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Air-conditioning apparatus

Abstract

An air-conditioner for performing a heating operation includes an indoor unit with an indoor heat exchanger set in an air-conditioning target space. There is an outdoor unit set outside the air-conditioning target space, the outdoor unit including a compressor, an outdoor heat exchanger, and an outdoor fan to supply outdoor air to the outdoor heat exchanger. Additionally, there is a humidifier to heat and evaporate condensed water in the outdoor unit to send the evaporated water into the indoor unit. The humidifier includes a water reservoir to store the condensed water in the outdoor unit, and a heating portion formed by a discharge pipe in which the refrigerant discharged from the compressor flows. The discharge pipe communicates between the compressor and the indoor heat exchanger in the heating operation, and the heating portion heats and evaporated the condensed water stored in the water reservoir with heat of the refrigerant.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION
(1) This application is based on PCT filing PCT/JP2021/015460, filed Apr. 14, 2021, the entire contents of which are incorporated herein by reference.
TECHNICAL FIELD
(2) The present disclosure relates to air-conditioning apparatuses and, in particular, to an air-conditioning apparatus having a humidification function of collecting moisture in air to humidify an indoor space.
BACKGROUND ART
(3) In general, an air-conditioning apparatus may humidify an indoor space in a heating operation in winter to prevent the indoor space from being dry. Known examples of a method for humidifying an indoor space include a non-water supply method in which condensed water is generated by condensing moisture in air and is evaporated to supply the evaporated water to an indoor space. An air-conditioning apparatus using such a non-water supply method includes an indoor unit, an outdoor unit in which condensed water is generated in a heating operation, and a humidifier configured to heat and evaporate the condensed water in the outdoor unit to send the evaporated water into the indoor unit (see, for example, Patent Literature 1). In Patent Literature 1, the outdoor unit includes a water reservoir configured to store the condensed water, and an evaporation device configured to heat and evaporate the condensed water stored in the water reservoir, and the water vapor generated by the evaporation is sent into the indoor unit by a humidification fan through a humidified air transport path. The air-conditioning apparatus in Patent Literature 1 uses, as a method for evaporating condensed water, a heating evaporation method in which a heater provided in the evaporation device is used.
CITATION LIST
Patent Literature
(4) Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2010-085045
SUMMARY OF INVENTION
Technical Problem
(5) However, as in the air-conditioning apparatus in Patent Literature 1, the configuration of an air-conditioning apparatus in which a heater evaporates condensed water to perform humidification in a heating operation of the air-conditioning apparatus necessitates electric power for driving the heater, thus increasing the amount of electric power consumed by the air-conditioning apparatus.
(6) The present disclosure is made to solve such a problem, and an object of the present disclosure is to provide an air-conditioning apparatus capable of performing humidification in a heating operation of the air-conditioning apparatus with a less amount of electric power consumed than existing air-conditioning apparatuses.
Solution to Problem

(7) An air-conditioning apparatus according to an embodiment of the present disclosure configured to perform a heating operation includes: an indoor unit set in an air-conditioning target space, the indoor unit including an indoor heat exchanger; an outdoor unit set outside the air-conditioning target space, the outdoor unit including a compressor configured to compress and discharge refrigerant, an outdoor heat exchanger, and an outdoor fan configured to supply outdoor air to the outdoor heat exchanger; and a humidifier configured to heat and evaporate condensed water in the outdoor unit to send the evaporated water into the indoor unit. The humidifier includes a water reservoir configured to store the condensed water in the outdoor unit, and a heating portion formed by a discharge pipe in which the refrigerant discharged from the compressor flows, the discharge pipe communicating between the compressor and the indoor heat exchanger in the heating operation, the heating portion being configured to heat and evaporate the condensed water stored in the water reservoir with heat of the refrigerant.
Advantageous Effects of Invention
(8) According to the embodiment of the present disclosure, the heating portion formed by the discharge pipe in which the refrigerant discharged from the compressor flows, the discharge pipe communicating between the compressor and the indoor heat exchanger in the heating operation, the heating portion being configured to heat and evaporate the condensed water stored in the water reservoir with heat of the refrigerant, is provided. Accordingly, in the heating operation, it is possible to humidify an indoor space by using heat of the high-temperature refrigerant discharged from the compressor for heating and evaporating the condensed water, thus eliminating the need for setting a heater at the water reservoir and for driving the heater. As a result, it is possible to perform humidification in the heating operation with a less amount of electric power consumed than existing air-conditioning apparatuses.

Description

BRIEF DESCRIPTION OF DRAWINGS
(1) FIG. **1** is a schematic configuration diagram of an air-conditioning apparatus according to Embodiment 1.
(2) FIG. **2** is a diagram illustrating the position where a water reservoir is set in the air-conditioning apparatus in FIG. **1**.
(3) FIG. **3** is a diagram illustrating a first disposition example of a heating portion and the water reservoir in the air-conditioning apparatus in FIG. **1**.
(4) FIG. **4** is a diagram illustrating a second disposition example of the heating portion and the water reservoir in the air-conditioning apparatus in FIG. **1**.
(5) FIG. **5** is a diagram illustrating a third disposition example of the heating portion and the water reservoir in the air-conditioning apparatus in FIG. **1**.
(6) FIG. **6** is a sectional view taken along A-A in FIG. **5**.
(7) FIG. **7** is a sectional view illustrating a modification example of the water reservoir in FIG. **6**.
(8) FIG. **8** is a diagram illustrating the position where a water reservoir is set in an air-conditioning apparatus according to Embodiment 3.
(9) FIG. **9** is a diagram illustrating the position where a water reservoir is set in an air-conditioning apparatus according to Embodiment 4.
(10) FIG. **10** is a schematic configuration diagram of an air-conditioning apparatus according to Embodiment 5.
(11) FIG. **11** is a block diagram illustrating functions of a controller in FIG. **10**.
DESCRIPTION OF EMBODIMENTS
Embodiment 1
(12) FIG. **1** is a schematic configuration diagram of an air-conditioning apparatus **100** according to

Embodiment 1. FIG. **2** is a diagram illustrating the position where a water reservoir **11** is set in the air-conditioning apparatus **100** in FIG. **1**. The air-conditioning apparatus **100** is configured to at least perform a heating operation. Straight solid arrows in FIG. **1** represent the direction in which refrigerant flows in the heating operation of the air-conditioning apparatus **100**. In addition, in FIG. **2**, the arrow X direction represents the width direction of an outdoor unit **2** of the air-conditioning apparatus **100**, the arrow Y direction represents the front-rear direction of the outdoor unit **2**, and the arrow Z direction represents the height direction of the outdoor unit **2**. The configuration of the air-conditioning apparatus **100** according to Embodiment 1 will be described with reference to FIGS. **1** and **2**.
(13) The forms in the drawings described below do not limit the present disclosure. The size relationships of the components in the following drawings including FIG. **1** may differ from those of actual ones. In the drawings, components having the same reference signs are the same or corresponding components, and this applies to the entire description. In the following description, terms that mean directions (for example, “up”, “down”, “right”, “left”, “forward”, and “rearward”) are used as appropriate to make the description easy to understand. These terms are used for description and do not limit the present disclosure. Unless otherwise noted, these terms that mean directions represent directions when the outdoor unit **2** is viewed from its forward side (front side).
(14) (Air-Conditioning Apparatus **100**)
(15) The air-conditioning apparatus **100** includes an indoor unit **3** set in an air-conditioning target space S (for example, an indoor space), the outdoor unit **2** set in the outside of the air-conditioning target space S (for example, an outdoor space), and a humidifier **1** configured to heat and evaporate condensed water W generated in the outdoor unit **2** to send the evaporated water into the indoor unit **3**. The air-conditioning apparatus **100** has a refrigerant circuit C.
(16) The refrigerant circuit C is formed by connecting, by refrigerant pipes **4**, a compressor **23**, an indoor heat exchanger **31**, a pressure reducing device **25**, and an outdoor heat exchanger **21**, for example. Hereinafter, a pipe of the refrigerant pipes **4** that connects the compressor **23** and the indoor heat exchanger **31** in the heating operation of the air-conditioning apparatus **100** may be referred to as a discharge pipe **41**.
(17) The compressor **23** has a suction port **23***a* and a discharge port **23***b* for refrigerant and compresses and discharges suctioned refrigerant to circulate the refrigerant in the refrigerant circuit C. The indoor heat exchanger **31** and the outdoor heat exchanger **21** exchange heat between refrigerant and surrounding air. The pressure reducing device **25** is formed by, for example, an expansion valve and expands and decompresses refrigerant. In addition, in the example illustrated in FIG. **1**, the refrigerant circuit C includes a flow switching device **24**. The flow switching device **24** is formed by, for example, a four-way valve or a combination of a plurality of valves and switches between passages for refrigerant discharged from the compressor **23**.
(18) In the example illustrated in FIG. **1**, the compressor **23**, the flow switching device **24**, the pressure reducing device **25**, and the outdoor heat exchanger **21** of the devices forming the refrigerant circuit C are provided in the outdoor unit **2**, and the indoor heat exchanger **31** of the devices forming the refrigerant circuit C is provided in the indoor unit **3**.
(19) The flow switching device **24** switches between the refrigerant passages, thus switching between a cooling operation and the heating operation. In the heating operation, refrigerant discharged from the compressor **23** flows in the indoor heat exchanger **31**, the pressure reducing device **25**, and the outdoor heat exchanger **21** in this order and returns to the compressor **23**. On the other hand, in the cooling operation, refrigerant discharged from the compressor **23** flows in the outdoor heat exchanger **21**, the pressure reducing device **25**, and the indoor heat exchanger **31** in this order and returns to the compressor **23**. That is, in the heating operation for an indoor space, the indoor heat exchanger **31** functions as a condenser, and the outdoor heat exchanger **21** functions as an evaporator. On the other hand, in the cooling operation for an indoor space, the outdoor heat exchanger **21** functions as a condenser, and the indoor heat exchanger **31** functions as an

evaporator.
(20) The configuration of the refrigerant circuit C of the air-conditioning apparatus **100** is not limited to the above configuration. For example, it is possible to omit the flow switching device **24**. In addition, in the example illustrated in FIG. **1**, the pressure reducing device **25** is disposed in the outdoor unit **2** but may be provided in the indoor unit **3** or in a pipe of the refrigerant pipes **4** that is located between the indoor unit **3** and the outdoor unit **2**.
(21) In FIG. **2**, a white arrow Fw represents a flow of the condensed water W, white arrows A**1** represent a flow of outdoor air in the outdoor unit **2**, and a white arrow A**2** represents a flow of humidified air. In addition, in FIG. **1**, a white arrow A**3** represents a flow of indoor air, and a white arrow A**4** represents a flow of conditioned air. Here, humidified air is air containing outdoor air and water vapor generated by evaporation of the condensed water W. In addition, indoor air is air in the air-conditioning target space S. Furthermore, conditioned air is air whose temperature and humidity are adjusted in the indoor unit **3**.
(22) (Outdoor Unit **2**)
(23) As illustrated in FIG. **2**, the outdoor unit **2** includes an outdoor unit housing **20** having a vent hole **20***a*, through which outdoor air passes. As illustrated in FIG. **1**, the compressor **23**, the flow switching device **24**, the pressure reducing device **25**, and the outdoor heat exchanger **21** of the refrigerant circuit C are mounted in the outdoor unit **2** as described above.
(24) In addition, the outdoor unit **2** includes an outdoor fan **22** configured to supply outdoor air (see the white arrows A**1**) to the outdoor heat exchanger **21**, a condensed water collecting path **26** configured to receive the condensed water W (see the white arrow Fw in FIG. **2**) generated in the outdoor unit **2**, and the humidifier **1**. As illustrated in FIG. **2**, the outdoor fan **22** is driven to supply outdoor air to the outdoor heat exchanger **21** via the vent hole **20***a* of the outdoor unit housing **20**. In addition, as illustrated in FIG. **1**, the humidifier **1** includes the water reservoir **11** configured to store the condensed water W, and the condensed water collecting path **26** is configured to guide the condensed water W into the water reservoir **11** of the humidifier **1**. Specifically, as illustrated in FIG. **2**, the condensed water collecting path **26** is provided below the outdoor heat exchanger **21** and is inclined downward toward the compressor **23** in a lateral direction (arrow X direction) of the outdoor unit **2**. A funnel portion **26***b* extending downward is formed at an end portion, closer to the compressor **23**, of the condensed water collecting path **26**. A tip end portion of the funnel portion **26***b* is connected to the water reservoir **11**.
(25) As illustrated in FIG. **1**, the humidifier **1** includes, for example, the water reservoir **11** and a heating portion **14** configured to heat and evaporate the condensed water W stored in the water reservoir **11**. In addition, the humidifier **1** includes a humidified air transport pipe **13**, which connects the outdoor unit **2** and the indoor unit **3**, and a humidified air fan **12**, which is configured to send, into the indoor unit **3** as humidified air (see the white arrow A**2**), water vapor generated by evaporation in the water reservoir **11** and outdoor air supplied to the inside of the outdoor unit **2**. The heating portion **14** is formed by the discharge pipe **41** and heats and evaporates the condensed water W in the water reservoir **11** with heat of high-temperature, high-pressure refrigerant discharged from the compressor **23**. More specifically, a part of the discharge pipe **41**, which has one end connected to the discharge port **23***b* of the compressor **23**, and the other end connected to the indoor heat exchanger **31**, is routed to be able to be in thermal contact with the outside of the water reservoir **11** and functions as the heating portion **14**.
(26) In the example illustrated in FIG. **1**, the humidified air transport pipe **13** connects the water reservoir **11** and an indoor unit housing **30** of the indoor unit **3**, and the inside of the water reservoir **11** and the inside of the indoor unit housing **30** communicate with each other. In addition, in the example illustrated in FIG. **1**, the humidified air fan **12** is provided at the humidified air transport pipe **13**. This configuration enables humidified air to be sent into the indoor unit **3** to be humidified air containing a sufficient amount of water vapor. In addition, airflow is generated in the indoor unit **3** by an indoor fan **32**, and the humidified air fan **12** is provided with the humidified air

transport pipe **13**, thus enabling humidified air in the humidified air transport pipe **13** to be sent toward the indoor unit **3** and to join the airflow in the indoor unit **3**. It is sufficient that the humidifier **1** have a configuration in which the heating portion **14** formed by the discharge pipe **41** heats and evaporates the condensed water W in the water reservoir **11**, and the configuration of the humidified air fan **12** and the humidified air transport pipe **13**, which form a humidified air transport unit, is not limited to the above configuration.
(27) (Indoor Unit **3**)
(28) As illustrated in FIG. **1**, the indoor unit **3** includes the indoor unit housing **30** having an air inlet **30***a*, through which indoor air (see the white arrow A**3**) passes, and an air outlet **30***b*, through which conditioned air (see the white arrow A**4**) passes. As described above, the indoor heat exchanger **31** of the refrigerant circuit C is mounted in the indoor unit **3**. In addition, the indoor unit **3** includes the indoor fan **32** configured to supply indoor air to the indoor heat exchanger **31**. The indoor fan **32** is driven to cause indoor air to be suctioned into the indoor unit housing **30** via the air inlet **30***a* of the indoor unit housing **30** to supply the indoor air to the indoor heat exchanger **31**. The indoor air suctioned into the indoor unit housing **30** is heated or cooled by being subjected to heat exchange with refrigerant in the indoor heat exchanger **31** and joins humidified air transported from the outdoor unit **2** to form conditioned air. In addition, the indoor fan **32** is driven to cause the conditioned air to be blown out to the air-conditioning target space S via the air outlet **30***b* of the indoor unit housing **30**.
(29) The shape of the water reservoir **11** and the disposition of the outdoor heat exchanger **21**, the compressor **23**, the water reservoir **11**, and the condensed water collecting path **26** in the outdoor unit **2** will be described with reference to FIG. **2**.
(30) The water reservoir **11** is formed by a top **11***a*, a bottom **11***b*, and sides **11***c* connecting the top **11***a* and the bottom **11***b* and has, for example, a hollow cuboid shape. The top **11***a* of the water reservoir **11** has a first opening **11***d* and a second opening **11***e*. The tip end of the funnel portion **26***b* of the condensed water collecting path **26** is connected to the first opening **11***d*. One end of the humidified air transport pipe **13** is connected to the second opening **11***e*. Apart of the discharge pipe **41**, that is, the heating portion **14**, is disposed at the bottom **11***b* of the water reservoir **11** to be along the bottom **11***b*.
(31) It is sufficient that the water reservoir **11** be configured to be able to store the condensed water W, and the shape of the water reservoir **11** is not limited to the above shape. In the example illustrated in FIG. **2**, the first opening **11***d* and the second opening **11***e* are formed in the top **11***a* of the water reservoir **11** but can be formed in the sides **11***c*.
(32) Although not illustrated, legs are provided at the lower end of the outdoor heat exchanger **21**, and a space is formed between the lower end of the outdoor heat exchanger **21** and a bottom portion **20***b* of the outdoor unit housing **20**. The water reservoir **11** is disposed closer to the outdoor heat exchanger **21** than the compressor **23** in the lateral direction (arrow X direction) of the outdoor unit **2** such that at least a part of the water reservoir **11** is located in the space below the outdoor heat exchanger **21**. Then, the tip end of the funnel portion **26***b*, which extends downward, of the condensed water collecting path **26** is connected to the top **11***a* of the water reservoir **11**.
(33) Next, the operation of the air-conditioning apparatus **100** will be described with reference to FIGS. **1** and **2**. FIG. **1** illustrates the air-conditioning apparatus **100** in the heating operation. In the heating operation, the flow switching device **24** connects the indoor heat exchanger **31** and the discharge port **23***b* of the compressor **23**, and high-temperature, high-pressure refrigerant compressed in the compressor **23** flows into the indoor heat exchanger **31** through the flow switching device **24**. The refrigerant that has flowed into the indoor heat exchanger **31** is condensed to heat the indoor space. The refrigerant condensed in the indoor heat exchanger **31** is decompressed and expanded in the pressure reducing device **25** and flows into the outdoor heat exchanger **21**. The refrigerant that has flowed into the outdoor heat exchanger **21** is evaporated and returns to the compressor **23** again through the flow switching device **24**. The above refrigeration

cycle is repeated during the heating operation.
(34) On the other hand, in a defrosting operation or the cooling operation of the air-conditioning apparatus **100**, the flow switching device **24** switches between connections to connect the outdoor heat exchanger **21** and the discharge port **23***b* of the compressor **23**. In the defrosting operation or the cooling operation, refrigerant flows in the direction opposite to the direction in which refrigerant flows in the heating operation.
(35) In the heating operation of the air-conditioning apparatus **100**, moisture in air is condensed into the condensed water W in the outdoor heat exchanger **21**. The condensed water W generated in the outdoor heat exchanger **21** drips onto the condensed water collecting path **26**, passes through the inclined condensed water collecting path **26**, and is stored in the water reservoir **11** as represented by the white arrow Fw in FIG. **2**. On the other hand, outdoor air (see the white arrows A**1**) is suctioned into the outdoor unit housing **20** by driving the outdoor fan **22**, passes through the outdoor heat exchanger **21**, and enters the water reservoir **11** via the funnel portion **26***b* of the condensed water collecting path **26**.
(36) As illustrated in FIG. **1**, the condensed water W stored in the water reservoir **11** is heated by the heating portion **14** and is thus evaporated into water vapor. Humidified air (see the white arrow A**2**) containing the water vapor and fresh outdoor air suctioned into the outdoor unit housing **20** is transported into the indoor unit **3** via the humidified air transport pipe **13** by driving the humidified air fan **12**. The humidified air transported into the indoor unit **3** from the outdoor unit **2** via the humidified air transport pipe **13** joins, in the indoor unit housing **30**, indoor air that has passed through the indoor heat exchanger **31** to form conditioned air containing the humidified air and the indoor air. Then, in the heating operation, the conditioned air that contains the humidified air and the indoor air and that is heated in the indoor heat exchanger **31** is blown out to the air-conditioning target space S via the air outlet **30***b* to heat and humidify the air-conditioning target space S. In addition, since the humidified air contains fresh outdoor air, the air-conditioning apparatus **100** is capable of providing ventilation while heating and humidifying the air-conditioning target space S.
(37) FIG. **3** is a diagram illustrating a first disposition example of the heating portion **14** and the water reservoir **11** in the air-conditioning apparatus **100** in FIG. **1**. FIG. **4** is a diagram illustrating a second disposition example of the heating portion **14** and the water reservoir **11** in the air-conditioning apparatus **100** in FIG. **1**. FIG. **5** is a diagram illustrating a third disposition example of the heating portion **14** and the water reservoir **11** in the air-conditioning apparatus **100** in FIG. **1**. FIG. **6** is a sectional view taken along A-A in FIG. **5**. FIG. **7** is a sectional view illustrating a modification example of the water reservoir **11** in FIG. **6**.
(38) The disposition of the heating portion **14** relative to the water reservoir **11** will be described with reference to FIGS. **3** to **7**. The disposition examples in which a part of the discharge pipe **41** forming the heating portion **14** is routed at the bottom **11***b* of the water reservoir **11** will be described below with reference to FIGS. **3** to **7**, but the heating portion **14** may be provided along one of the sides **11***c* or the top **11***a* of the water reservoir **11**. However, when the heating portion **14** is provided at the top **11***a* or the upper side of one of the sides **11***c* of the water reservoir **11**, heat is difficult to transmit to the condensed water W unless a large amount of the condensed water W is collected in the water reservoir **11**. Thus, provision of the heating portion **14** at the bottom **11***b* is effective. Alternatively, the heating portion **14** may be disposed along two or more of the top **11***a*, the sides **11***c*, and the bottom **11***b* of the water reservoir **11**.
(39) In the first disposition example illustrated in FIG. **3**, the part of the discharge pipe **41** forming the heating portion **14** is routed straight at the bottom **11***b* of the water reservoir **11**. In the second disposition example illustrated in FIG. **4** and the third disposition example illustrated in FIG. **5**, the part of the discharge pipe **41** forming the heating portion **14** is routed to be folded back one or a plurality of times at the bottom **11***b* of the water reservoir **11**, and the heating portion **14** is shaped to include one or a plurality of folded portions **14***a*. In the second disposition example, the folded portions **14***a* are located inside the bottom **11***b* in the bottom view of the water reservoir **11**. On the

other hand, in the third disposition example, the folded portions **14***a* are located outside the bottom **11***b* in the bottom view of the water reservoir **11**.
(40) As illustrated in FIG. **6**, a surface of the bottom **11***b* of the water reservoir **11** is a flat surface, and the part of the discharge pipe **41** forming the heating portion **14** is disposed to be in contact with the surface of the bottom **11***b*. In this manner, the discharge pipe **41** is in contact with the surface of the water reservoir **11**, thus improving the efficiency of heating the water reservoir **11** and the condensed water W compared with a case in which the discharge pipe **41** is not in contact with the water reservoir **11**. In the modification example of the water reservoir **11** illustrated in FIG. **7**, the bottom **11***b* of the water reservoir **11** has recessed portions **11***f*, and a part of the heating portion **14** is configured to be fitted into the recessed portions **11***f*. Similarly to the case illustrated in FIG. **6**, the modification example illustrated in FIG. **7** is also improved in the efficiency of heating the water reservoir **11** and the condensed water W compared with the case in which the discharge pipe **41** is not in contact with the water reservoir **11**. In addition, in the modification example illustrated in FIG. **7**, the contact area between the heating portion **14** and the water reservoir **11** is larger than that in the case illustrated in FIG. **6**, thus further improving the efficiency of heating the water reservoir **11** and the condensed water W. In the modification example, when the heating portion **14** is disposed along one of the sides **11***c* or the top **11***a*, the side **11***c* or the top **11***a* where the heating portion **14** is disposed preferably has the recessed portions **11***f*.
(41) A space may be formed between the heating portion **14** and the water reservoir **11** although this configuration impairs the efficiency of heating the condensed water W compared with a case in which the heating portion **14** is in contact with the water reservoir **11**.
(42) As described above, the air-conditioning apparatus **100** according to Embodiment 1 is configured to perform the heating operation and includes the indoor unit **3** set in the air-conditioning target space S, the outdoor unit **2** set outside the air-conditioning target space S, and the humidifier **1** configured to heat and evaporate the condensed water W in the outdoor unit **2** to send the evaporated water into the indoor unit **3**. The indoor unit **3** includes the indoor heat exchanger **31**. The outdoor unit **2** includes the compressor **23** configured to compress and discharge refrigerant, the outdoor heat exchanger **21**, and the outdoor fan **22** configured to supply outdoor air to the outdoor heat exchanger **21**. The humidifier **1** includes the water reservoir **11** configured to store the condensed water W in the outdoor unit **2**, and the heating portion **14** formed by the discharge pipe **41** and configured to heat and evaporate the condensed water W stored in the water reservoir **11** with heat of the refrigerant. The discharge pipe **41** connects the compressor **23** and the indoor heat exchanger **31** in the heating operation, and the refrigerant discharged from the compressor **23** flows in the discharge pipe **41**.
(43) Thus, the heating portion **14** formed by the discharge pipe **41**, which connects the compressor **23** and the indoor heat exchanger **31** in the heating operation, and configured to heat and evaporate the condensed water W in the outdoor unit **2** stored in the water reservoir **11** with heat of the refrigerant is provided. Accordingly, in the heating operation, it is possible to humidify the indoor space by using heat of the high-temperature refrigerant discharged from the compressor **23** for heating and evaporating the condensed water W, thus eliminating the need for setting a heater at the water reservoir **11** and for driving the heater as in the existing air-conditioning apparatus. As a result, it is possible to perform humidification in the heating operation with a less amount of electric power consumed than existing air-conditioning apparatuses.
(44) In addition, the humidifier **1** includes the humidified air transport pipe **13** connecting the water reservoir **11** and the indoor unit **3**, and the humidified air fan **12** provided at the humidified air transport pipe **13** and configured to send, into the indoor unit **3** as humidified air, water vapor generated by evaporation in the water reservoir **11** and outdoor air supplied to the inside of the outdoor unit **2**.
(45) This configuration enables humidified air to be sent into the indoor unit **3** to be humidified air containing a sufficient amount of water vapor and enables humidified air in the humidified air

transport pipe **13** to be sent into the indoor unit **3** by the humidified air fan **12** provided at the humidified air transport pipe **13** and to join airflow in the indoor unit **3**. Accordingly, it is possible to prevent insufficient humidification in the air-conditioning target space S. In addition, this configuration also has an effect of ventilating the air-conditioning target space S by supply of fresh outdoor air to the air-conditioning target space S.

Embodiment 2

(46) The air-conditioning apparatus **100** according to Embodiment 2 will be described with reference to FIG. **1**. The air-conditioning apparatus **100** in Embodiment 2 differs from that in Embodiment 1 in that the shape of the discharge pipe **41** is limited, and the other configurations thereof are similar to those in Embodiment 1. In Embodiment 2, the same parts as those in Embodiment 1 have the same reference signs, and description is given with a focus on the difference between Embodiments 1 and 2.

(47) In the refrigerant circuit C in Embodiment 2, the discharge pipe **41** is shaped to connect the compressor **23** and the indoor heat exchanger **31** without branching. In the example illustrated in FIG. **1**, the discharge pipe **41** is formed by only one pipe connecting the indoor heat exchanger **31** and the discharge port **23***b* of the compressor **23**.

(48) Also in the refrigerant circuit C in Embodiment 2, similarly to the case in Embodiment 1, the flow switching device **24** can be provided at the discharge pipe **41**. In addition, also in Embodiment 2, similarly to the case in Embodiment 1, a part of the discharge pipe **41** is routed to be able to be in thermal contact with the outside of the water reservoir **11** and functions as the heating portion **14** configured to heat and evaporate the condensed water W.

(49) As described above, in the configuration in which the discharge pipe **41** connects the compressor **23** and the indoor heat exchanger **31** without branching, refrigerant that flows from the indoor heat exchanger **31** to the compressor **23** always flows through the heating portion **14** in the cooling operation in which the refrigerant flows in the cycle opposite to that in the heating operation. Accordingly, since the degree of superheat of the refrigerant is easy to increase in the cooling operation of the air-conditioning apparatus **100**, the air-conditioning apparatus **100** is capable of effectively performing the cooling operation even under a low outdoor air temperature condition.

(50) It is possible to connect a plurality of the indoor units **3** to the outdoor unit **2**. In a configuration in which a plurality of the indoor units **3** are connected to the outdoor unit **2**, the discharge pipe **41** branches into a plurality of pipes at a position therein closer to the indoor units **3**, and the tip of each branch pipe is connected to the indoor heat exchanger **31** of a corresponding one of the indoor units **3**. Here, the configuration in which the discharge pipe **41** connects the compressor **23** and the indoor heat exchanger **31** without branching is a concept including the configuration in which, when a plurality of the indoor units **3** are connected to the outdoor unit **2**, the discharge pipe **41** branches, at a position therein closer to the indoor units **3**, into a plurality of pipes connected to the respective indoor heat exchangers **31** of the indoor units **3**. That is, the configuration in which the discharge pipe **41** connects the compressor **23** and the indoor heat exchanger **31** without branching may be a configuration in which the discharge pipe **41** branches to be connected to a plurality of the indoor heat exchangers **31**. However, the configuration in which the discharge pipe **41** connects the compressor **23** and the indoor heat exchanger **31** without branching does not include a configuration in which the discharge pipe **41** has both a branch point P**1** and a joining point P**2** between the compressor **23** and the indoor heat exchanger **31**.

(51) As described above, in the air-conditioning apparatus **100** according to Embodiment 2, the discharge pipe **41** connects the compressor **23** and the indoor heat exchanger **31** without branching. This configuration enables the heat loss of the refrigerant discharged from the compressor **23** between the compressor **23** and the indoor heat exchanger **31** to be minimum.

Embodiment 3

(52) FIG. **8** is a diagram illustrating the position where the water reservoir **11** is set in the air-

conditioning apparatus **100** according to Embodiment 3. As illustrated in FIG. **8**, Embodiment 3 differs from Embodiment 1 in the position where the water reservoir **11** is set in the outdoor unit **2** and the configuration of a condensed water collecting path **126**, and the other configurations thereof are similar to those in Embodiment 1. In Embodiment 3, the same parts as those in Embodiment 1 have the same reference signs, and description is given with a focus on the difference between Embodiments 1 and 3.
(53) As illustrated in FIG. **8**, the outdoor unit **2** has a space, below the compressor **23**, between the compressor **23** and the bottom portion **20***b* of the outdoor unit housing **20**. In Embodiment 1, as illustrated in FIG. **2**, the water reservoir **11** is disposed closer to the outdoor heat exchanger **21** than the compressor **23** in the lateral direction (arrow X direction) of the outdoor unit **2** such that at least a part of the water reservoir **11** is located below the outdoor heat exchanger **21**. In Embodiment 3, as illustrated in FIG. **8**, the water reservoir **11** is disposed closer to the compressor **23** than the outdoor heat exchanger **21** in the lateral direction (arrow X direction) of the outdoor unit **2** such that at least a part of the water reservoir **11** is located in the space below the compressor **23**.
(54) In addition, in Embodiment 3, the condensed water collecting path **126** includes a water receiving portion **126***a* disposed below the outdoor heat exchanger **21**, and an extension path **126***b* connecting the water receiving portion **126***a* and the water reservoir **11**. The water receiving portion **126***a* is inclined downward toward the compressor **23** in the lateral direction (arrow X direction) of the outdoor unit **2**. The extension path **126***b* is provided at an end portion, closer to the compressor **23**, of the water receiving portion **126***a*. The extension path **126***b* extends to a position below the compressor **23** in the height direction (arrow Z direction) of the outdoor unit **2**.
(55) In the example illustrated in FIG. **8**, the compressor **23** is disposed at the right of the outdoor heat exchanger **21**, and the water receiving portion **126***a* is inclined downward toward the right. In addition, in the example illustrated in FIG. **8**, the extension path **126***b* is shaped to be continuous with the right end portion of the water receiving portion **126***a*, extends right and downward, and is connected to the top **11***a* of the water reservoir **11**.
(56) As represented by the white arrow Fw in FIG. **8**, the condensed water W that has dripped from the outdoor heat exchanger **21** flows, along the water receiving portion **126***a* of the condensed water collecting path **126**, to the extension path **126***b*, then flows into the water reservoir **11** via the extension path **126***b*, and is stored in the water reservoir **11**. On the other hand, outdoor air (see the white arrows A**1**) suctioned into the outdoor unit housing **20** passes through the outdoor heat exchanger **21** and enters the water reservoir **11** via the extension path **126***b* of the condensed water collecting path **126**. Then, the condensed water W stored in the water reservoir **11** is heated by the heating portion **14** formed by the discharge pipe **41** and is thus evaporated into water vapor. As illustrated in FIG. **1**, humidified air (see the white arrow A**2**) containing the water vapor and the outdoor air suctioned into the outdoor unit housing **20** is transported into the indoor unit **3** via the humidified air transport pipe **13** by driving the humidified air fan **12**.
(57) As described above, in the air-conditioning apparatus **100** according to Embodiment 3, the water reservoir **11** is set below the compressor **23**. Thus, the distance between the water reservoir **11** and the compressor **23** connected to the discharge pipe **41** is smaller than that in a case in which the water reservoir **11** is set below the outdoor heat exchanger **21**. Accordingly, it is possible to reduce the pipe length of the discharge pipe **41** and to thus reduce the heat loss of refrigerant. In addition, the pipe length of the part of the discharge pipe **41** from the compressor **23** to the heating portion **14** can be smaller than that in the case in which the water reservoir **11** is set below the outdoor heat exchanger **21**. Accordingly, it is possible to reduce the heat loss of the refrigerant flowing to the heating portion **14** and to thus inhibit a reduction in the heating capacity of the heating portion **14**.
(58) In addition, the outdoor unit **2** includes the water receiving portion **126***a* disposed below the outdoor heat exchanger **21**, and the extension path **126***b* connecting the water receiving portion **126***a* and the water reservoir **11**. Thus, it is possible to store the condensed water W in the water

reservoir **11** with the simple structure. Accordingly, it is possible to dispose the water reservoir **11** according to the heat loss of refrigerant and limitations on the disposition of the devices in the outdoor unit **2**, thus improving the flexibility in the position where the water reservoir **11** is set.

Embodiment 4

(59) FIG. **9** is a diagram illustrating the position where the water reservoir **11** is set in the air-conditioning apparatus **100** according to Embodiment 4. The air-conditioning apparatus **100** in Embodiment 4 differs from that in Embodiment 3 in the position where the water reservoir **11** is set in the outdoor unit **2**, the configuration of the condensed water collecting path **126**, and the position where the condensed water collecting path **126** is connected to the water reservoir **11**, and the other configurations thereof are similar to those in Embodiment 1. In Embodiment 4, the same parts as those in Embodiment 1 have the same reference signs, and description is given with a focus on the difference between Embodiments 1 and 4.

(60) In Embodiment 1, as illustrated in FIG. **2**, the water reservoir **11** is disposed closer to the outdoor heat exchanger **21** than the compressor **23** in the lateral direction (arrow X direction) of the outdoor unit **2** such that at least a part of the water reservoir **11** is located below the outdoor heat exchanger **21**. In Embodiment 4, as illustrated in FIG. **9**, the water reservoir **11** is disposed between the outdoor heat exchanger **21** and the compressor **23** in the lateral direction (arrow X direction) of the outdoor unit **2**.

(61) In addition, in Embodiment 4, the condensed water collecting path **126** includes the water receiving portion **126***a* disposed below the outdoor heat exchanger **21**, and the extension path **126***b* connecting the water receiving portion **126***a* and the water reservoir **11**. The water receiving portion **126***a* is inclined downward toward the compressor **23** in the lateral direction (arrow X direction) of the outdoor unit **2**. The extension path **126***b* is provided at the end portion, closer to the compressor **23**, of the water receiving portion **126***a*. In addition, in Embodiment 4, the extension path **126***b* of the condensed water collecting path **126** is connected to the side **11***c*, closer to the outdoor heat exchanger **21**, of the water reservoir **11**.

(62) In the example illustrated in FIG. **9**, the compressor **23** is disposed at the right of the outdoor heat exchanger **21**, and the water receiving portion **126***a* is inclined downward toward the right. In addition, in the example illustrated in FIG. **9**, the extension path **126***b* is shaped to be continuous with the right end portion of the water receiving portion **126***a*, extends right, and is connected to the side **11***c* of the water reservoir **11**.

(63) As described above, in the air-conditioning apparatus **100** according to Embodiment 4, the water reservoir **11** is set between the outdoor heat exchanger **21** and the compressor **23**. Thus, Embodiment 4 can also achieve effects similar to those in Embodiment 3. That is, the distance between the water reservoir **11** and the compressor **23** connected to the discharge pipe **41** is smaller than that in a case in which the water reservoir **11** is set below the outdoor heat exchanger **21** as in Embodiment 1. Accordingly, it is possible to reduce the pipe length of the discharge pipe **41** and to thus reduce the heat loss of refrigerant. In addition, the pipe length of the part of the discharge pipe **41** from the compressor **23** to the heating portion **14** can be smaller than that in the case in which the water reservoir **11** is set below the outdoor heat exchanger **21**. Accordingly, it is possible to reduce the heat loss of the refrigerant flowing to the heating portion **14** and to thus inhibit a reduction in the heating capacity of the heating portion **14**. In addition, the water reservoir **11** and the heating portion **14** face a part of the side of the compressor **23**. Thus, when the compressor **23** is a high-pressure shell compressor, radiant heat from a compressor shell having a high temperature due to operation of the compressor **23** can further promote heating and evaporation of the condensed water W in the water reservoir **11**.

Embodiment 5

(64) FIG. **10** is a schematic configuration diagram of the air-conditioning apparatus **100** according to Embodiment 5. FIG. **11** is a block diagram illustrating functions of a controller **5** in FIG. **10**. The air-conditioning apparatus **100** in Embodiment 5 differs from that in Embodiment 1 in provision of

a water level sensor **15** and the shape of a discharge pipe **141**, and the other configurations thereof are similar to those in Embodiment 1. In Embodiment 5, the same parts as those in Embodiment 1 have the same reference signs, and description is given with a focus on the difference between Embodiments 1 and 5.

(65) In Embodiment 5, the humidifier **1** includes the water level sensor **15** configured to detect the water level of the condensed water W stored in the water reservoir **11**. The provision of the water level sensor **15** enables grasping of whether or not the condensed water W is stored in the water reservoir **11** and the water level of the condensed water W. Thus, for example, the temperature of refrigerant in the discharge pipe **141** or the flow rate of the refrigerant is adjusted according to a detection result, that is, it is possible to use such a detection result for control of the heating power of the heating portion **14**.

(66) A configuration example in which a detection result of the water level sensor **15** is used for control of the heating power of the heating portion **14** will be described below.

(67) As illustrated in FIG. **10**, the discharge pipe **141** is shaped to have the branch point P**1** and the joining point P**2**, and a part of the discharge pipe **141** branches into two parallel pipe portions. A part of one of the two pipe portions is routed to be able to be in thermal contact with the outside of the water reservoir **11** and forms the heating portion **14**. That is, the discharge pipe **141** includes a heating pipe portion **141***b*, which forms the heating portion **14**, and a non-heating pipe portion **141***a*, which does not form the heating portion **14**. In the example illustrated in FIG. **10**, the branch point P**1** and the joining point P**2** are provided, in the discharge pipe **141**, closer to the indoor heat exchanger **31** than the flow switching device **24**.

(68) The humidifier **1** includes a flow control mechanism **16** (see FIG. **11**), which is configured to control the flow rate of refrigerant that flows into the heating pipe portion **141***b* and is formed by a plurality of valves. Specifically, the flow control mechanism **16** is formed by on-off valves or valves each capable of continuously changing the opening degree thereof. In the example illustrated in FIG. **10**, the flow control mechanism **16** (see FIG. **11**) is formed by a first flow control valve **16***a*, which is provided at the non-heating pipe portion **141***a*, and a second flow control valve **16***b*, which is provided at the heating pipe portion **141***b*.

(69) In addition, the air-conditioning apparatus **100** includes the controller **5** configured to control operation of actuators such as the compressor **23** to cause the air-conditioning apparatus **100** to perform various operations. Although not illustrated, the air-conditioning apparatus **100** includes various sensors configured to detect, for example, the temperature and the pressure of refrigerant and the temperature of indoor air. As illustrated in FIG. **11**, the controller **5** controls the frequency of the compressor **23**, the opening degree of the pressure reducing device **25**, the rotation speed of each of the outdoor fan **22** and the indoor fan **32**, and switching of the flow switching device **24** on the basis of detection values of these various sensors (not illustrated).

(70) In addition, the controller **5** also controls the rotation speed of the humidified air fan **12** of the humidifier **1** in the heating operation. In addition, a detection value of the water level sensor **15** is inputted into the controller **5**, and the controller **5** controls the opening degree of each of the first flow control valve **16***a* and the second flow control valve **16***b* of the flow control mechanism **16** according to, for example, the load of the heating operation and such a detection value of the water level sensor **15**.

(71) The controller **5** is formed by dedicated hardware or a central processing unit (CPU) configured to execute a program stored in memory. The CPU is also referred to as a central processing unit, a processing unit, an arithmetic unit, a microprocessor, a microcomputer, or a processor.

(72) When the controller **5** is dedicated hardware, the controller **5** corresponds to, for example, a single circuit, a combined circuit, an application specific integrated circuit (ASIC), a field-programmable gate array (FPGA), or a combination thereof. Respective functional units of the controller **5** may be implemented by separate pieces of hardware or a single piece of hardware.

(73) When the controller **5** is a CPU, respective functions executed by the controller **5** are implemented by software, firmware, or a combination of software and firmware. Such software and firmware are each described as a program and stored in memory. The CPU reads and executes a program stored in the memory to implement the respective functions of the controller **5**. Here, the memory is a nonvolatile or volatile semiconductor memory such as RAM, ROM, flash memory, EPROM, or EEPROM.
(74) Some of the functions of the controller **5** may be implemented by dedicated hardware, and the others of the functions of the controller **5** may be implemented by software or firmware.
(75) The controller **5** includes, as the functional units, a main control unit **51** and a storage unit **52**. The main control unit **51** controls, for example, the compressor **23**, the pressure reducing device **25**, the outdoor fan **22**, the indoor fan **32**, the flow switching device **24**, the humidified air fan **12**, and the flow control mechanism **16** on the basis of information inputted into the main control unit **51**, and information stored in the storage unit **52**. The storage unit **52** stores, for example, information inputted into the storage unit **52**, and control parameters to which the main control unit **51** refers.
(76) As represented by straight solid arrows in FIG. **10**, in the heating operation of the air-conditioning apparatus **100**, high-temperature, high-pressure refrigerant compressed in the compressor **23** flows into the indoor heat exchanger **31** through the discharge pipe **141**. Apart of the refrigerant that has been discharged from the compressor **23** and that has branched off into the heating pipe portion **141***b* at the branch point P**1** of the discharge pipe **141** radiates, in the heating portion **14**, heat to the condensed water W, then joins, at the joining point P**2**, a part of the refrigerant that has passed through the non-heating pipe portion **141***a*, and flows into the indoor heat exchanger **31**. The flow control mechanism **16** (see FIG. **11**) includes not only the second flow control valve **16***b* provided at the heating pipe portion **141***b* but also the first flow control valve **16***a* provided at the non-heating pipe portion **141***a*. Accordingly, appropriate control of the opening degree of each of the first flow control valve **16***a* and the second flow control valve **16***b* enables the refrigerant expected to flow toward the indoor heat exchanger **31** at the joining point P**2** to be prevented from flowing in the opposite direction toward the heating pipe portion **141***b*.
(77) As described above, in the air-conditioning apparatus **100** according to Embodiment 5, the humidifier **1** includes the water level sensor **15** configured to detect the water level of the condensed water W stored in the water reservoir **11**. Thus, it is possible to grasp whether or not the condensed water W is stored in the water reservoir **11** and the water level of the condensed water W. Accordingly, it is possible to use such detection results for control including, for example, adjustment of the temperature of refrigerant in the discharge pipe **141** or the flow rate of the refrigerant in the discharge pipe **141**.
(78) In addition, the discharge pipe **141** includes the heating pipe portion **141***b*, which forms the heating portion **14**, and the non-heating pipe portion **141***a*, which is connected in parallel to the heating pipe portion **141***b*. The humidifier **1** includes the flow control mechanism **16** configured to control the flow rate of refrigerant that flows into the heating pipe portion **141***b*. The flow control mechanism **16** includes the first flow control valve **16***a*, which is provided at the non-heating pipe portion **141***a*, and the second flow control valve **16***b*, which is provided at the heating pipe portion **141***b*. In addition, the air-conditioning apparatus **100** includes the controller **5** configured to control the opening degree of each of the first flow control valve **16***a* and the second flow control valve **16***b* according to a water level detected by the water level sensor **15**. Thus, it is possible to control the flow rate of refrigerant that flows in the heating portion **14** and to thus control the heating power according to the amount of the condensed water W stored in the water reservoir **11**. As a result, it is possible to avoid, for example, heating without water.
(79) Embodiments described above can be combined, modified, or omitted as appropriate.
REFERENCE SIGNS LIST
(80) **1**: humidifier, **2**: outdoor unit, **3**: indoor unit, **4**: refrigerant pipe, **5**: controller, **11**: water

reservoir, **11***a*: top, **11***b*: bottom, **11***c*: side, **11***d*: first opening, **11***e*: second opening, **11***f*: recessed portion, **12**: humidified air fan, **13**: humidified air transport pipe, **14**: heating portion, **14***a*: folded portion, **15**: water level sensor, **16**: flow control mechanism, **16***a*: first flow control valve, **16***b*: second flow control valve, **20**: outdoor unit housing, **20***a*: vent hole, **20***b*: bottom portion, **21**: outdoor heat exchanger, **22**: outdoor fan, **23**: compressor, **23***a*: suction port, **23***b*: discharge port, **24**: flow switching device, **25**: pressure reducing device, **26**: condensed water collecting path, **26***b*: funnel portion, **30**: indoor unit housing, **30***a*: air inlet, **30***b*: air outlet, **31**: indoor heat exchanger, **32**: indoor fan, **41**: discharge pipe, **51**: main control unit, **52**: storage unit, **100**: air-conditioning apparatus, **126**: condensed water collecting path, **126***a*: water receiving portion, **126***b*: extension path, **141**: discharge pipe, **141***a*: non-heating pipe portion, **141***b*: heating pipe portion, A**1**: white arrow, A**2**: white arrow, A**3**: white arrow, A**4**: white arrow, C: refrigerant circuit, Fw: white arrow, P**1**: branch point, P**2**: joining point, S: air-conditioning target space, W: condensed water, X: arrow, Y: arrow, Z: arrow

Claims

1. An air-conditioning apparatus configured to perform a heating operation, the air-conditioning apparatus comprising: an indoor unit set in an air-conditioning target space, the indoor unit including an indoor heat exchanger; an outdoor unit set outside the air-conditioning target space, the outdoor unit including a compressor configured to compress and discharge refrigerant, an outdoor heat exchanger, and an outdoor fan configured to supply outdoor air to the outdoor heat exchanger; a humidifier configured to heat and evaporate condensed water in the outdoor unit to send the evaporated water into the indoor unit; and a controller, wherein the humidifier includes a water reservoir configured to store the condensed water in the outdoor unit, a heating portion formed by a discharge pipe in which the refrigerant discharged from the compressor flows, the discharge pipe communicating between the compressor and the indoor heat exchanger in the heating operation, the heating portion being configured to heat and evaporate the condensed water stored in the water reservoir with heat of the refrigerant, a water level sensor configured to detect a water level of the condensed water stored in the water reservoir, and a flow control mechanism, the discharge pipe includes a heating pipe portion forming the heating portion, and a non-heating pipe portion connected in parallel to the heating pipe portion, the flow control mechanism is configured to control a flow rate of refrigerant that flows into the heating pipe portion, the flow control mechanism includes a first flow control valve provided at the non-heating pipe portion, and a second flow control valve provided at the heating pipe portion, and the controller is configured to control an opening degree of each of the first flow control valve and the second flow control valve according to the water level detected by the water level sensor.
2. The air-conditioning apparatus of claim 1, wherein the humidifier further includes a humidified air transport pipe connecting the water reservoir and the indoor unit, and a humidified air fan provided at the humidified air transport pipe, the humidified air fan being configured to send, into the indoor unit as humidified air, water vapor generated by evaporation in the water reservoir and the outdoor air supplied to an inside of the outdoor unit.
3. The air-conditioning apparatus of claim 1, wherein the water reservoir is set below the compressor.
4. The air-conditioning apparatus of claim 1, wherein the water reservoir is set between the outdoor heat exchanger and the compressor.
5. The air-conditioning apparatus of claim 3, wherein the outdoor unit further includes a water receiving portion disposed below the outdoor heat exchanger, and an extension path connecting the water receiving portion and the water reservoir.

6. The air-conditioning apparatus of claim 1, wherein the discharge pipe connects the compressor and the indoor heat exchanger without branching.