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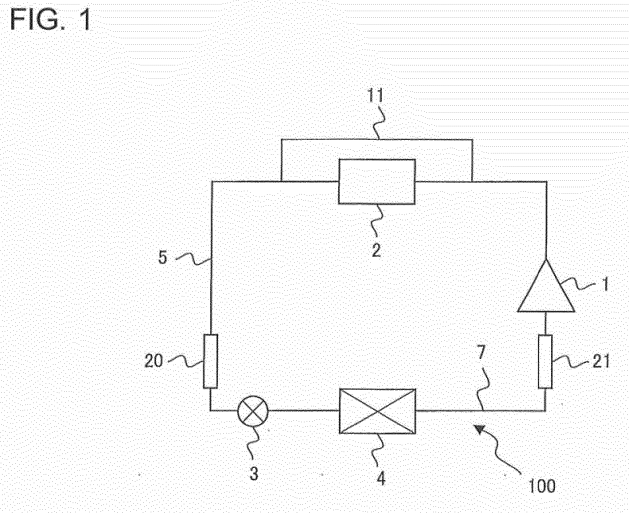
(54) REFRIGERATING AND AIR CONDITIONING DEVICE

(57) It is an object to a refrigerating and air-conditioning apparatus capable of preventing dew condensation on a refrigerant pipe by adjusting a temperature of liquid refrigerant even when refrigerant condensed at a refrigerant cooling unit (2) using a first heat source at a temperature lower than the dew-point temperature of outdoor air is equal to or lower than the dew-point temperature of ambient outdoor air. The refrigerating and air-conditioning apparatus includes a main refrigerant circuit in which a compressor (1), the refrigerant cooling unit (2), a first decompression device (3), and an evaporator (4) are connected circularly through a refrigerant pipe, and a bypass (11) connecting a refrigerant pipe on an inflow side of the refrigerant cooling unit (2) and a refrigerant pipe on an outflow side of the refrigerant cooling unit (2). The bypass (11) transfers part of refrigerant discharged from the compressor (1) to the refrigerant pipe on the outflow side of the refrigerant cooling unit (2), bypassing the refrigerant cooling unit (2).

FIG. 1



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Description

Technical Field

[0001] The present invention relates to a refrigerating and air-conditioning apparatus, and particularly relates to dew condensation on a liquid pipe.

Background Art

[0002] In conventional refrigerating and air-conditioning apparatuses, a controller controls cooling operation of a cooling device so that the temperature of a liquid pipe is at least higher than the ambient temperature. This control intends to prevent generation of dew condensation on the liquid pipe included in a refrigerant circuit, while enhancing the cooling capacity (see, for example, Patent Literature 1).

[0003] The conventional refrigerating and air-conditioning apparatus achieves an increased cooling capacity with increased subcooling of liquid refrigerant, and further energy saving (see, for example, Non Patent Literature 1).

Citation List

Patent Literature

[0004]

Patent Literature 1: Japanese Patent No. 4444220 (claim 2)
Non Patent Literature 1: Mitsubishi Electric Corporation, "General Catalog of Mitsubishi Electric Corporation R410A Low-Temperature Instrument", January 2014, p.6

Summary of Invention

Technical Problem

[0005] In a case of a refrigerating and air-conditioning apparatus disclosed in Patent Literature 1, any existing pipe on site is reused in some cases when the device is renewed. In such a case, heat insulation is not provided to some existing liquid pipes. When the refrigerating and air-conditioning apparatus alone is renewed and such an existing liquid pipe is used without heat insulation, dew condensation occurs to the liquid pipe at a surface temperature of the liquid pipe lower than the dew-point temperature of outdoor air. Water droplets generated in this dew condensation fall on the floor of the room to cause drench and mold in the room.

[0006] In a case of a refrigerating and air-conditioning apparatus disclosed in Non Patent Literature 1, when no heat insulation treatment is provided to a liquid pipe, the temperature of liquid refrigerant needs to be maintained to be higher than the dew-point temperature of outdoor air surrounding the liquid pipe to prevent generation of dew condensation on the liquid pipe. Accordingly, the subcooling of the liquid refrigerant and hence the cooling capacity cannot be increased, and thus the energy saving cannot be achieved.

[0007] Moreover, when the subcooling of the liquid refrigerant is increased to achieve a large cooling capacity and hence energy saving, the temperature of refrigerant at the exit of a condenser becomes equal to or lower than the dew-point temperature of outdoor air surrounding the liquid pipe in some cases. This causes dew condensation on the liquid pipe, and thus the liquid pipe needs to be provided with heat insulation treatment.

[0008] The present invention is made to overcome the above-described problems, and first object of the present invention is to provide a refrigerating and air-conditioning apparatus capable of preventing dew condensation on a liquid pipe even when liquid refrigerant condensed through a heat source at a temperature lower than the dew-point temperature of outdoor air is equal to or lower than the dew-point temperature of ambient outdoor air.

[0009] Heat insulation treatment on an on-site pipe requires a large work cost and a longer work time. It is thus a second object of the present invention to provide a refrigerating and air-conditioning apparatus capable of adjusting the temperature of liquid refrigerant to achieve, with a single device, selection of whether to perform heat insulation treatment on an on-site liquid pipe to prevent dew condensation thereon, and responding flexibly to a customer's request on cost and due date of, for example, heat insulation treatment.

Solution to Problem

[0010] A refrigerating and air-conditioning apparatus of one embodiment of the present invention includes: a main refrigerant circuit in which a compressor, a refrigerant cooling unit using a first heat source at a temperature lower than a dew-point temperature of outdoor air, a first decompression device, and an evaporator are connected circularly through a refrigerant pipe; and a bypass connecting a refrigerant pipe on an inflow side of the refrigerant cooling unit and a refrigerant pipe on an outflow side of the refrigerant cooling unit, the bypass being configured to bypass the refrigerant cooling unit and transfer part of refrigerant discharged from the compressor to the refrigerant pipe on the outflow side of the refrigerant cooling unit. Advantageous Effects of Invention

[0011] The present invention achieves a configuration including a bypass bypassing the refrigerant cooling unit. With this configuration, the temperature of liquid refrigerant is adjusted to exceed the dew-point temperature of ambient outdoor air by adding superheated gas from the compressor to the refrigerant condensed at the refrigerant cooling unit even when the refrigerant is equal to or lower than the dew-point temperature. This provides the effect of preventing dew condensation on a refrigerant pipe (liquid pipe).

Brief Description of Drawings

[0012]

[Fig. 1] Fig. 1 is a diagram illustrating a schematic configuration of a refrigerant circuit of a refrigerating and air-conditioning apparatus according to Embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is a diagram illustrating a schematic configuration of a refrigerant circuit of a refrigerating and air-conditioning apparatus according to Embodiment 2 of the present invention.

[Fig. 3] Fig. 3 is a diagram illustrating a schematic configuration of a refrigerant circuit of a refrigerating and air-conditioning apparatus according to Embodiment 3 of the present invention.

[Fig. 4] Fig. 4 is a diagram illustrating a schematic configuration of a refrigerant circuit of a refrigerating and air-conditioning apparatus according to Embodiment 4 of the present invention.

[Fig. 5] Fig. 5 is a flowchart of a control operation of a flow rate control device of a bypass in Fig. 4.

Description of Embodiments

Embodiment 1

[0013] Fig. 1 is a diagram of a refrigerant circuit of a refrigerating and air-conditioning apparatus according to Embodiment 1 of the present invention.

[0014] As illustrated in Fig. 1, a refrigerant circuit 100 of the refrigerating and air-conditioning apparatus has a configuration in which a compressor 1, a refrigerant cooling unit 2, a use side expansion valve 3, and a use side heat exchanger 4 are connected circularly through a refrigerant pipe. A circuit including these components is referred to as a main refrigerant circuit.

[0015] The compressor 1 and the refrigerant cooling unit 2 constitute a heat source side unit, and the use side expansion valve 3 and the use side heat exchanger 4 constitute a use side unit. The refrigerant cooling unit 2 and the use side expansion valve 3 are connected with each other through a liquid pipe 5 that includes an on-site connection liquid pipe 20. The use side heat exchanger 4 and the compressor 1 are connected with each other through a gas pipe 7 that includes an on-site connection gas pipe 21. The on-site connection liquid pipe 20 and the on-site connection gas pipe 21 may be existing pipes.

[0016] The refrigerant circuit 100 of the refrigerating and air-conditioning apparatus also includes a bypass 11 (sub refrigerant circuit). The bypass 11 connects a refrigerant pipe on an inflow side of the refrigerant cooling unit 2 and a refrigerant pipe on an outflow side of the refrigerant cooling unit 2. The bypass 11 transfers part of refrigerant discharged from the compressor 1 to the liquid pipe 5, bypassing the refrigerant cooling unit 2.

[0017] In Embodiment 1, the refrigerant cooling unit 2 exchanges heat with a heat source (first heat source), such as tap water, groundwater, geothermal heat, or an evaporator of another refrigerating device, at a temperature lower than the dew-point temperature of outdoor air. In this manner, the refrigerant of the refrigerant cooling unit 2 is cooled.

[0018] The following describes an operation of the refrigerating and air-conditioning apparatus according to Embodiment 1 with reference to Fig. 1.

[0019] The refrigerant in the refrigerant circuit 100 is compressed to superheated gas at high temperature and high pressure through the compressor 1, and then transferred to the refrigerant cooling unit 2. The refrigerant passing through the refrigerant cooling unit 2 is condensed to liquid refrigerant at high temperature and high pressure through heat exchange with the first heat source. Then, the liquid refrigerant passes through the liquid pipe 5, and becomes gas-liquid two-phase refrigerant at low temperature and low pressure through the use side expansion valve 3. The gas-liquid two-phase refrigerant at low temperature and low pressure becomes superheated gas at low temperature and low pressure through heat exchange in the use side heat exchanger 4 with ambient air and water, and passes through the gas pipe 7 to be sucked into the compressor 1 again. This series of operations is a refrigerant cycle of the main refrigerant circuit.

[0020] The bypass 11 connected with both ends of the refrigerant cooling unit 2 bypasses the refrigerant cooling unit 2 by branching, on upstream of the refrigerant cooling unit 2, part of the refrigerant compressed to the superheated gas at high temperature and high pressure through the compressor 1. The bypass 11 joins, downstream of the refrigerant cooling unit 2, the branched refrigerant with the cooled refrigerant flowing from the refrigerant cooling unit 2, and transfers the joined refrigerant to the liquid pipe 5. The flow rate of the refrigerant branched to the bypass 11 is adjusted based on, for example, a ratio of the flow path resistance (pipe diameter and length) of the refrigerant cooling unit 2 and the flow path resistance (pipe diameter and length) of the bypass 11.

[0021] As described above, in Embodiment 1, the bypass 11 (sub refrigerant circuit) is provided to the main refrigerant circuit to join the liquid refrigerant at high temperature and high pressure and the superheated gas, thereby controlling the temperature of the liquid refrigerant to be higher than the temperature of outdoor air surrounding the liquid pipe 5. This achieves a refrigerating and air-conditioning apparatus in which no dew condensation is generated on the liquid pipe 5 (the on-site connection liquid pipe 20, in particular) irrespective of whether heat insulation treatment is applied on the liquid pipe 5 (the on-site connection liquid pipe 20, in particular).

[0022] Thus, Embodiment 1 provides a solution to the problem of the conventional technology, that is the dew condensation generated on the surface of the liquid pipe 5 when the surface temperature of the liquid pipe 5 is at

a temperature lower than the dew-point temperature of ambient outdoor air, and dew condensation water falls on a surface above a ceiling where the liquid pipe 5 is installed, generating drench and mold on the surface above a ceiling and in the room.

[0023] In Embodiment 1, dew condensation on the liquid pipe 5 is prevented by controlling the temperature of the liquid refrigerant to be higher than the temperature of outdoor air, but the present invention is not limited thereto. For example, dew condensation can be prevented in a similar manner by controlling the temperature of the liquid refrigerant to be higher than the dew-point temperature of outdoor air.

[0024] The use side expansion valve 3 corresponds to a "first decompression device" according to the present invention, and the use side heat exchanger 4 corresponds to an "evaporator" according to the present invention. The liquid pipe 5 corresponds to a "refrigerant pipe between a refrigerant cooling unit using a first heat source at a temperature lower than the dew-point temperature of outdoor air and the first decompression device" according to the present invention.

Embodiment 2

[0025] Embodiment 2 includes a subcooling refrigerant circuit added to the refrigerant circuit in Embodiment 1 described above. In Embodiment 2, the basic configuration of the main refrigerant circuit is the same as the configuration of the main refrigerant circuit in Embodiment 1, and thus the following description will be mainly made on any difference of Embodiment 2 from Embodiment 1.

[0026] As illustrated in Fig. 2, the refrigerant circuit 100 of the refrigerating and air-conditioning apparatus includes a subcooling refrigerant circuit 30. In the subcooling refrigerant circuit 30, an opening control device 12, a heat exchanger 13, and a refrigerant pipe 14 are sequentially connected with each other.

[0027] The entrance of the bypass 11 is provided between an outflow side of a condenser 6 and a refrigerant pipe on upstream of the heat exchanger 13, and the exit of the bypass 11 is provided between a refrigerant pipe on downstream of the heat exchanger 13 and a bifurcation part 16. With this configuration, the bypass 11 bypasses the heat exchanger 13.

[0028] The subcooling refrigerant circuit 30 is connected with the bifurcation part 16 downstream of the exit of the bypass 11, and then connected with the heat exchanger 13 through the opening control device 12. The heat exchanger 13 is provided between the entrance of the bypass 11 and the exit of the bypass 11 to allow heat exchange between refrigerant (first refrigerant) decompressed at the opening control device 12 and refrigerant (second refrigerant) before bifurcation on the outflow side of the condenser 6. The refrigerant subjected to the heat exchange at the heat exchanger 13 is discharged to an injection pipe 1 a included in the compressor 1 through the refrigerant pipe 14. The compressor 1 causes the refrigerant at medium temperature and medium pressure flowed in through the injection pipe 1 a to flow into an intermediate part of a compression process of the compressor 1.

[0029] The following describes an operation of the refrigerating and air-conditioning apparatus according to Embodiment 2 with reference to Fig. 2.

[0030] An operation of the subcooling refrigerant circuit 30 will be described first.

[0031] In the subcooling refrigerant circuit 30, part of the liquid refrigerant at high temperature and high pressure discharged from the condenser 6 is branched at the bifurcation part 16 to flow into the opening control device 12. The opening control device 12 is a variable flow control valve configured to control a flow rate, and allows the liquid refrigerant at high temperature and high pressure to flow into the heat exchanger 13 as gas-liquid two-phase refrigerant (second heat source) at medium temperature and medium pressure. The heat exchanger 13 provides subcooling on the liquid refrigerant on the outflow side of the condenser 6 by performing heat exchange between the liquid refrigerant at high temperature and high pressure discharged from the condenser 6 and the gas-liquid two-phase refrigerant (second heat source) at medium temperature and medium pressure flowing in the subcooling refrigerant circuit 30. Thereafter, the refrigerant flowing in the subcooling refrigerant circuit 30 flows into the refrigerant pipe 14.

[0032] The refrigerant (refrigerant at medium temperature and medium pressure) flowing into the refrigerant pipe 14 then flows into the intermediate part of the compression process of the compressor 1 through the injection pipe 1 a. This cools the compressor 1, thereby decreasing the temperature of discharged refrigerant and a motor temperature of the compressor 1.

[0033] The operation of the refrigerating and air-conditioning apparatus according to Embodiment 2 will be described next based on the above-described operation of the refrigerant pipe 14.

[0034] The refrigerant in the refrigerant circuit 100 is compressed to the superheated gas at high temperature and high pressure through the compressor 1, and then condensed to the liquid refrigerant at high temperature and high pressure through heat exchange with the first heat source at the condenser 6. The liquid refrigerant discharged from the condenser 6 is provided with subcooling at high pressure by the heat exchanger 13 of the subcooling refrigerant circuit 30 as described above.

[0035] The bypass 11 bifurcates, downstream of the condenser 6, part of the refrigerant compressed to the superheated gas at high temperature and high pressure through the compressor 1 to bypass the heat exchanger 13, and joins the part of the refrigerant with cooled refrigerant flowing from the heat exchanger 13, downstream of the heat exchanger 13, before transferring the part of the refrigerant to the liquid pipe 5.

[0036] Thereafter, similarly to Embodiment 1 described above, the refrigerant transferred to the liquid

pipe 5 becomes the gas-liquid two-phase refrigerant at low temperature and low pressure through the use side expansion valve 3, and then becomes the superheated gas at low temperature and low pressure through heat exchange in the use side heat exchanger 4 with ambient air and water, before being sucked into the compressor 1 again.

[0037] As described above, according to Embodiment 2, the liquid refrigerant at high temperature and high pressure passing through the condenser 6 is largely subcooled at the heat exchanger 13 of the subcooling refrigerant circuit 30. Then, when the temperature of the liquid refrigerant is equal to or lower than the temperature of outdoor air, the temperature of the liquid refrigerant can be controlled to be higher than the temperature of outdoor air surrounding the liquid pipe 5 by joining the liquid refrigerant with the liquid refrigerant at high temperature and high pressure through the bypass 11. This achieves a refrigerating and air-conditioning apparatus in which no dew condensation is generated on the liquid pipe 5 (the on-site connection liquid pipe 20, in particular) irrespective of heat insulation treatment on the liquid pipe 5 (the on-site connection liquid pipe 20, in particular).

[0038] The refrigerant in the subcooling refrigerant circuit 30 is returned to the compressor 1 so that the refrigerant is controlled to be at medium temperature and medium pressure through the opening control device 12 of the subcooling refrigerant circuit 30, and then subjected to heat exchange with the refrigerant in the main refrigerant circuit at the heat exchanger 13 before being flowed into the compressor 1, thereby cooling the compressor 1.

[0039] The opening control device 12 corresponds to a "second decompression device" according to the present invention. Refrigerant (refrigerant at medium temperature and medium pressure) downstream of the opening control device 12 of the subcooling refrigerant circuit 30 corresponds to "first refrigerant" according to the present invention, and refrigerant (the liquid refrigerant at high temperature and high pressure) on the outflow side of the condenser 6 corresponds to "second refrigerant" according to the present invention. The liquid pipe 5 corresponds to a "refrigerant pipe between the condenser and the first decompression device" according to the present invention.

Embodiment 3

[0040] Embodiment 3 includes a variable flow control valve or an openable and closable switching valve in addition to the bypass 11 in Embodiment 2 described above. In Embodiment 3, the basic configuration of the refrigerant circuit 100 is the same as the configuration of the refrigerant circuit 100 in Embodiment 2, and thus the following description will be mainly made on any difference of Embodiment 3 from Embodiment 2.

[0041] As illustrated in Fig. 3, the refrigerant circuit 100 of the refrigerating and air-conditioning apparatus additionally includes a valve 15 in the bypass 11 bypassing the heat exchanger 13. The valve 15 of the bypass 11 is a variable flow control valve configured to control the flow rate of refrigerant, or a switching valve capable of opening and closing the flow path of refrigerant.

[0042] The following describes an operation of the valve 15 of the bypass 11 with reference to Fig. 3.

[0043] When the temperature of the liquid refrigerant in the liquid pipe 5 is higher than the temperature of ambient outdoor air, no dew condensation is generated on the liquid pipe 5 and thus the valve 15 of the bypass 11 is closed.

[0044] However, when the temperature of the liquid refrigerant in the liquid pipe 5 is equal to or lower than the temperature of ambient outdoor air, the valve 15 of the bypass 11 is opened to allow the liquid refrigerant at high temperature and high pressure to flow into the bypass 11. The temperature of the liquid refrigerant is increased to be higher than the temperature of ambient outdoor air through this operation to prevent dew condensation on the liquid pipe 5.

[0045] The use of a variable flow control valve configured to control the flow rate of refrigerant allows fine adjustment of the flow rate of refrigerant flowing through the bypass 11 to control the temperature of the liquid pipe 5 to be near a temperature closely exceeding the ambient temperature (or dew-point temperature) of the liquid pipe 5.

[0046] When the openable and closable switching valve of the variable flow control valve configured to control the flow rate of refrigerant is controlled to be fully closed, refrigerant stops passing through the bypass 11. This operation achieves the same configuration as that of the refrigerant circuit 100 in which the bypass 11 is not installed.

[0047] As described above, in the refrigerating and air-conditioning apparatus according to Embodiment 3, when heat insulation treatment cannot be provided to the liquid pipe 5 on site, the flow rate of refrigerant through the valve 15 of the bypass 11 is adjusted to join the liquid refrigerant condensed through the condenser 6 and the liquid refrigerant provided with subcooling at the heat exchanger 13. In this manner, the temperature of the liquid refrigerant can be controlled to be higher than the temperature of outdoor air surrounding the liquid pipe 5, thereby preventing dew condensation on the liquid pipe 5.

[0048] When heat insulation treatment can be provided to the liquid pipe 5 on site (the on-site connection liquid pipe 20, in particular) (or when an existing refrigerant pipe provided with heat insulation treatment is used as the on-site connection liquid pipe 20), the valve 15 of the bypass 11 is fully closed to provide subcooling, at the heat exchanger 13, to the whole liquid refrigerant at high temperature and high pressure discharged from the condenser 6, thereby achieving large subcooling of the liquid refrigerant. This leads to increase in the cooling capacity of the refrigerating and air-conditioning apparatus to achieve energy saving.

[0049] With these configurations, a refrigerating and air-conditioning apparatus can be provided that is capable of achieving, with a single device, selection of whether to perform heat insulation treatment on the liquid pipe 5 on site to prevent dew condensation thereon, and thus responding flexibly to a customer's request on cost and due date of, for example, heat insulation treatment.

Embodiment 4

[0050] In Embodiment 4, the opening degree of the valve 15 of the bypass 11 in Embodiment 3 described above is automatically controlled. The configuration of the refrigerant circuit 100 according to Embodiment 4 is the same as the configuration in Embodiment 3, and thus the following description will be mainly made on any difference of Embodiment 4 from Embodiment 3.

[0051] As illustrated in Fig. 4, the refrigerant circuit 100 according to Embodiment 4 additionally includes an outdoor-air temperature sensor 31, a refrigerant temperature sensor 32, and a flow rate control device 33. The flow rate control device 33 is, for example, a microcomputer.

[0052] The outdoor-air temperature sensor 31 detects the temperature of ambient outdoor air, and the flow rate control device 33 acquires data on this temperature of outdoor air from the outdoor-air temperature sensor 31. Similarly, the refrigerant temperature sensor 32 detects the temperature of the liquid refrigerant flowing through the liquid pipe 5, the flow rate control device 33 acquires data on this temperature of the liquid refrigerant from the refrigerant temperature sensor 32.

[0053] The flow rate control device 33 previously stores therein, for example, a table of the temperature of outdoor air and the opening degree of the valve 15 of the bypass 11 corresponding to the temperature of liquid refrigerant. The flow rate control device 33 obtains the opening degree of the valve 15 of the bypass 11 by referring to this table based on the data on the temperature of outdoor air and the temperature of liquid refrigerant thus acquired, and controls the valve 15 based on this opening degree.

[0054] Fig. 5 is a flowchart of a control operation of the flow rate control device 33. The following describes the control operation of the flow rate control device 33 with reference to Fig. 4 based on steps in Fig. 5.

(S1) The refrigerating and air-conditioning apparatus is started.

(S2) The flow rate control device 33 of the bypass 11 acquires information on the temperature of outdoor air surrounding the liquid pipe 5 from the outdoor-air temperature sensor 31, and simultaneously acquires information on the temperature of liquid refrigerant flowing through the liquid pipe 5 from the refrigerant temperature sensor 32.

(S3) The temperature of outdoor air and the temperature of liquid refrigerant are compared. When the temperature of outdoor air is equal to or higher than the temperature of liquid refrigerant, the process proceeds to step S4. Otherwise, the process proceeds to step S5.

(S4) The valve 15 of the bypass 11 is opened to increase the amount of refrigerant flowing through the bypass 11 to increase the temperature of liquid refrigerant.

(S5) The valve 15 of the bypass 11 is closed to decrease the amount of refrigerant flowing through the bypass 11 to decrease the temperature of liquid refrigerant, adjusting the temperature of liquid refrigerant to be near the temperature of outdoor air.

[0055] As described above, the valve 15 and the flow rate control device 33 are provided to the bypass 11, and the opening degree of the valve 15 is controlled to join the liquid refrigerant condensed at the condenser 6 and the liquid refrigerant provided with subcooling at the heat exchanger 13, thereby controlling the temperature of the liquid refrigerant to be higher than the temperature of outdoor air surrounding the liquid pipe 5. With this configuration, a refrigerating and air-conditioning apparatus can be provided that is capable of achieving, with a single device, selection of whether to perform heat insulation treatment on the liquid pipe 5 to prevent dew condensation thereon, and responding flexibly to a customer's request on cost on the customer and due date.

[0056] In addition, the flow rate control device 33 is provided to the bypass 11 to control the amount of refrigerant flowing in a circuit bypassing the heat exchanger 13, thereby controlling the temperature of liquid refrigerant to be near the temperature of outdoor air. This achieves a refrigerating and air-conditioning apparatus capable of preventing dew condensation on the liquid pipe 5.

[0057] In Embodiment 4, the opening degree of the valve 15 of the bypass 11 is controlled based on the comparison between the temperature of outdoor air and the temperature of liquid refrigerant, but the present invention is not limited thereto. For example, the dew-point temperature of outdoor air may be obtained by using a dew-point meter in place of the outdoor-air temperature sensor 31, and compared with the temperature of liquid refrigerant to control the opening degree of the valve 15 of the bypass 11.

Reference Signs List

[0058] 1 compressor 1a injection pipe 2 refrigerant cooling unit using a first heat source at a temperature lower than the dew-point temperature of outdoor air 3 use side expansion valve4 use side heat exchanger 5 liquid pipe 6 condenser 7 gas pipe 11 bypass 12 opening control device 13 heat exchanger 14 refrigerant pipe 15 valve 16 bifurcation part 20 on-site connection liquid pipe 21 on-site connection gas pipe 30 subcooling refrigerant circuit 31 outdoor-air temperature sensor 32 refrigerant temperature sensor 33 flow rate control device 100 re-

frigerant circuit

Claims

1. A refrigerating and air-conditioning apparatus comprising:

   a main refrigerant circuit in which a compressor, a refrigerant cooling unit using a first heat source at a temperature lower than a dew-point temperature of outdoor air, a first decompression device, and an evaporator are connected circularly through a refrigerant pipe; and
   a bypass connecting a refrigerant pipe on an inflow side of the refrigerant cooling unit and a refrigerant pipe on an outflow side of the refrigerant cooling unit,
   the bypass being configured to bypass the refrigerant cooling unit and transfer part of refrigerant discharged from the compressor to the refrigerant pipe on the outflow side of the refrigerant cooling unit.

2. The refrigerating and air-conditioning apparatus of claim 1, wherein the bypass is configured to transfer the part of refrigerant discharged from the compressor to the refrigerant pipe on the outflow side of the condenser to yield the refrigerant in a refrigerant pipe between the refrigerant cooling unit and the first decompression device having a temperature higher than a dew-point temperature of ambient outdoor air.

3. The refrigerating and air-conditioning apparatus of claim 1, wherein the bypass is configured to transfer the part of refrigerant discharged from the compressor to the refrigerant pipe on the outflow side of the condenser to yield the refrigerant in a refrigerant pipe between the refrigerant cooling unit and the first decompression device having a temperature higher than a temperature of ambient outdoor air.

4. The refrigerating and air-conditioning apparatus of any one of claims 1 to 3, wherein the refrigerant cooling unit is configured to exchange heat with tap water, groundwater, geothermal heat, or an evaporator of another refrigerating device.

5. A refrigerating and air-conditioning apparatus comprising:

   a main refrigerant circuit in which a compressor, a condenser, a first decompression device, and an evaporator are connected circularly through a refrigerant pipe;
   a subcooling refrigerant circuit including a heat exchanger configured to cool refrigerant on an outflow side of the condenser; and
   a bypass connecting a refrigerant pipe on upstream of the heat exchanger and a refrigerant pipe on downstream of the heat exchanger, and configured to bypass the heat exchanger,
   the bypass being configured to bypass the heat exchanger and transfer part of refrigerant condensed at the condenser to a refrigerant pipe on downstream of the heat exchanger.

6. The refrigerating and air-conditioning apparatus of claim 5, wherein
   the compressor includes an injection pipe,
   the subcooling refrigerant circuit includes
   a second decompression device configured to decompress first refrigerant branching between an exit of the bypass and the first decompression device, and
   the heat exchanger configured to subcool second refrigerant discharged from the condenser through heat exchange between the first refrigerant transferred from the second decompression device and the second refrigerant, and
   the subcooling refrigerant circuit is configured to transfer the first refrigerant subjected to heat exchange at the heat exchanger to the injection pipe of the compressor.

7. The refrigerating and air-conditioning apparatus of claim 6, wherein the second decompression device comprises a variable flow control valve configured to control a flow rate.

8. The refrigerating and air-conditioning apparatus of any one of claims 5 to 7, wherein the bypass is configured to transfer the part of refrigerant condensed at the condenser to the refrigerant pipe on downstream of the heat exchanger to yield the refrigerant in a refrigerant pipe between the condenser and the first decompression device having a temperature higher than a dew-point temperature of ambient outdoor air.

9. The refrigerating and air-conditioning apparatus of any one of claims 5 to 7, wherein the bypass is configured to transfer the part of refrigerant condensed at the condenser to the refrigerant pipe on downstream of the heat exchanger to yield the refrigerant in a refrigerant pipe between the condenser and the first decompression device having a temperature higher than a temperature of ambient outdoor air.

10. The refrigerating and air-conditioning apparatus of any one of claims 5 to 9, wherein the bypass includes a variable flow control valve or an openable and closable switching valve configured to adjust a flow rate of refrigerant.

11. The refrigerating and air-conditioning apparatus of

claim 10, further comprising:

a refrigerant temperature sensor configured to detect a temperature of refrigerant in a refrigerant pipe between the condenser and the first decompression device;
an outdoor-air temperature sensor configured to detect a temperature of outdoor air; and
a flow rate control device configured to control the flow control valve or the switching valve based on the temperature of the refrigerant detected by the refrigerant temperature sensor and the temperature of outdoor air detected by the outdoor-air temperature sensor.

12. The refrigerating and air-conditioning apparatus of claim 11, wherein the flow rate control device is configured to adjust a flow rate of refrigerant flowing through the bypass to yield the refrigerant in the liquid pipe to have a temperature higher than a dew-point temperature of ambient outdoor air.

13. The refrigerating and air-conditioning apparatus of claim 11, wherein the flow rate control device is configured to adjust a flow rate of refrigerant flowing through the bypass to yield the refrigerant in the liquid pipe to have a temperature higher than a temperature of ambient outdoor air.

FIG. 1

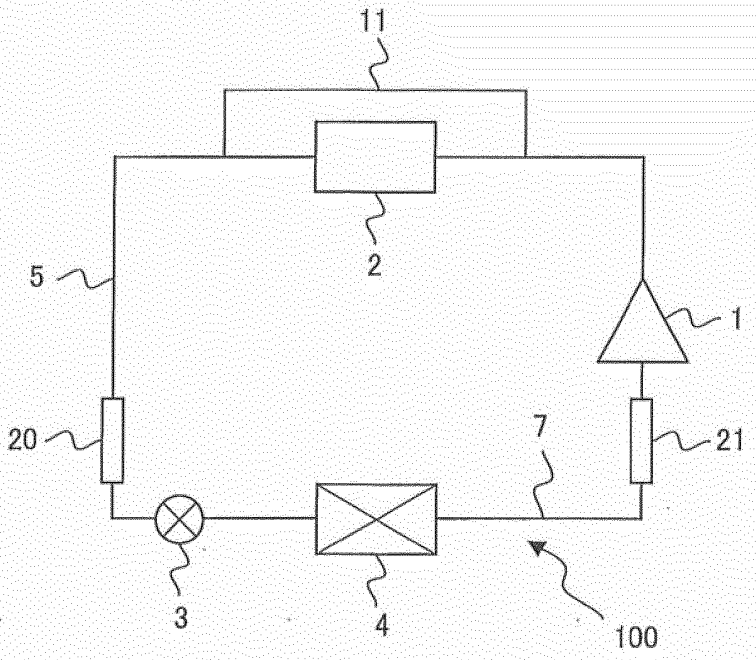


FIG. 2

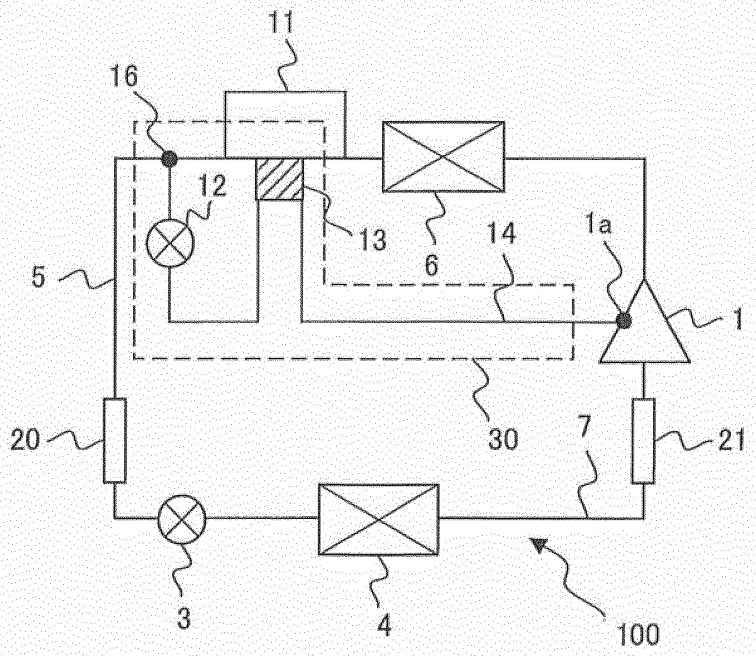
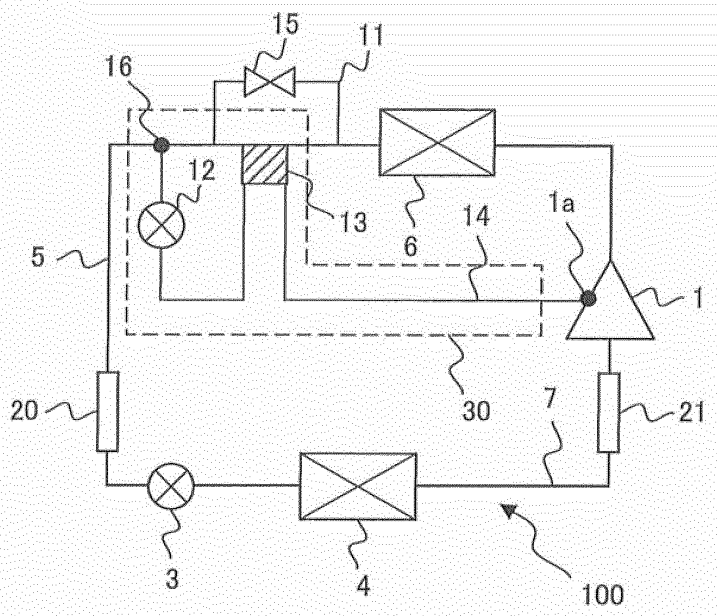


FIG. 3


15
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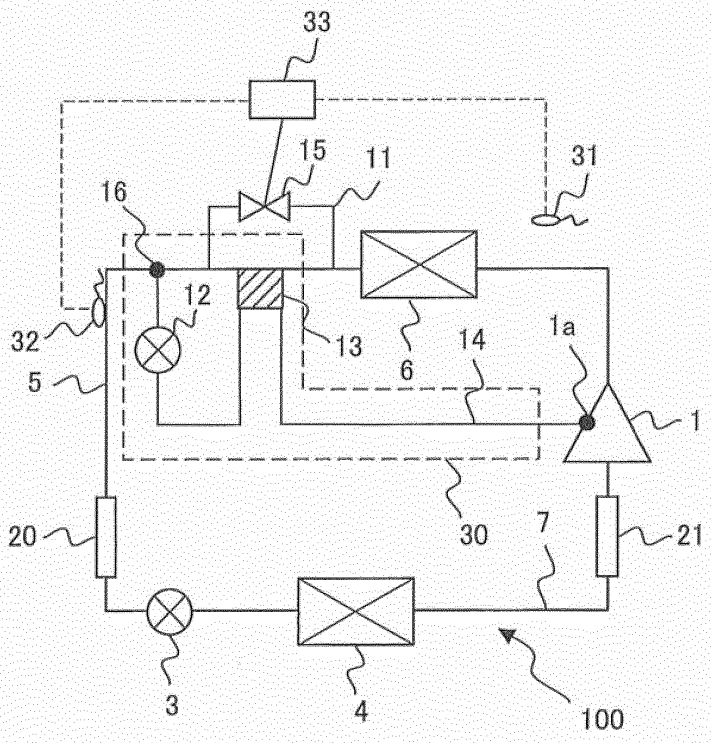
16
12
13
6
14
1a
5
1
20
30
7
21
3
4
100

FIG. 4


33
15
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16
12
32
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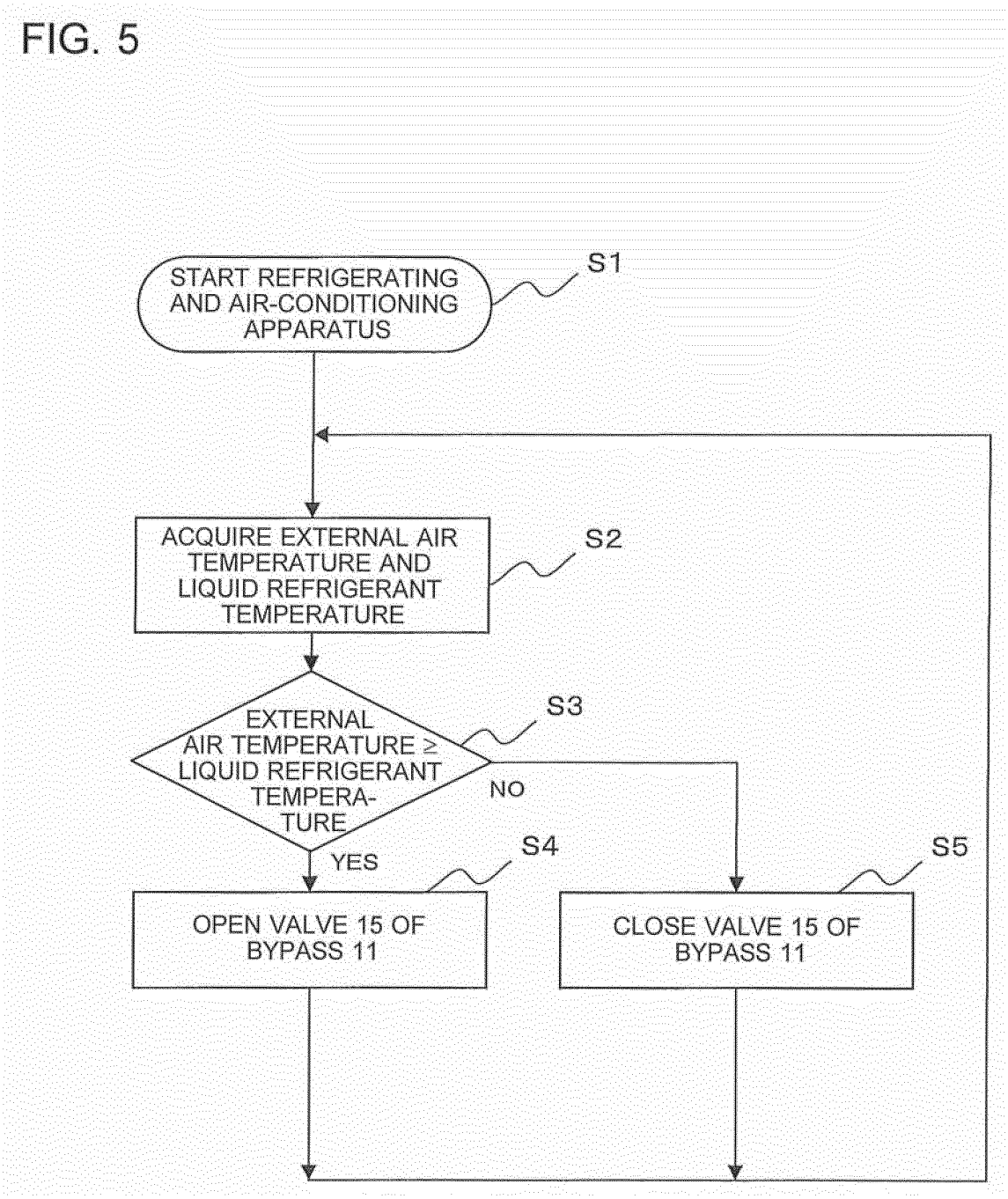
1a
5
1
20
30
7
21
3
4
100

FIG. 5


START REFRIGERATING AND AIR-CONDITIONING APPARATUS
S1
ACQUIRE EXTERNAL AIR TEMPERATURE AND LIQUID REFRIGERANT TEMPERATURE
S2
EXTERNAL AIR TEMPERATURE ≥ LIQUID REFRIGERANT TEMPERA-TURE
S3
NO
YES
OPEN VALVE 15 OF BYPASS 11
S4
CLOSE VALVE 15 OF BYPASS 11
S5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/068959

A. CLASSIFICATION OF SUBJECT MATTER
F25B1/00(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25B1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014
Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2005-49073 A (CKD Corp.), 24 February 2005 (24.02.2005), entire text; all drawings (particularly, paragraphs [0014], [0018]; fig. 1 to 2) (Family: none)	1-4 5-13
Y A	JP 2009-236404 A (Denso Corp.), 15 October 2009 (15.10.2009), entire text; all drawings (particularly, paragraphs [0046] to [0059], [0086] to [0096]; fig. 1, 3) & US 2009/0241573 A1 & DE 102009014607 A & CN 101545690 A	1-4 5-13

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

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"P" document published prior to the international filing date but later than the priority date claimed
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 October, 2014 (08.10.14)	21 October, 2014 (21.10.14)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/068959

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 10-47836 A (Matsushita Refrigeration Co.), 20 February 1998 (20.02.1998), entire text; all drawings (particularly, paragraphs [0011] to [0013]; fig. 1 to 3) (Family: none)	2-3
Y	JP 8-285426 A (Matsushita Refrigeration Co.), 01 November 1996 (01.11.1996), entire text; all drawings (particularly, paragraphs [0006] to [0007], [0021] to [0032], [0047]; fig. 1, 6) (Family: none)	2-3
A	JP 2011-208887 A (Mitsubishi Electric Corp.), 20 October 2011 (20.10.2011), entire text; all drawings (Family: none)	1,5-6
A	JP 2006-112708 A (Mitsubishi Electric Corp.), 27 April 2006 (27.04.2006), entire text; all drawings (particularly, paragraphs [0010] to [0067]; fig. 1, 11) & US 2010/0192607 A1	5-13

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 4444220 B **[0004]**

Non-patent literature cited in the description

- General Catalog of Mitsubishi Electric Corporation R410A Low-Temperature Instrument. Mitsubishi Electric Corporation, January 2014, 6 **[0004]**