air in the house 30 as the user side heat transfer medium to be condensed and liquidized. The liquidized refrigerant is depressurized and expanded by the second expansion valve 9, turning into a vapor-liquid two-phase state. The refrigerant turned into the vapor-liquid two-phase state, while flowing through the first divided heat exchanger 58a, absorbs heat from the air in the house 30 to be thereby evaporated, and then while flowing through the second divided heat exchanger 58b, similarly absorbs the heat from the air in the house 30 to be thereby further evaporated and gasified. The gasified refrigerant flows into the suction port 1a of the compressor 1, and is compressed again by the compressor 1, turning into a high-temperature/highpressure gas refrigerant.

[0071] In this operation mode No. 7, the air in the house 30 is heated by the first user side heat exchanger 6, and the room air in the house 30 is cooled and dehumidified by the first divided heat exchanger 52a and the second divided heat exchanger 52b.

"Operation mode No. 8 (FIG. 11)"

[0072] The operation mode No. 8 is a reheating and dehumidification operation mode solely using the second vapor compression cycle PC4, and is a mode used for load condition that the indoor temperature is lower than the set temperature, the room humidity is higher than the set humidity, and heating and cooling and dehumidification are required. This operation mode No. 8 is a mode adopted in a case where "the room temperature Tapp-the set temperature Tuser≤0", also "the room humidity Happ-the set humidity Huser>10", and also "the outside temperature Ths-the set temperature Tuse≤0", for example, a case where the set humidity Huser is 50%, the room humidity Happ is 70%, the set temperature Tuser is 23 degrees Celsius, the indoor temperature Tapp is 20 degrees Celsius, and the outside temperature Ths is 18 degrees Celsius. Note that a refrigerant circulation path in the operation mode No. 8 is directions of arrows of FIG. 11 and is a path opposite to that of the operation mode No. 6.

[0073] In this operation mode, first by the vapor compression cycle four-way valve 2, the refrigerant pipe 10 and the refrigerant pipe 19 are communicated to each other and the refrigerant pipe 11 and the refrigerant pipe 20 are communicated to each other. Moreover, by the cycle switching four-way valve 3, the refrigerant pipe 12 and the refrigerant pipe 13 are communicated to each other and the refrigerant pipe 16 and the refrigerant pipe 17 are communicated to each other. Here, in the operation mode No. 8, the first expansion valve 5 and the second expansion valve 9 are fully open, and the dehumidification valve 51 is adjusted at a predetermined degree of opening.

[0074] A high-temperature/high-pressure gas refrigerant discharged from the discharge port 1b of the compressor 1, while flowing through the second divided heat exchanger 58b, dissipates heat to the air in the house 30 as the user side heat transfer medium to be condensed and liquidized. The liquidized refrigerant is depressurized and expanded by the dehumidification valve 51, turning into a vapor-liquid two-phase state. The refrigerant in the vapor-liquid two-phase state, while flowing through the first divided heat exchanger 58a, absorbs heat from the air in the house 30 to be evaporated, and then while flowing through the first user side heat exchanger 6, similarly absorbs the heat from the air in the house 30 to be further evaporated. Then the refrigerant in the vapor-liquid two-phase state exiting from the first user side heat exchanger 6, while flowing through the first heat source side heat exchanger 4 and the second heat source side heat exchanger 7, absorbs heat from the air as the heat source side heat transfer medium to be evaporated and then gasified. The gasified refrigerant flows into the suction port 1a of the compressor 1 and is compressed again by the compressor 1, turning into a high-temperature/high-pressure gas refrigerant.

[0075] In this operation mode No. 8, the air in the house 30 is cooled and dehumidified by the first user side heat exchanger 6 and the first divided heat exchanger 52a, and the air in the house 30 is heated by the second divided heat exchanger 52b.

"Operation mode No. 9 (FIG. 12)"

[0076] The operation mode No. 9 is a reheating and dehumidification operation mode solely using the second vapor compression cycle PC4, and is a mode used for load condition that the indoor temperature is lower than the set temperature, the room humidity is slightly higher than the set humidity, and heating and slight dehumidification are required. This operation mode No. 9 is a mode adopted in a case where "the indoor temperature Tapp-the set temperature Tuser≤0", "the room humidity Happ-the set humidity Huser≥0", and also "the outside temperature Ths-the set temperature Tuser≤0", for example, a case where the set humidity Huser is 50%, the room humidity Happ is 60%, the set temperature Tuser is 23 degrees Celsius, the indoor temperature Tapp is 20 degrees Celsius, and the outside temperature Ths is 18 degrees Celsius. Note that in this operation mode No. 9, a refrigerant circulation path is directions of arrows of FIG. 12 and a path opposite to that of the operation mode No. 7.

[0077] In this operation mode, first by the vapor compression cycle four-way valve 2, the refrigerant pipe 10 and the refrigerant pipe 19 are communicated to each other and the refrigerant pipe 11 and the refrigerant pipe 20 are communicated to each other. Moreover, by the cycle switching four-way valve 3, the refrigerant pipe 12 and the refrigerant pipe 13 are communicated to each other and the refrigerant pipe 16 and the refrigerant pipe 17 are communicated to each other. Here, in the operation mode No. 9, the first expansion valve 5 is fully open, the second expansion valve 9 is adjusted at a predetermined degree of opening, and the dehumidification valve 51 is fully open.

[0078] A high-temperature/high-pressure gas refrigerant discharged from the discharge port 1b of the compressor 1, while flowing through the second divided heat exchanger 58b, dissipates heat to the air in the house 30 as the user side heat transfer medium to be condensed, and then while flowing through the first divided heat exchanger 58a, similarly dissipates heat to the air in the house 30 to be condensed and liquidized. The liquidized refrigerant is depressurized and expanded by the second expansion valve 9 to be evaporated, turning into a vapor-liquid tow-phase state. The refrigerant in the vapor-liquid two-phase state, while flowing through the first user side heat exchanger 6, absorbs heat from the air in the house 30 to be further evaporated. Then the refrigerant in the vapor-liquid two-phase state exiting from the first user side heat exchanger 6, while flowing through the first heat source side heat exchanger 4 and the second heat source side heat exchanger 7, absorbs heat from the air as the heat source side heat transfer medium to be evaporated and gasified. The gasified refrigerant flows into the suction port 1a of the compressor 1 and is compressed again by the compressor 1, turning into a high-temperature/high-pressure gas refrigerant.

[0079] In this operation mode No. 9, the air in the house 30 is cooled and dehumidified by the first user side heat exchanger 6, and the air in the house 30 is heated by the first divided heat exchanger 58a and the second divided heat exchanger 58b.

"Operation mode No. 10 (FIG. 13)"

[0080] The operation mode No. 10 is a reheating and dehumidification operation mode using both the natural circulation type cycle TS3 and the first vapor compression cycle PC3, and is a mode used for load condition that the indoor temperature is slightly higher than the set temperature and the room humidity is higher than the set humidity and thus cooling and dehumidification and heating are required, and in a case where the outside air temperature is considerably lower than the indoor temperature. This operation mode No. 10 is a mode adopted in a case where "the indoor temperature Tapp-the set temperature Tuser≤0", also "the room humidity Happ-the set humidity Huser≥0", and also "the outside temperature Ths-the set temperature Tuser≤-10", for example, a case where the set humidity Huser is 50%, the room humidity Happ is 70%, the set temperature Tuser is 23 degrees Celsius, the indoor temperature Tapp is 25 degrees Celsius, and the outside temperature Ths is 10 degrees Celsius. Note that in this operation mode No. 10, a refrigerant circulation path is directions of arrows of FIG. 13.

[0081] In this operation mode, first by the vapor compression cycle four-way valve 2, the refrigerant pipe 10 and the refrigerant pipe 11 are communicated to each other and the refrigerant pipe 19 and the refrigerant pipe 20 are communicated to each other. Moreover, by the cycle switching four-way valve 3, the refrigerant pipe 12 and the refrigerant pipe 17 are communicated to each other and the refrigerant pipe 13 and the refrigerant pipe 16 are communicated to each other. In the operation mode No. 10, the first expansion valve 5 is adjusted at a predetermined degree of opening in accordance with the amount of exchanged heat to be obtained by the first user side heat exchanger 6, the second expansion valve 9 is fully open, and the dehumidification valve 51 is adjusted at a predetermined degree of opening.

[0082] On a side of the first vapor compression cycle PC3, a high-temperature/high-pressure gas refrigerant discharged from the discharge port 1b of the compressor 1, while flowing through the second heat source side heat exchanger 7, dissipates heat to the air as the heat source side heat transfer medium to be condensed, and flows in a vapor-liquid two-phase state into the first divided heat exchanger 58a. The refrigerant in the vapor-liquid two-phase state, while flowing through the first divided heat exchanger 58a, dissipates heat to the air in the house 30 as the user side heat transfer medium to be condensed and liquidized. The liquidized refrigerant is depressurized and expanded by the dehumidification valve 51, turning into a vapor-liquid two-phase state. The refrigerant in the vapor-liquid two-phase state, while flowing through the second divided heat exchanger 52b, absorbs heat from the air in the house 30 to be evaporated and gasified. The gasified refrigerant flows into the suction port 1a of the compressor 1 and is compressed again by the compressor 1, turning into a high-temperature/high-pressure gas refrigerant.

[0083] On the other hand, on a side of the natural circulation cycle TS3, the refrigerant remaining at the first heat source side heat exchanger 4 dissipates heat to the air to be condensed and liquidized. The liquid refrigerant with great density falls down under the influence of gravitational force, passes through the first expansion valve 5, and while flowing through the first user side heat exchanger 6, absorbs heat from the air in the house 30 to be evaporated. At this point, a pressure gradient due to a refrigerant density difference is provided, and thus the evaporated refrigerant flows toward the first heat source side heat exchanger 4.

[0084] In this operation mode No. 10, the air in the house 30 is cooled by the first user side heat exchanger 6, is reheated by the first divided heat exchanger 58a, and is cooled and dehumidified by the second divided heat exchanger 58b. Therefore, even in a case where the outside air temperature is equal to or lower than the indoor temperature of the house 30 and a difference between the outside air temperature and the indoor temperature is small, by using both the natural circulation type cycle TS3 and the first vapor compression cycle PC3, it is possible to perform appropriate cooling and dehumidification and heating, providing desired temperature and humidity environment. Therefore, compared to the natural circulation cycle, dehumidification capabilities can be improved.

"Operation Mode No. 11 (FIG. 14)"

[0085] The operation mode No. 11 is a reheating and dehumidification operation mode using both the natural circulation type cycle TS3 and the first vapor compression cycle PC3 and is a mode used for load condition that the indoor temperature is lower than the set temperature but the room humidity is higher than the set temperature and thus heating and dehumidification are required, and in a case where the outside air temperature is considerably lower than the indoor temperature. This operation mode No. 11 is a mode adopted in a case where "the indoor temperature Tapp-the set temperature Tuser≤0", also "the room humidity Happ-the set humidity Huser≥0", and also "the outside temperature Ths-the set temperature Tuser≤-10", for example, a case where the set humidity Huser is 50%, the room humidity Happ is 70% and the set temperature Tuser is 23 degrees Celsius, the indoor temperature Tapp is 21 degrees Celsius, and the outside temperature Ths is 10 degrees Celsius.

Note that a refrigerant circulation path in this operation mode No. 11 is directions of arrows of FIG. 14, and a direction of a refrigerant circulation path in the first vapor compression cycle PC3 is opposite to that of the operation mode No. 10 as is clear from comparison between FIGS. 13 and 14.

[0086] In this operation mode, first by the vapor compression cycle four-way valve 2, the refrigerant pipe 10 and the refrigerant pipe 19 are communicated to each other and the refrigerant pipe 11 and the refrigerant pipe 20 are communicated to each other. Moreover, by the cycle switching four-way valve 3, the refrigerant pipe 12 and the refrigerant pipe 17 are communicated to each other and the refrigerant pipe 13 and the refrigerant pipe 16 are communicated to each other. In the operation mode No. 11, the first expansion valve 5 is adjusted at a predetermined degree of opening in accordance with the amount of exchanged heat to be obtained by the first user side heat exchanger 6, the second expansion valve 9 is fully open, and the dehumidification valve 51 is adjusted at a predetermined degree of opening.

[0087] On a side of the first vapor compression cycle PC3, a high-temperature/high-pressure gas refrigerant discharged from the discharge port 1b of the compressor 1, while flowing through the second divided heat exchanger 58b, dissipates heat to the air in the house 30 as the user side heat transfer medium to be condensed and liquidized. The liquidized refrigerant is depressurized and expanded by the dehumidification valve 51, turning into a vapor-liquid two-phase state. The refrigerant in the vapor-liquid two-phase state, while flowing through the first divided heat exchanger 58a, absorbs heat from the air in the house 30 to be evaporated, and further while flowing through the second heat source side heat exchanger 7, absorbs heat from the air as the heat source side heat transfer medium to be evaporated and gasified. The gasified refrigerant flows into the suction port 1a of the compressor 1 and is compressed again by the compressor 1, turning into a high-temperature/high-pressure gas refrigerant.

[0088] On the other hand, on a side of the natural circulation cycle TS3, the refrigerant remaining at the first heat source side heat exchanger 4 dissipates heat to the air to be condensed and liquidized. The liquid refrigerant with great density falls down under the influence of gravitational force, passes through the first expansion valve 5, and while flowing through the first user side heat exchanger 6, absorbs heat from the air in the house 30 to be evaporated. At this point, a pressure gradient due to a refrigerant density difference is provided, and thus the evaporated refrigerant flows toward the first heat source side heat exchanger 4.

[0089] In this operation mode No. 11, the air in the house 30 is cooled by the first user side heat exchanger 6, is cooled and dehumidified by the first divided heat exchanger 58a, and is reheated by the second divided heat exchanger 58b. Therefore, even in a case where the outside air temperature is equal to or lower than the indoor temperature of the house 30 and, in particular, a case where a difference between the outside air temperature and the room temperature is small, by using both the natural circulation type cycle TS3 and the first vapor compression cycle PC3, it is possible to perform appropriate cooling and dehumidification and heating, providing desired temperature and humidity environment. Therefore, compared to the natural circulation cycle, the dehumidification capabilities can be improved.

[0090] Needless to say, in the air conditioning device according to the third embodiment, stopping the compressor 1 in the operation mode No. 11 permits performance of operation using only the natural circulation type cycle TS3.

[Fourth Embodiment of the Present Invention]

[0091] Next, an air conditioning device according to the fourth embodiment of the present invention will be described with reference to FIG. 15, and the same configuration as that of the air conditioning device according to the first embodiment will be provided with the same reference signs and their description will be omitted. The air conditioning device according to the fourth embodiment is characterized by configuration such that an intermediate hot water circulation circuit (heat source side heat transfer medium circulation circuit) MW including the second heat source side heat exchanger 7 is formed and water is circulated as the heat source side heat transfer medium in this intermediate hot water circulation circuit MW.

[0092] The intermediate hot water circulation circuit MW is a circular-shaped circuit formed by connecting together the second heat source side heat exchanger 7 and a heat storage tank 61 with intermediate hot water pipes (heat source side heat transfer medium pipes) 62 and 63. Then by a circulation pump, not shown, the water forcibly circulates in the intermediate hot water circulation circuit MW. The heat storage tank 61 is filled with a heat storage material.

[0093] In the air conditioning device according to the fourth embodiment configured in such a manner, for example, as a result of performing operation by the operation mode No. 1 and the operation mode No. 3 described above, heat of the refrigerant is discharged to outside by the second heat source side heat exchanger 7, and the water flowing inside the intermediate hot water circulation circuit MW absorbs the heat of the second heat source side heat exchanger 7 therefrom. The heat absorbed by the water is stored by the heat storage tank 61 and the water circulating inside the intermediate hot water circulation circuit MW turns into intermediate hot water. As described above, according to the fourth embodiment, the heat discharged by the second heat source side heat exchanger 7 can effectively be used to produce the intermediate hot water. Typically, while demands for indoor cooling is great for daytime, demands for hot water supply is great for night time, but with the air conditioning device according to the fourth embodiment, the heat discharged by the second heat source side heat exchanger 7 upon cooling operation in daytime can be used to store the intermediate hot water in the heat storage tank 61, thus making it possible to use the intermediate hot water in the heat storage tank 61 for the hot water supply, achieving effective energy usage. Needless to say, a solar heat collector can be connected to the heat storage tank 61 to permit use of recyclable energy.

[0094] Moreover, the second heat source side heat exchanger 7 can also be used as an evaporator for a hot water supply cycle. More specifically, as shown in FIG. 15, a hot water supply compressor 71, a hot water supply condenser 72, a hot water supply expansion valve 73, and the second heat source side heat exchanger 7 are sequentially connected with hot water supply refrigerant pipes 74a to 74d to form the circular-shaped hot water supply cycle, and the hot water supply condenser 72 and a hot water storage tank 75 are connected with hot water supply pipes 76 and 77 to construct a hot water supply system for hot water supply. In the hot water supply cycle, a hot water supply refrigerant in a vapor-liquid two-phase state depressurized and expanded by the hot water supply expansion valve 73 absorbs heat from the second heat source side heat exchanger 7 to be evaporated and gasified. That is, in the hot water supply cycle, the second heat source side heat exchanger 7 functions as an evaporator. In this example, the heat source side heat transfer medium heat-exchanged with the second heat source side heat exchanger 7 turn into a hot water supply refrigerant. With this configuration, the second heat source side heat exchanger 7 can be used for both the hot water supply system and an air conditioning system, thus permitting cost reduction. Note that as the hot water supply refrigerant, any of, for example, R134a, HFO1234yf, HFO1234ze, and CO_2 may be used.

[0095] As described above, according to the embodiments described above, the heat exchanger used for the natural cycle can be used as a heat exchanger for the vapor compression cycle, thus permitting improvement in heat exchange efficiency. Moreover, in the embodiments described above, both the natural circulation type cycle and the vapor compression cycle can be used, thus permitting improvement in the dehumidification capabilities even in a case where the outside air temperature is equal to or lower than the indoor temperature and when the difference between the outside air temperature and the indoor temperature is small. Moreover, in the embodiments described above, the heat discharged by the heat exchanger can be used for water supply or hot water supply facilities, thus permitting effective energy usage.

REFERENCE SIGN LIST

[0096]

1 Compressor,
1a Suction port,
1b Discharge port,
2 Vapor compression cycle four-way valve (flow path switching valve),
3 Cycle switching four-way valve (cycle switching means),
4 First heat source side heat exchanger,
5 First expansion valve,
6 First user side heat exchanger,
7 Second heat source side heat exchanger,
8 Second user side heat exchanger,
9 Second expansion valve,
10 to 20 Refrigerant pipe,
30 House (cooled space),
31 Indoor heat exchanger,
32 Circulation pump,
33 Cooled and heated water circuit four-way valve,
35 to 40 Cooled and heated water pipe (user side heat transfer medium pipe),
41 First bypass three-way valve (bypass opening and closing means),
42 Second bypass three-way valve (bypass opening and closing means),
43 Bypass refrigerant pipe (bypass pipe),
51 Dehumidification valve (third expansion valve),
52a, 52b Coupling refrigerant pipe,
58a First divided heat exchanger,
58b Second divided heat exchanger,
61 Heat storage tank,
62, 63 Intermediate hot water pipe (heat source side heat transfer medium pipe),
71 Hot water supply compressor,
72 Hot water supply condenser,
73 Hot water supply expansion valve,
74a to 74b Hot water supply refrigerant pipe,
75 Hot water storage tank,
76, 77 Hot water supply pipe,
TS1 to TS3 Natural circulation type cycle,
PC1, PC3 First vapor compression cycle,
PC2, PC4 Second vapor compression cycle,
CW Cooled and heated water circulation circuit (user side heat transfer medium circulation circuit),
MW Intermediate hot water circulation circuit (heat source side heat transfer medium circulation circuit).

Claims

1. An air conditioning device comprising: a compressor; first and second heat source side heat exchangers making heat exchange between a heat source side heat transfer medium and a refrigerant; first and second user side heat exchangers making heat exchange between a user side heat transfer medium and the refrigerant; a flow path switching valve switching a flow direction of the refrigerant; and first and second expansion valves, the air conditioning device being capable of forming at least three refrigeration cycles including:

a natural circulation type cycle being formed into a circular shape by sequentially connecting the first heat source side heat exchanger, the first expansion valve, and the first user side heat exchanger installed at a position lower than the first heat source side heat exchanger with refrigerant pipes, wherein the refrigerant is naturally circulated by a density difference;
a first vapor compression cycle being formed into a circular shape by sequentially connecting a discharge port of the compressor, the flow path switching valve, the second heat source side heat exchanger, the second expansion valve, the second user side heat exchanger, and a suction port of the compressor with refrigerant pipes, wherein the refrigerant is forcibly circulated by the compressor; and
a second vapor compression cycle being formed into a circular shape by sequentially connecting the discharge port of the compressor, the flow path switching valve, the second heat source side heat exchanger, the first heat source side heat exchanger, the first expansion valve, the first user side heat exchanger, the second user side heat exchanger, and the suction port of the compressor with refrigerant pipes, wherein the refrigerant is forcibly circulated by the compressor, the air conditioning device further comprising
cycle switching means adapted to switch the refrigeration cycle between a first state in which the natural circulation type cycle and the first vapor compression cycle are formed independently and a second state in which the second vapor compression cycle is formed.

2. The air conditioning device according to claim 1, wherein the first user side heat exchanger, the second user side heat exchanger, and an indoor heat exchanger installed in a cooled space are sequentially connected with user side heat transfer medium pipes to form a circular-shaped user side heat transfer medium circulation circuit, and
water or brine as the user side heat transfer medium is forcibly circulated through the user side heat transfer medium circulation circuit.

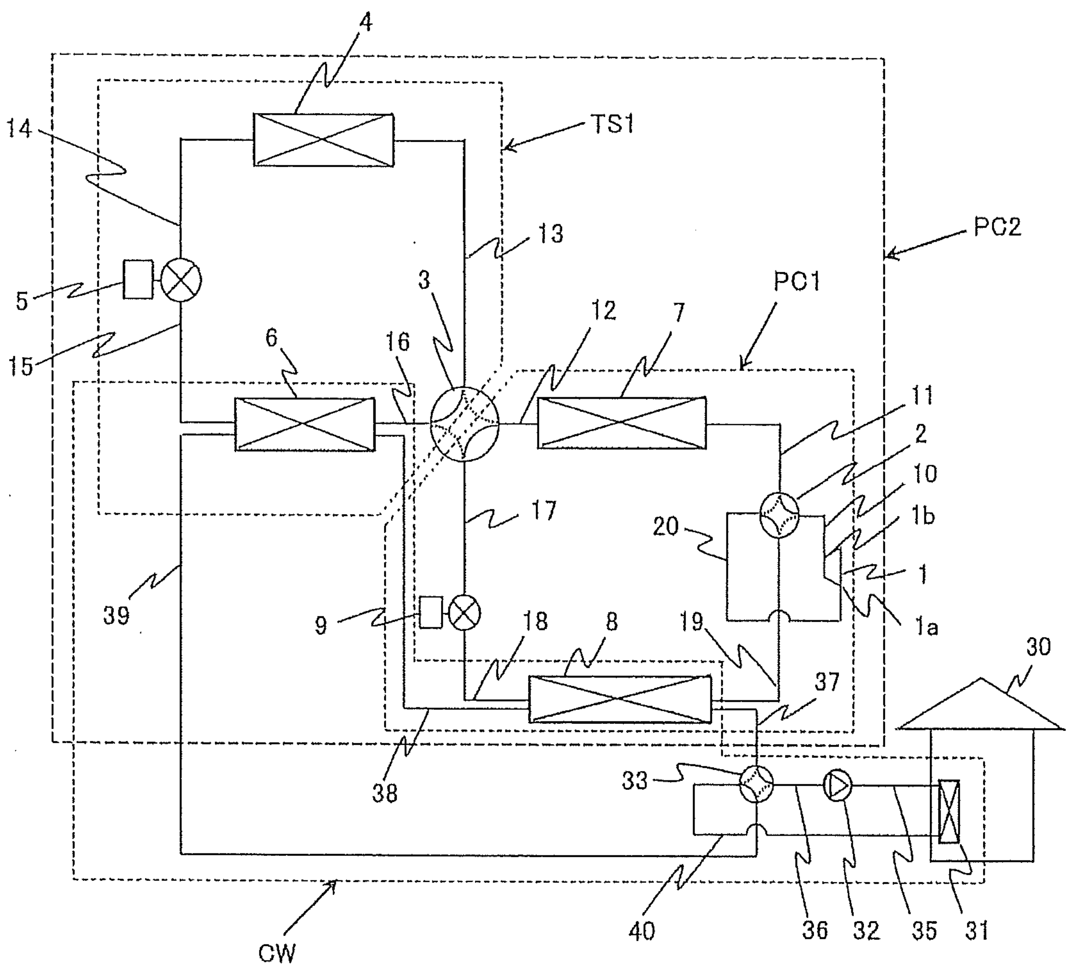
3. The air conditioning device according to claim 1 or 2, wherein the second user side heat exchanger is halved into a first divided heat exchanger and a second divided heat exchanger, and a third expansion valve is provided at a coupling refrigerant pipe linking together the first divided heat exchanger and the second divided heat exchanger.

4. The air conditioning device according to any one of claims 1 through 3,
wherein the second heat source side heat exchanger and a heat storage tank are connected together with a heat source side heat transfer medium pipe to form a circular-shaped heat source side heat transfer medium circulation circuit, and
water as the heat source side heat transfer medium is forcibly circulated through the heat source side heat transfer medium circulation circuit.

5. The air conditioning device according to any one of claims 1 through 3,
wherein a hot water supply compressor, a hot water supply user side heat exchanger, a hot water supply expansion valve, and the second heat source side heat exchanger are sequentially connected with hot water supply refrigerant pipes to form a circular-shaped hot water supply cycle, and
a hot water supply refrigerant as the heat source side heat transfer medium is forcibly circulated through the hot water supply cycle by the hot water supply compressor.

6. The air conditioning device according to any one of claims 1 through 5, further comprising: a bypass pipe bypassing the suction port and the discharge port of the compressor; and bypass opening and closing means adapted to switch a refrigerant flow path between a flow path extending through the compressor and a flow path extending through the bypass pipe.

FIG. 1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PC2
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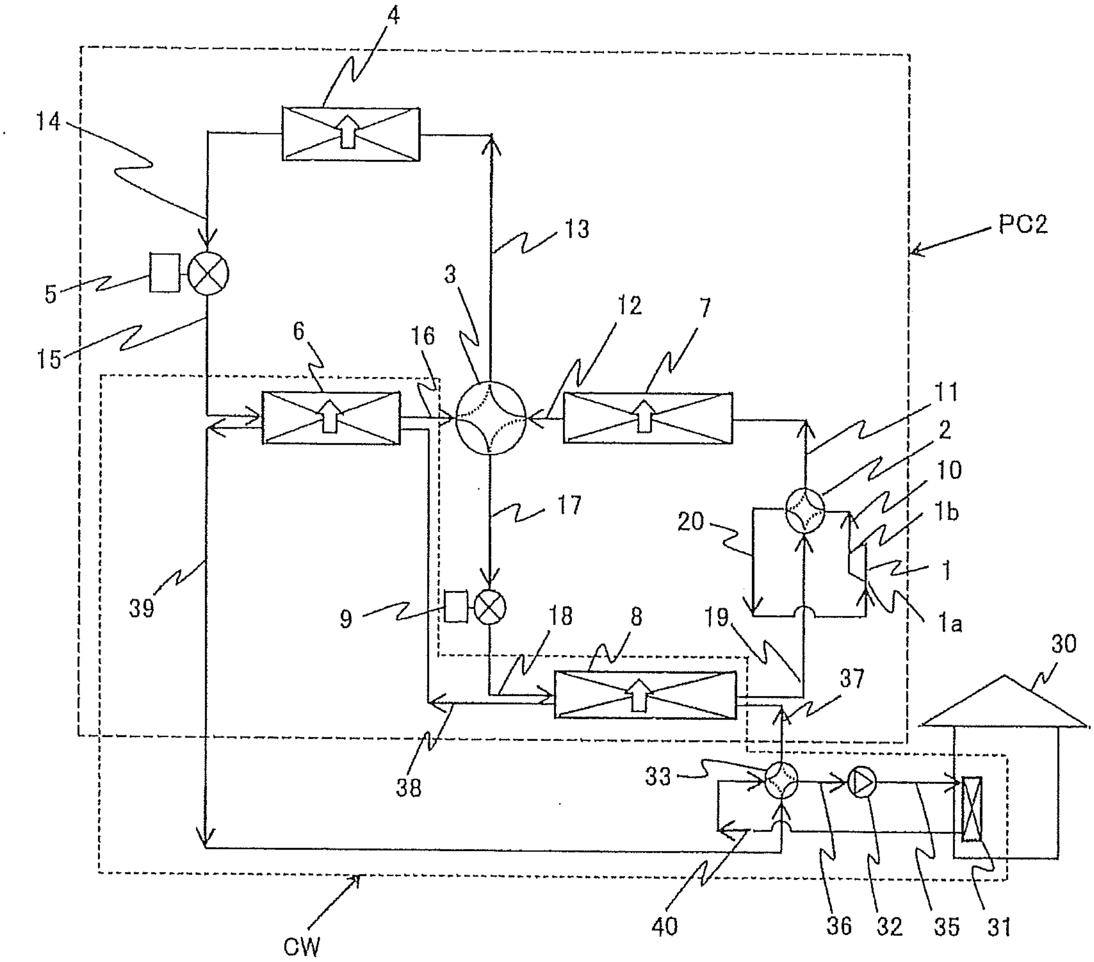
CW

FIG. 2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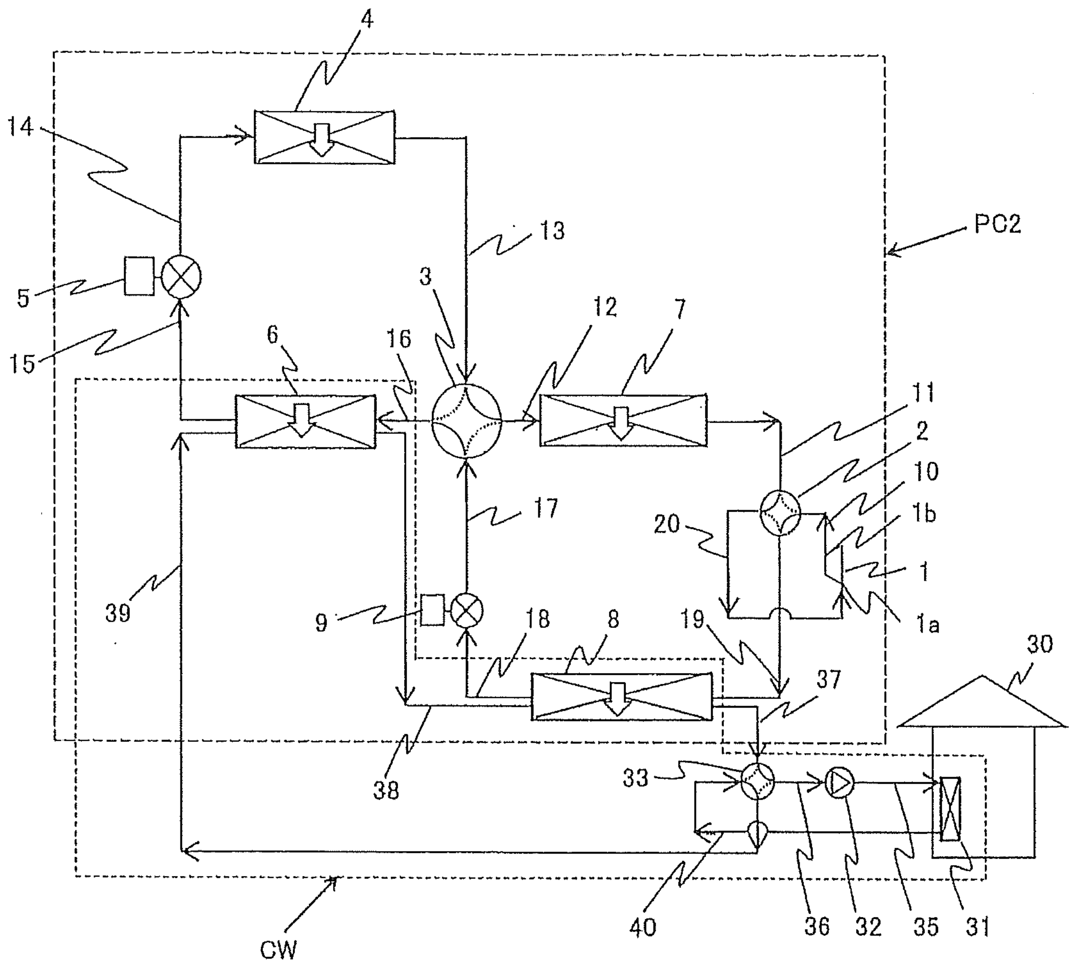
CW

FIG. 3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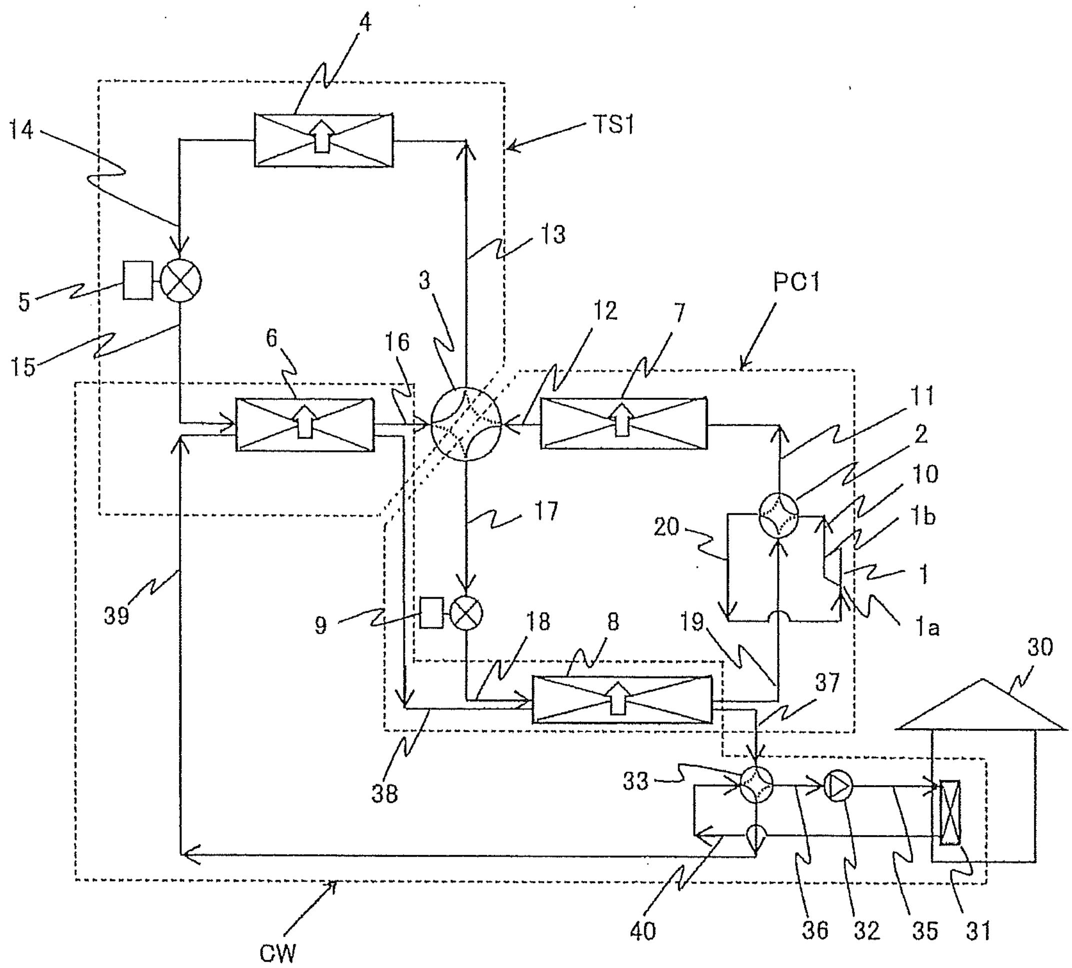
CW

FIG. 4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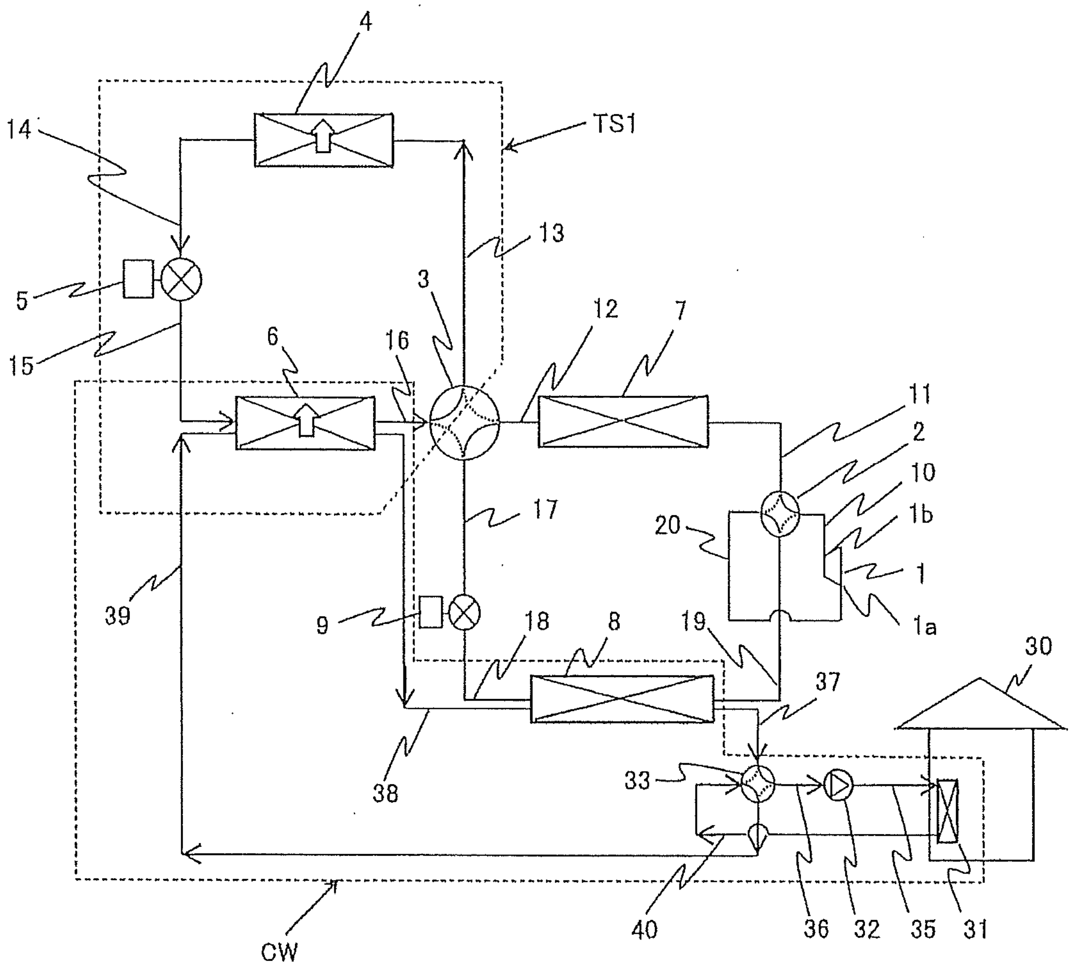
CW

FIG. 5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CW

FIG. 6

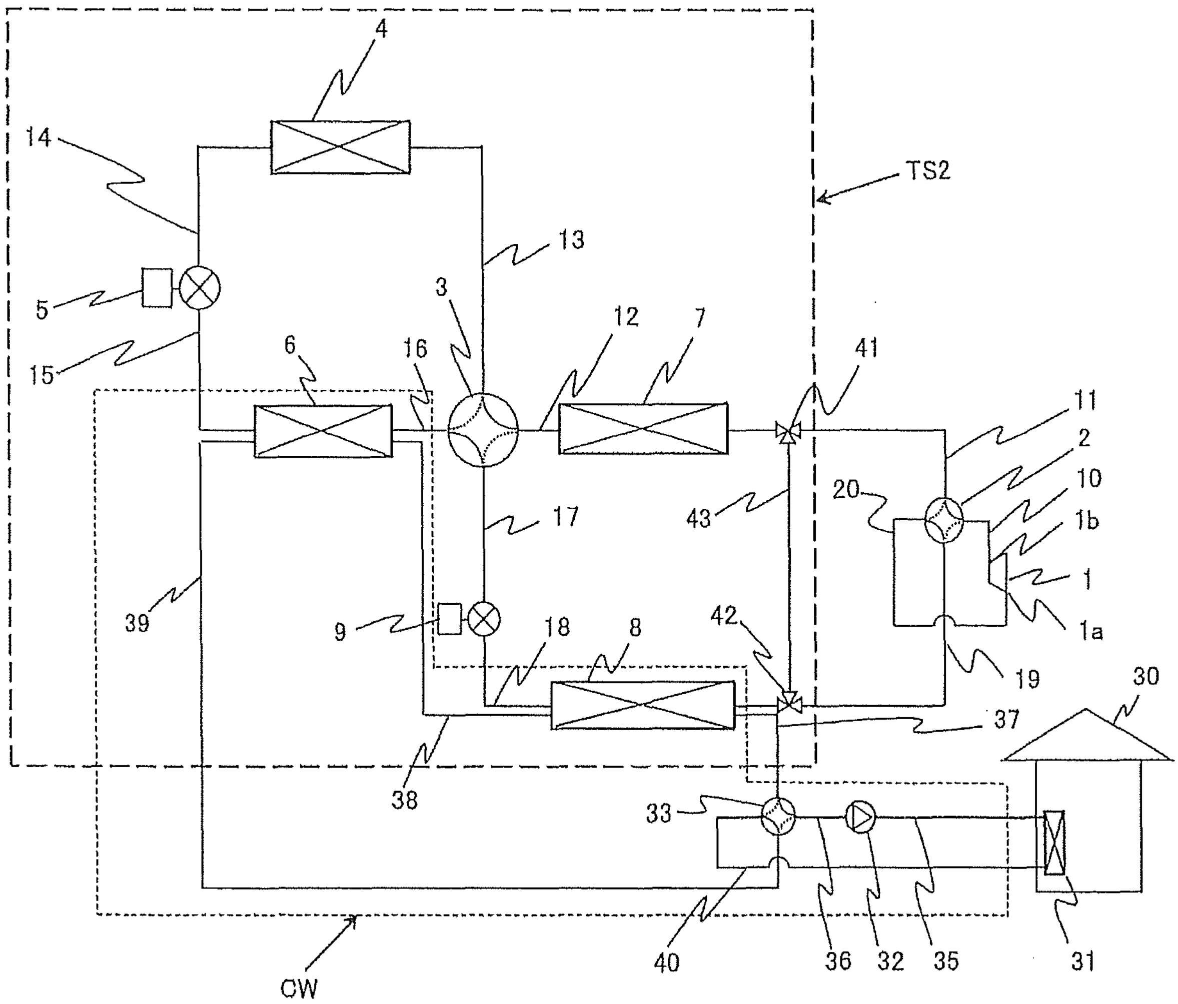
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FIG. 7

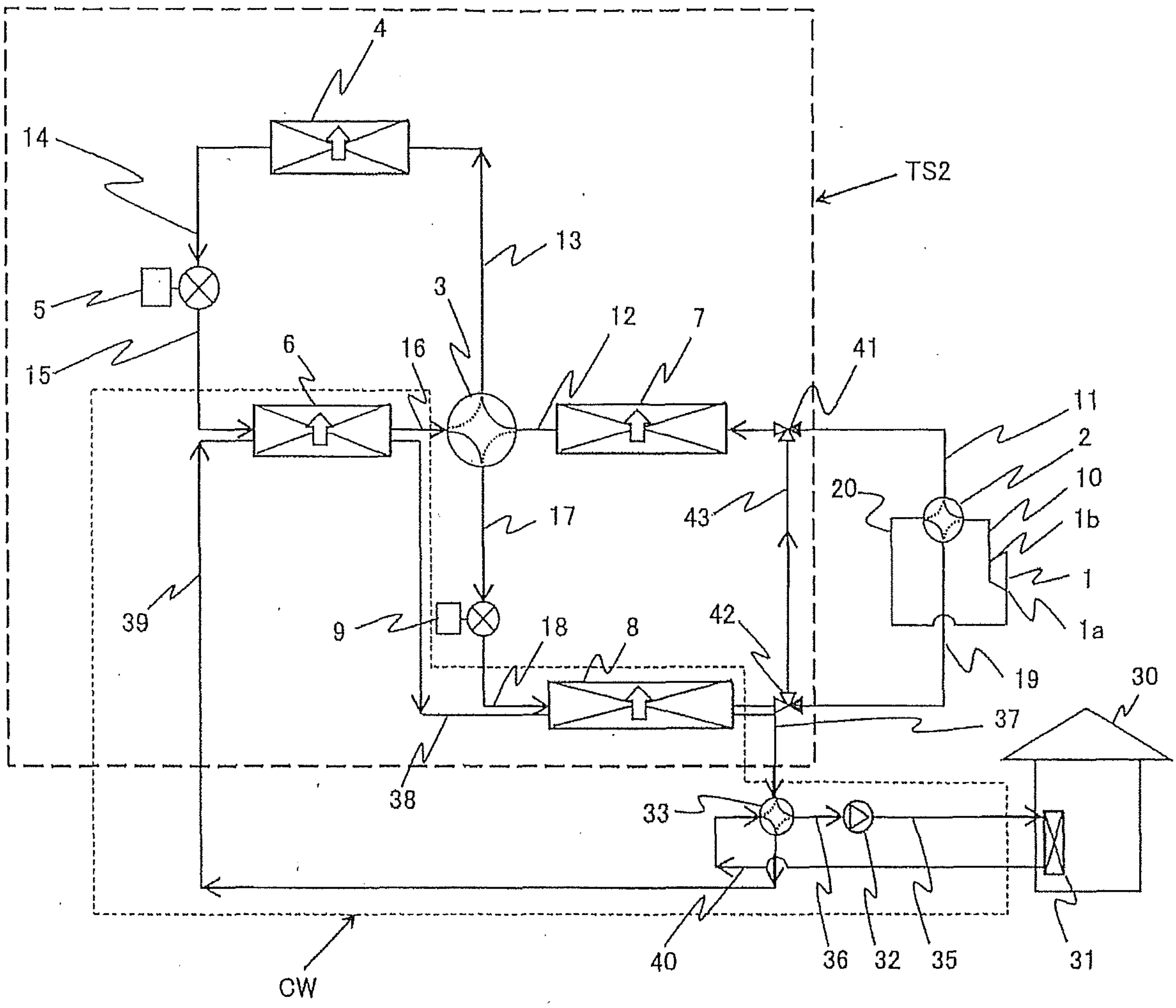

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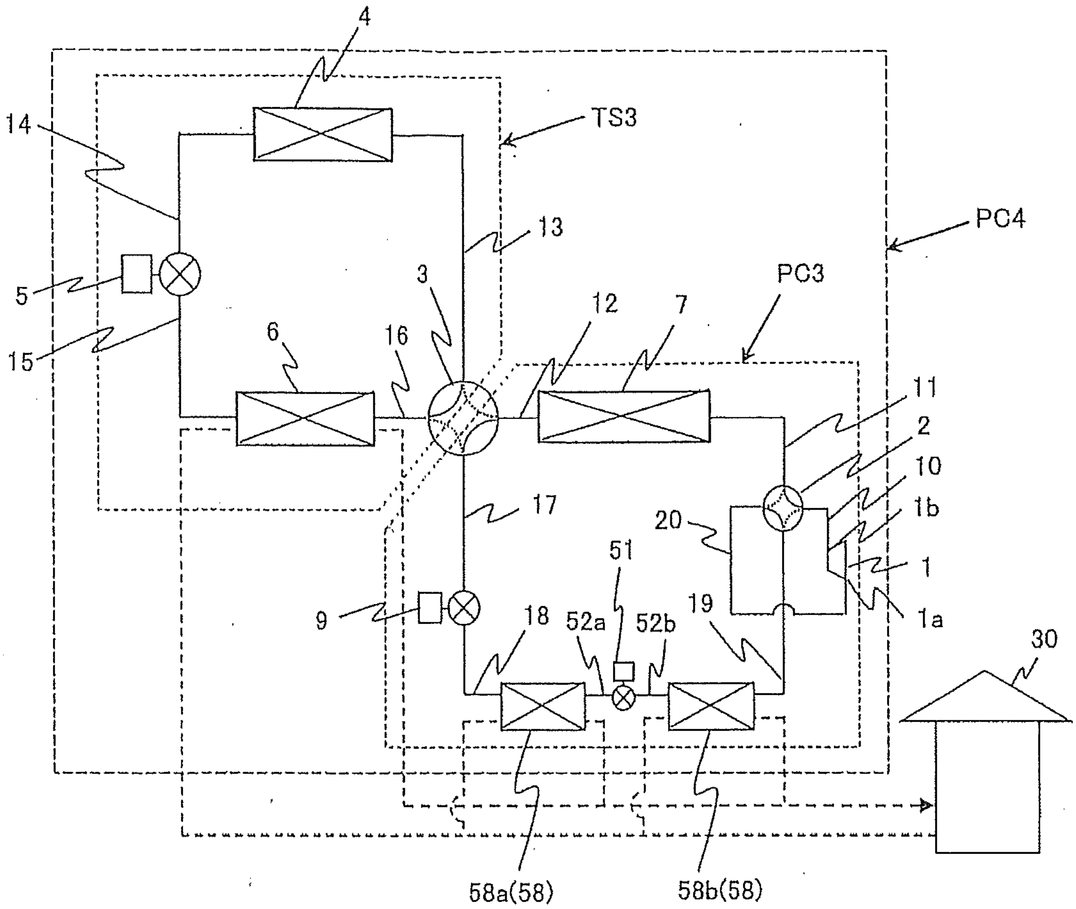
FIG. 8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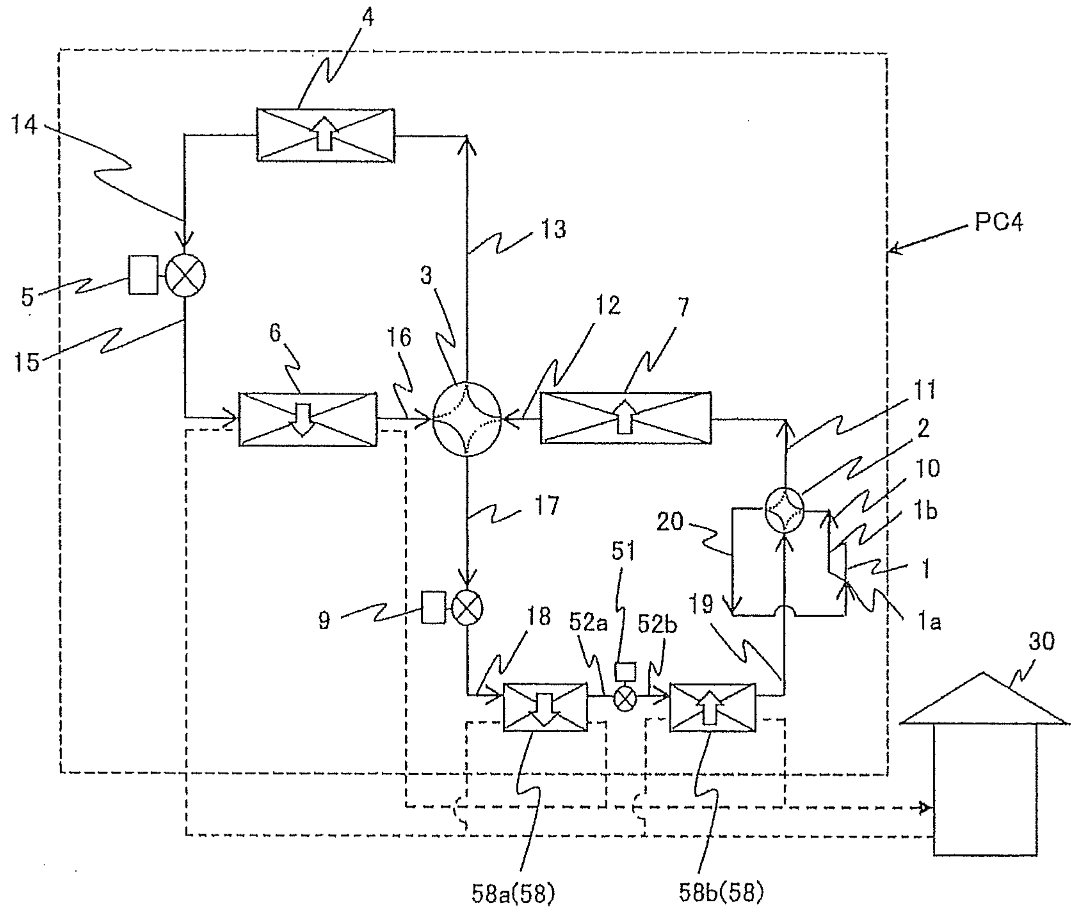
58a(58)
58b(58)

FIG. 9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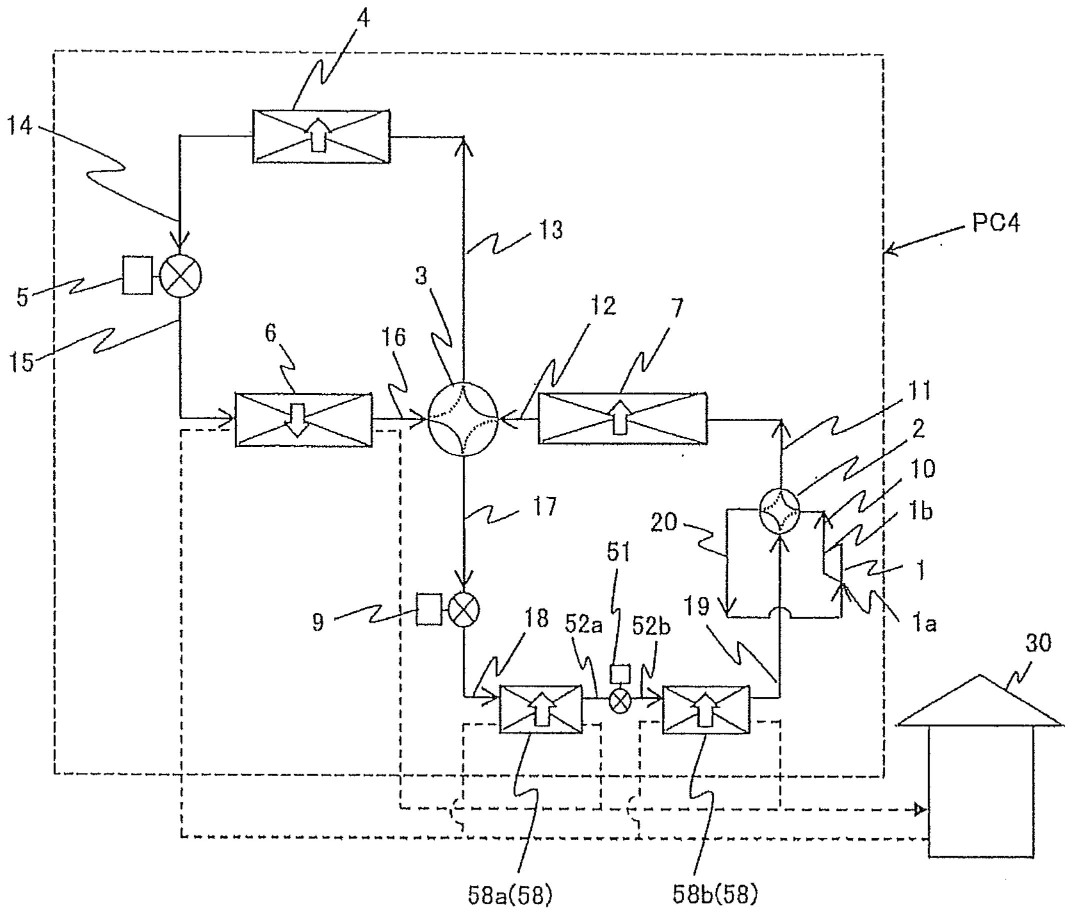
58b(58)

FIG.10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58a(58)
58b(58)

FIG.11

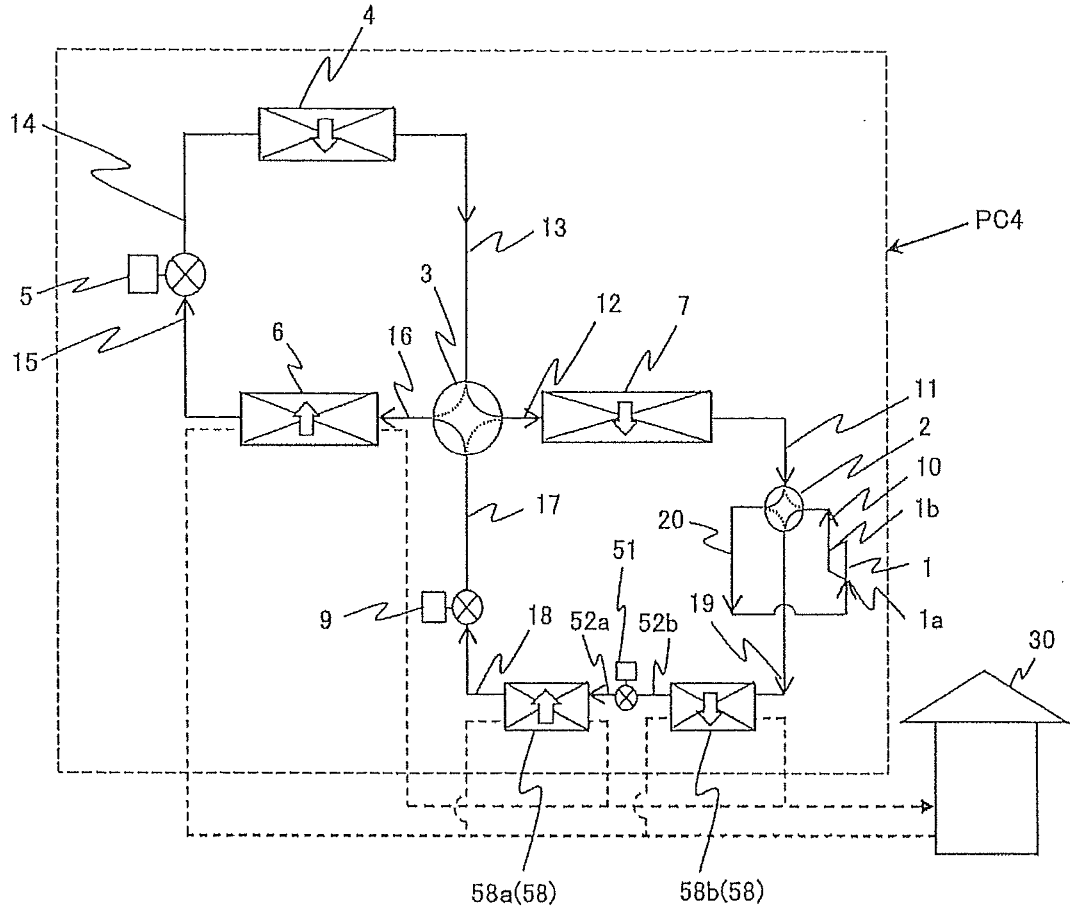
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FIG.12

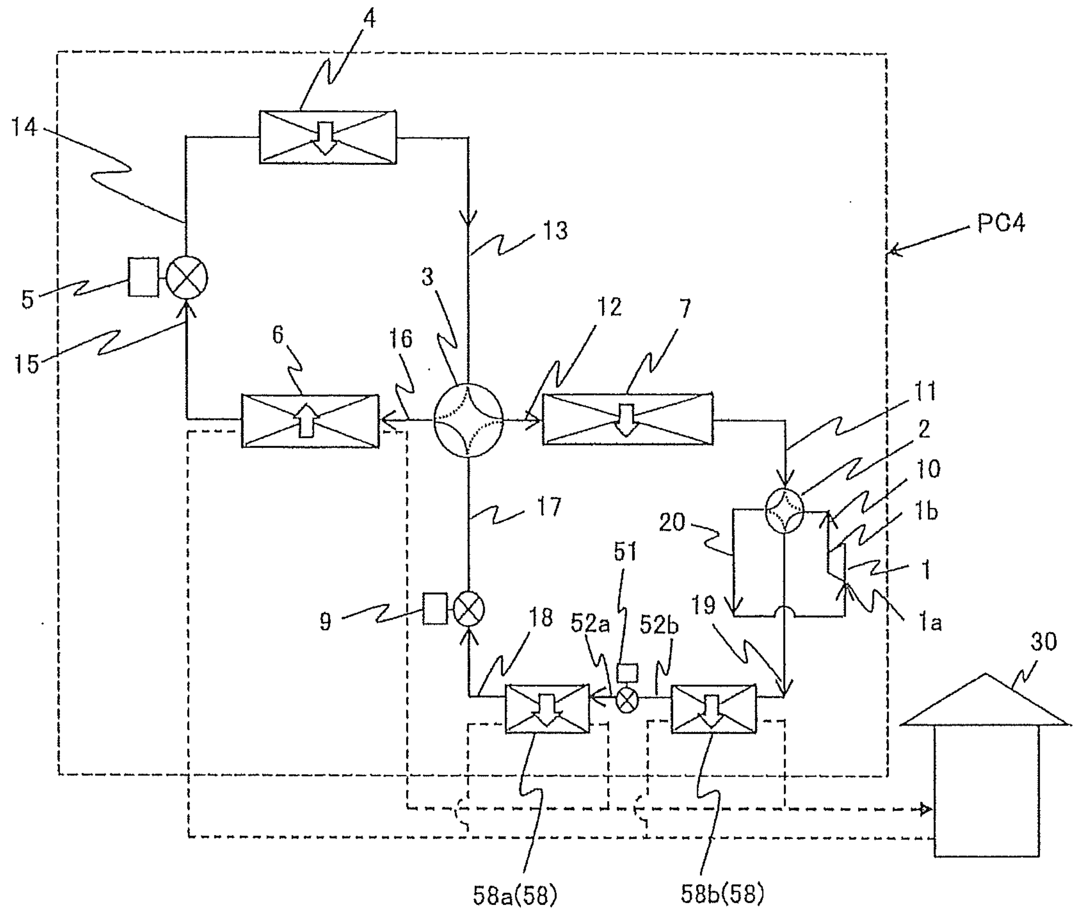
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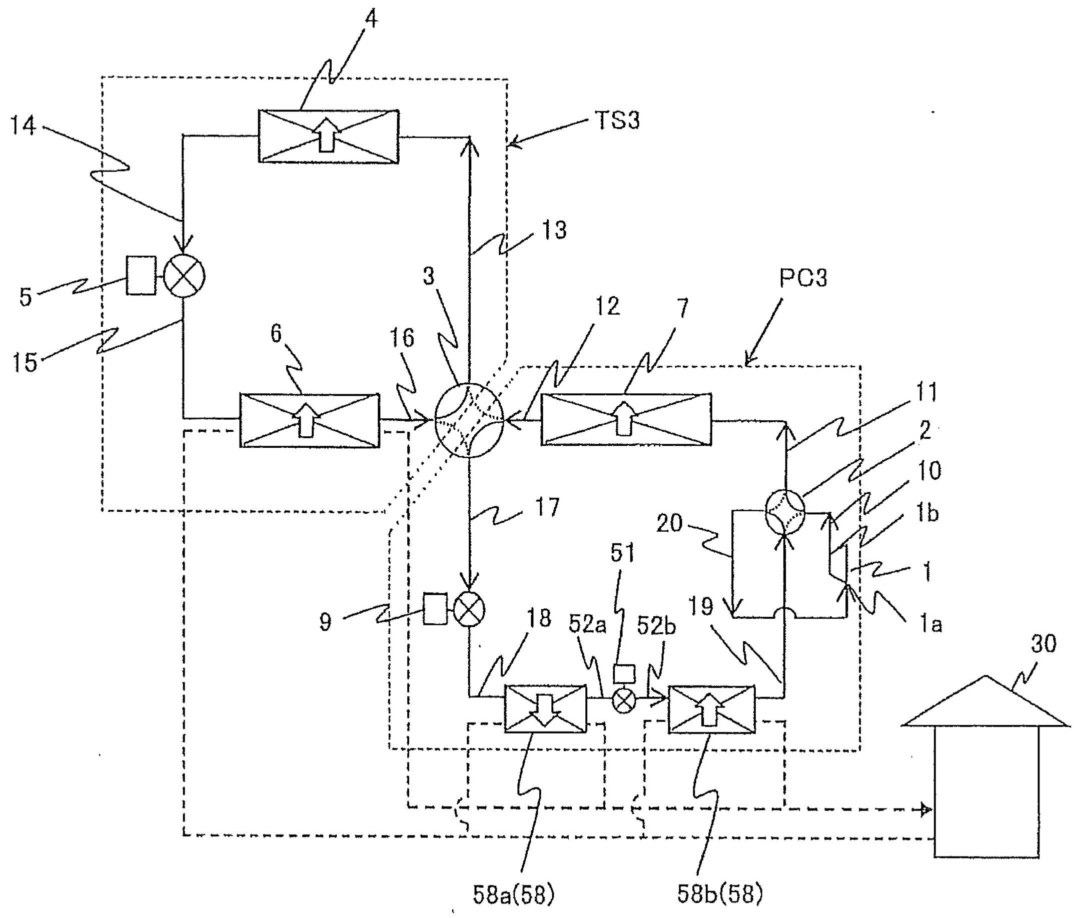
FIG.13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58b(58)

FIG.14

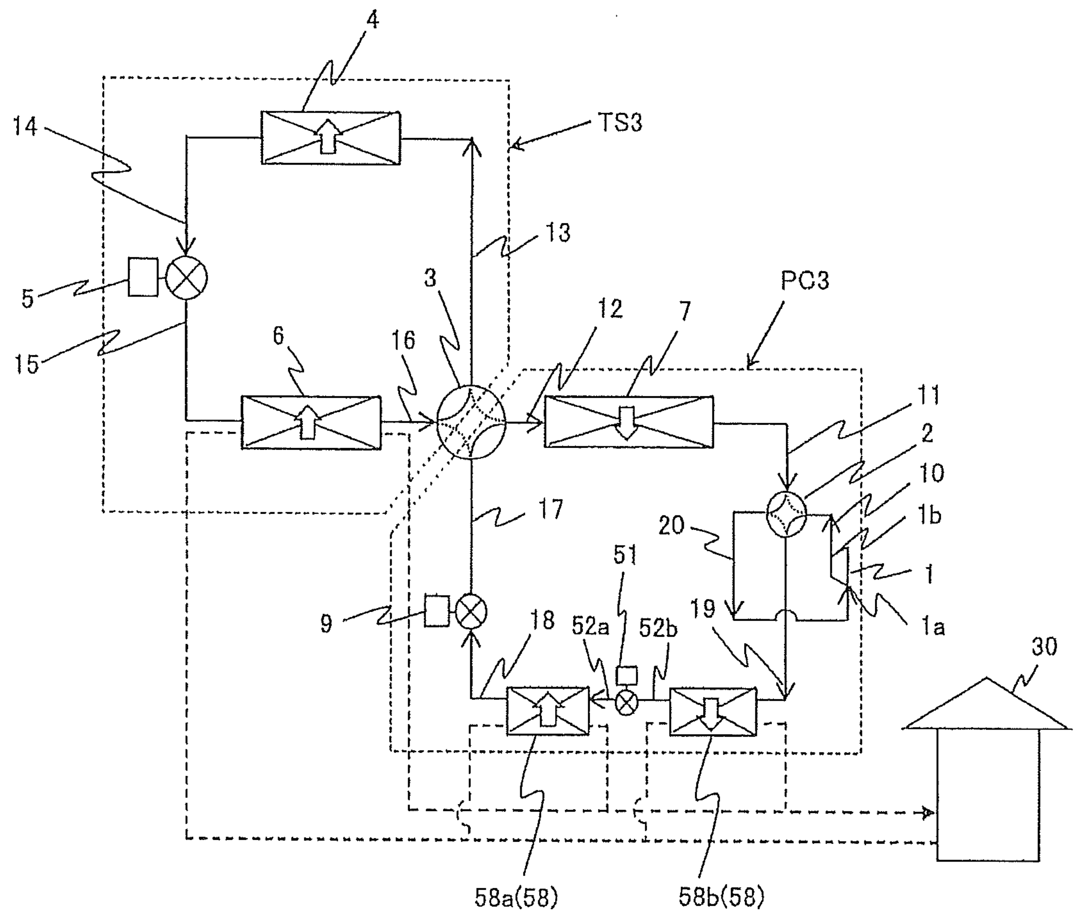
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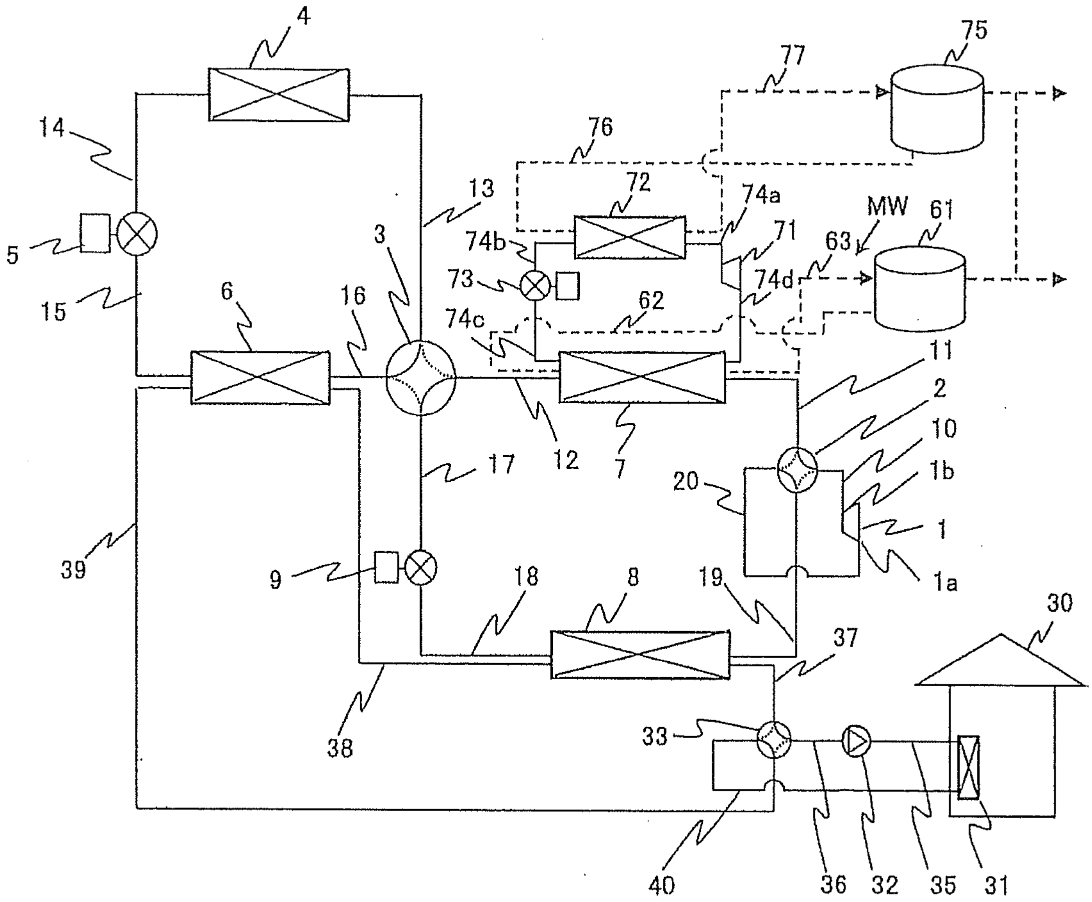
FIG.15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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/052892

A. CLASSIFICATION OF SUBJECT MATTER
F25B29/00(2006.01)i, *F24F5/00*(2006.01)i, *F25B1/00*(2006.01)i, *F25B5/04*(2006.01)i, *F25B6/04*(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)
F25B29/00, F24F5/00, F25B1/00, F25B5/04, F25B6/04

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	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

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.
A	JP 2000-111190 A (Mitsubishi Electric Building Techno-Service Co., Ltd.), 18 April 2000 (18.04.2000), entire text; all drawings (Family: none)	1-6
A	JP 2000-74515 A (Mitsubishi Electric Building Techno-Service Co., Ltd.), 14 March 2000 (14.03.2000), entire text; all drawings (Family: none)	1-6
A	JP 2003-121072 A (Mitsubishi Electric Corp.), 23 April 2003 (23.04.2003), entire text; all drawings (Family: none)	1-6

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"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	Date of mailing of the international search report
11 May, 2010 (11.05.10)	18 May, 2010 (18.05.10)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
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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	JP 10-300128 A (Matsushita Electric Works, Ltd.), 13 November 1998 (13.11.1998), entire text; all drawings (Family: none)	1-6

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REFERENCES CITED IN THE DESCRIPTION

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