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(54) **COOLING AND HEATING DEVICE**

(71) Applicant: **ADTEX Inc.**, Gunma (JP)

(72) Inventors: **Hiroshi MUKAIYAMA**, Gunma (JP); **Hiroo SATO**, Gunma (JP)

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(57) **ABSTRACT**

A cooling and heating apparatus includes: a refrigeration cycle circuit where a compression means, a gas cooler, a throttle means, and an evaporator are sequentially connected and a refrigerant circulates; and a circulation fluid circuit provided with a circulating pump and a heating device, in which circulation fluid that adjusts a temperature of a control target circulates, wherein the circulation fluid circuit includes: a freely openable and closable low-temperature path where the circulation fluid flows through the evaporator in such a manner that heat is exchangeable between the circulation fluid and the refrigerant, and a freely openable and closable high-temperature path where the circulation fluid flows through the gas cooler in such a manner that heat is exchangeable between the circulation fluid and the refrigerant, and the high-temperature path is provided with a high-temperature tank where the circulation fluid heated by the refrigerant in the gas cooler is stored.

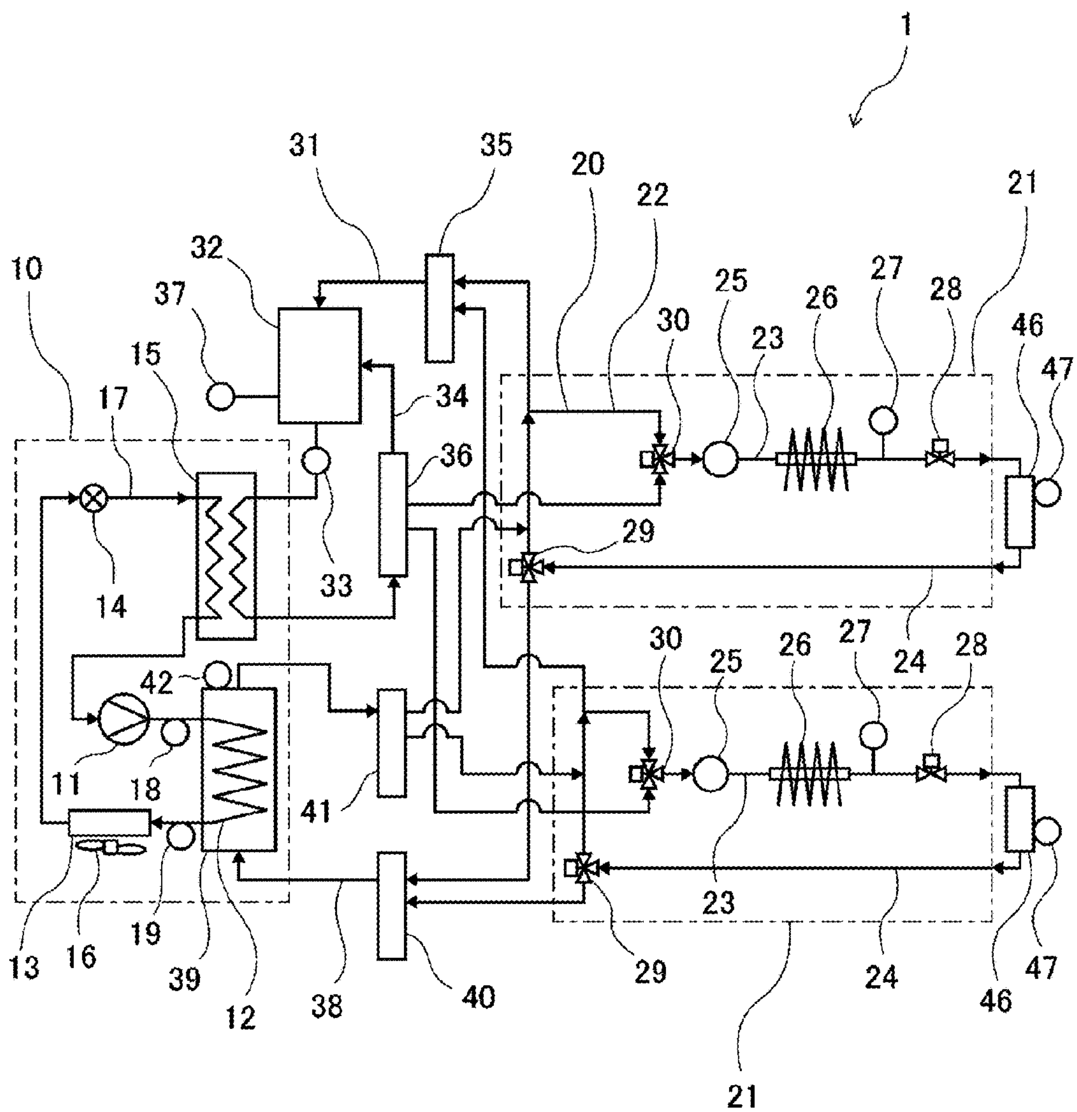

FIG. 1

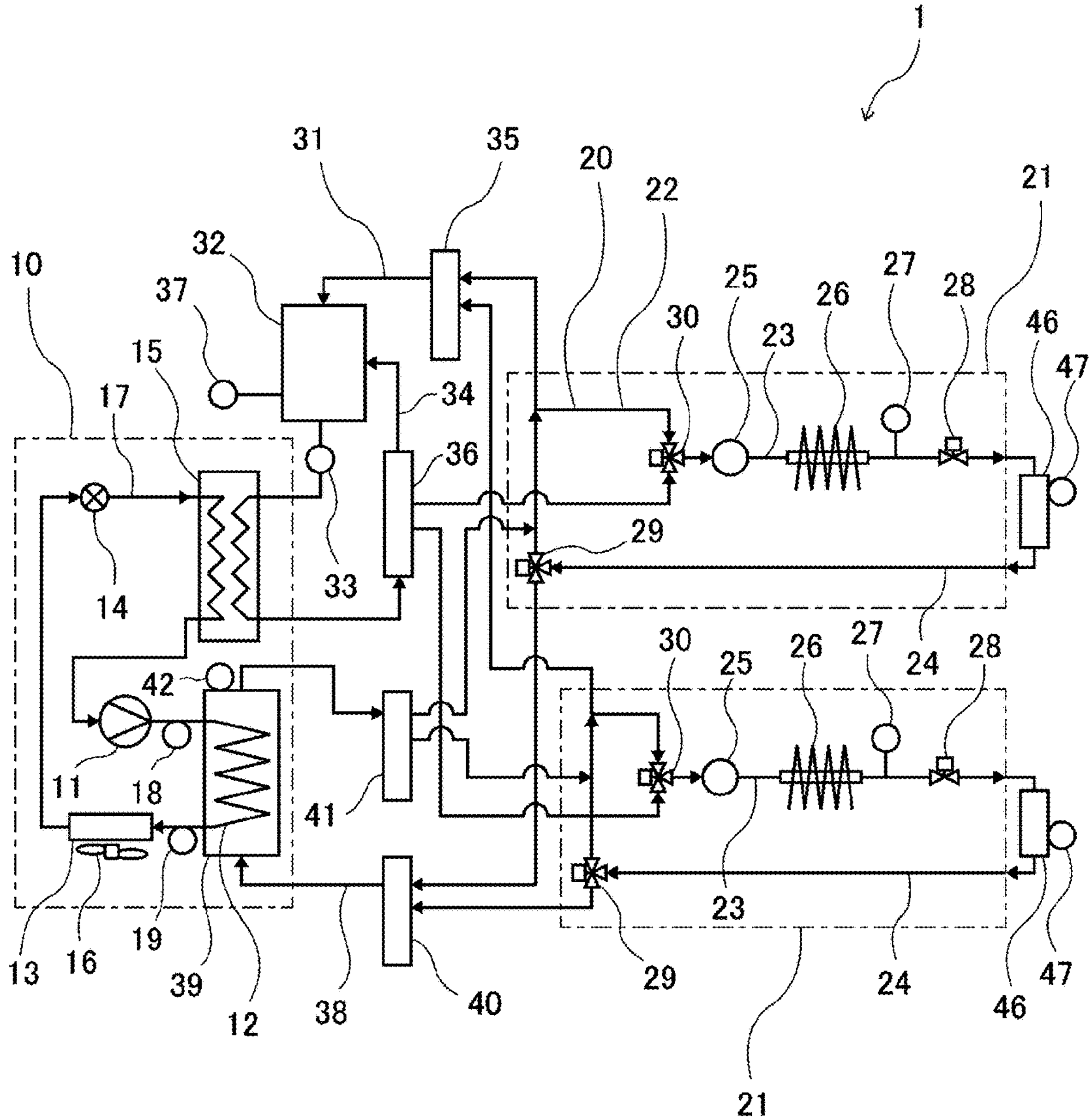
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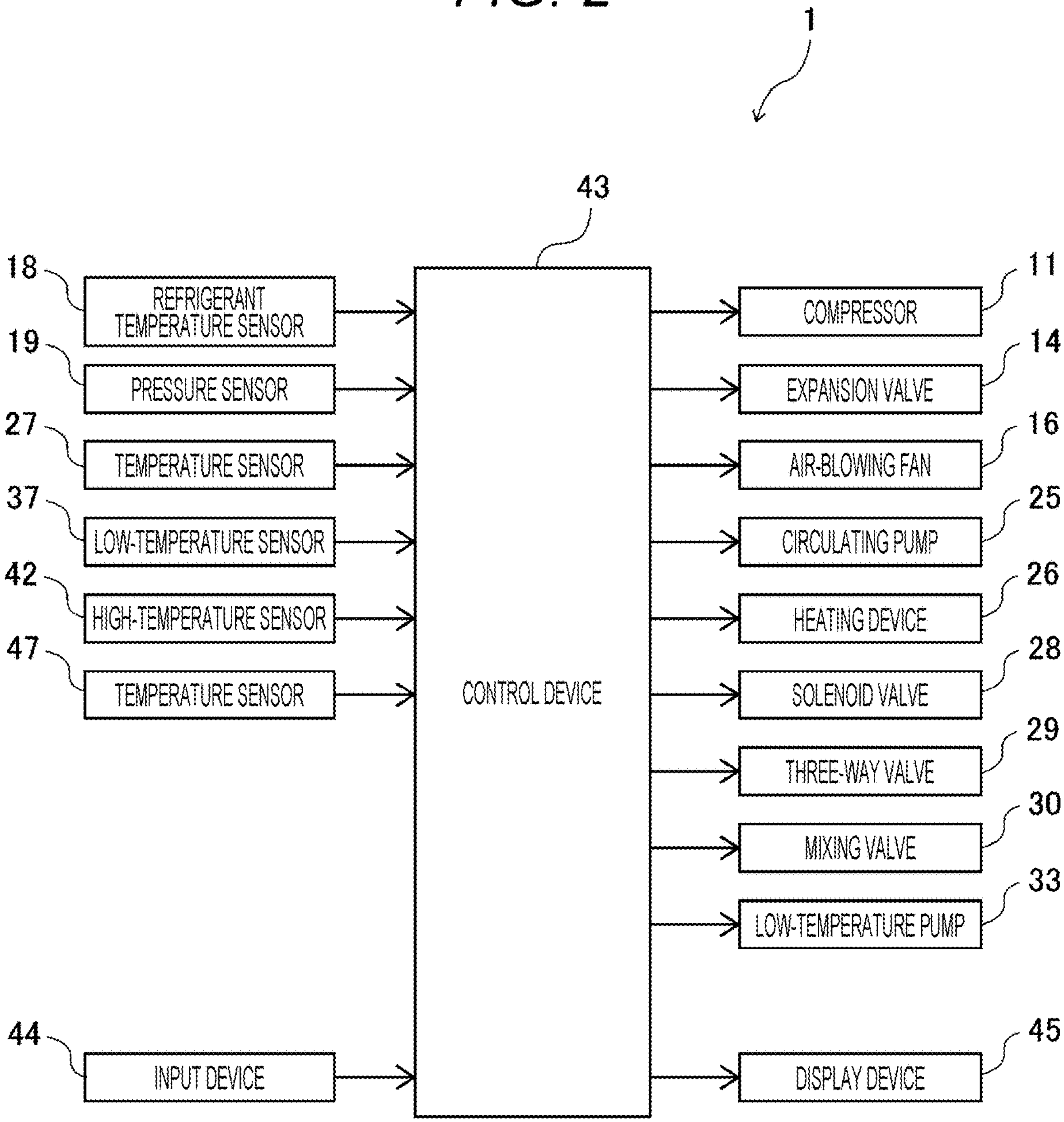
FIG. 2



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REFRIGERANT TEMPERATURE SENSOR
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PRESSURE SENSOR
27
TEMPERATURE SENSOR
37
LOW-TEMPERATURE SENSOR
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HIGH-TEMPERATURE SENSOR
47
TEMPERATURE SENSOR
44
INPUT DEVICE
CONTROL DEVICE
11
COMPRESSOR
14
EXPANSION VALVE
16
AIR-BLOWING FAN
25
CIRCULATING PUMP
26
HEATING DEVICE
28
SOLENOID VALVE
29
THREE-WAY VALVE
30
MIXING VALVE
33
LOW-TEMPERATURE PUMP
45
DISPLAY DEVICE

FIG. 3

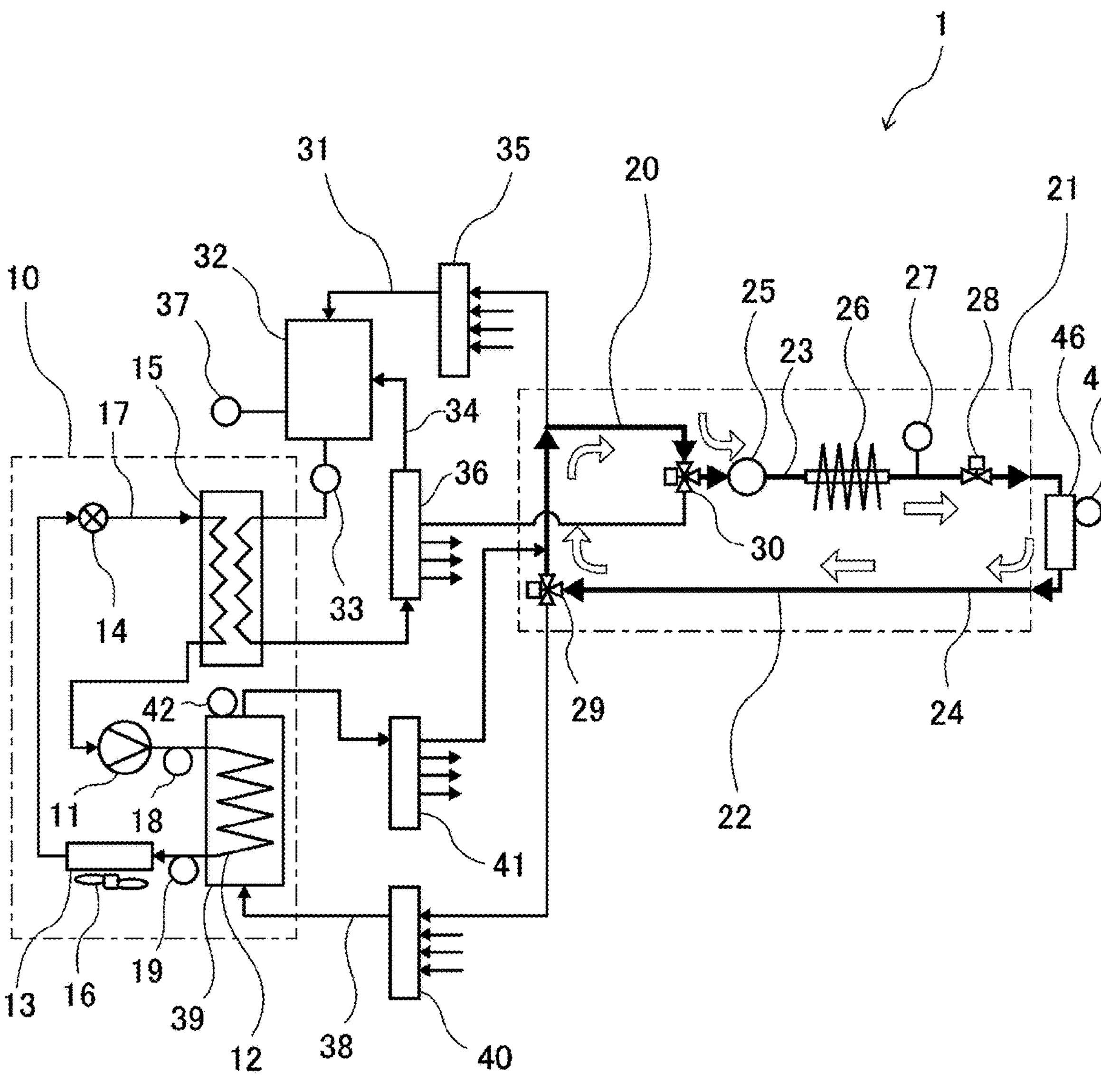

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FIG. 4

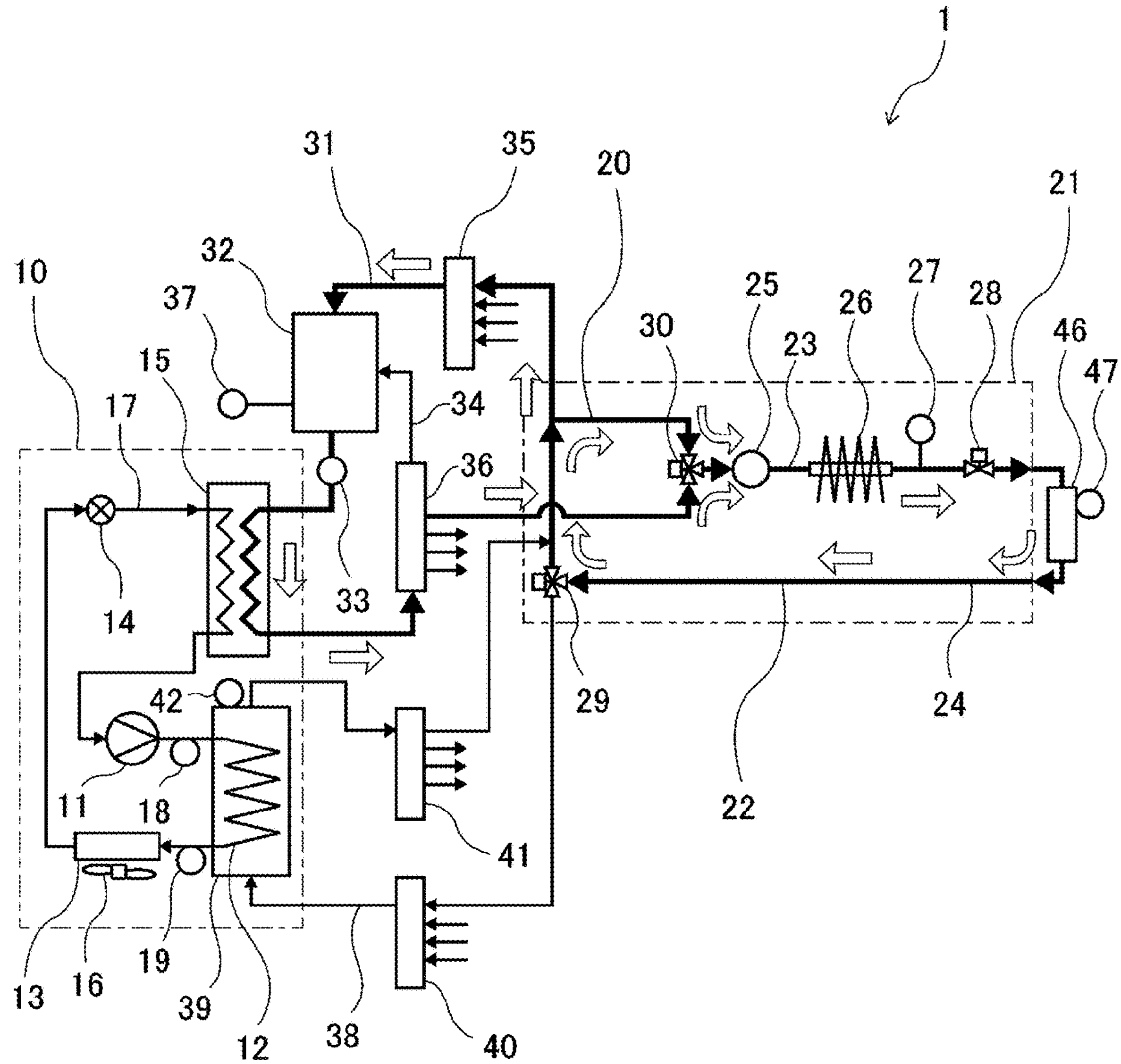
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FIG. 5

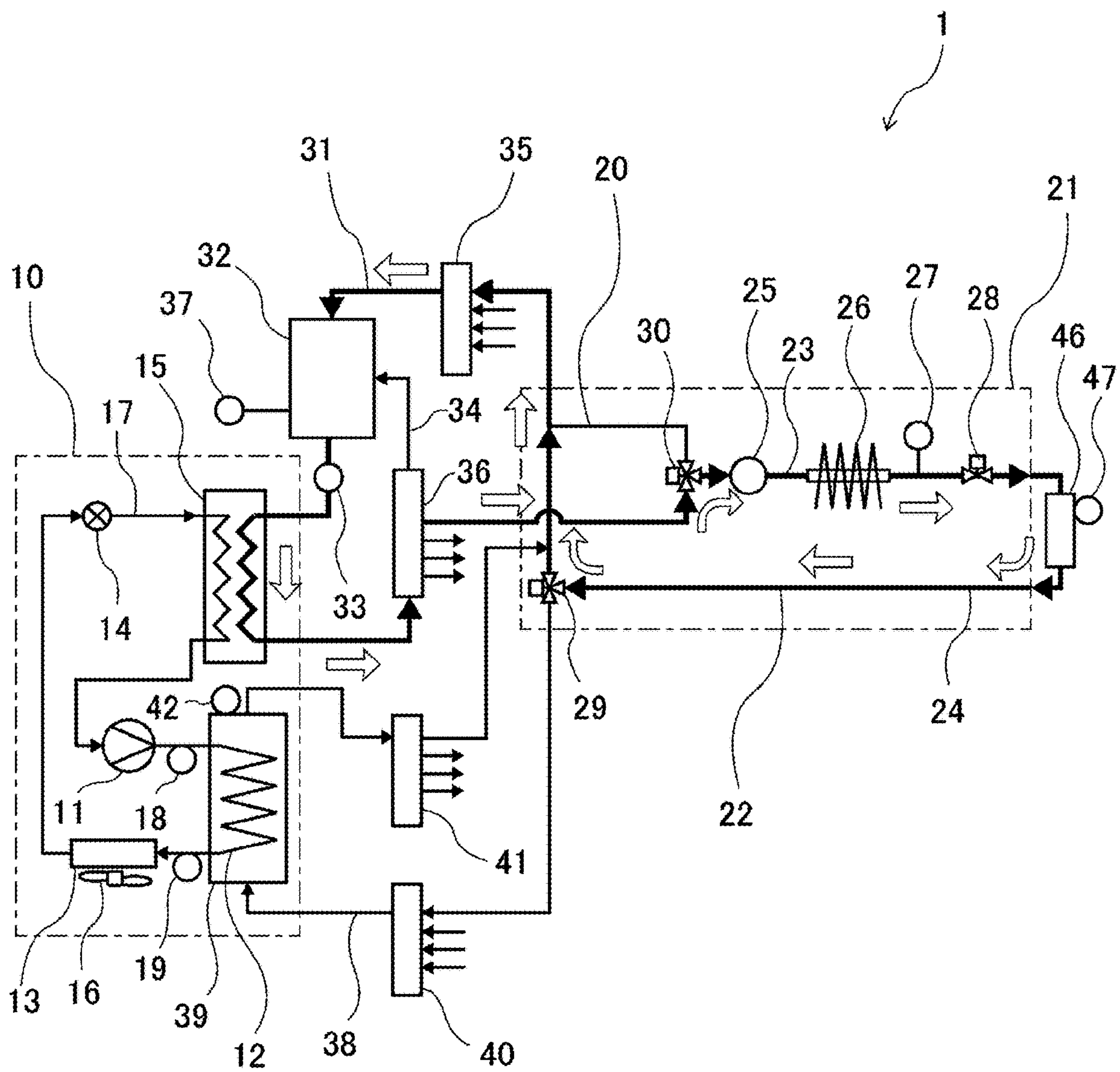
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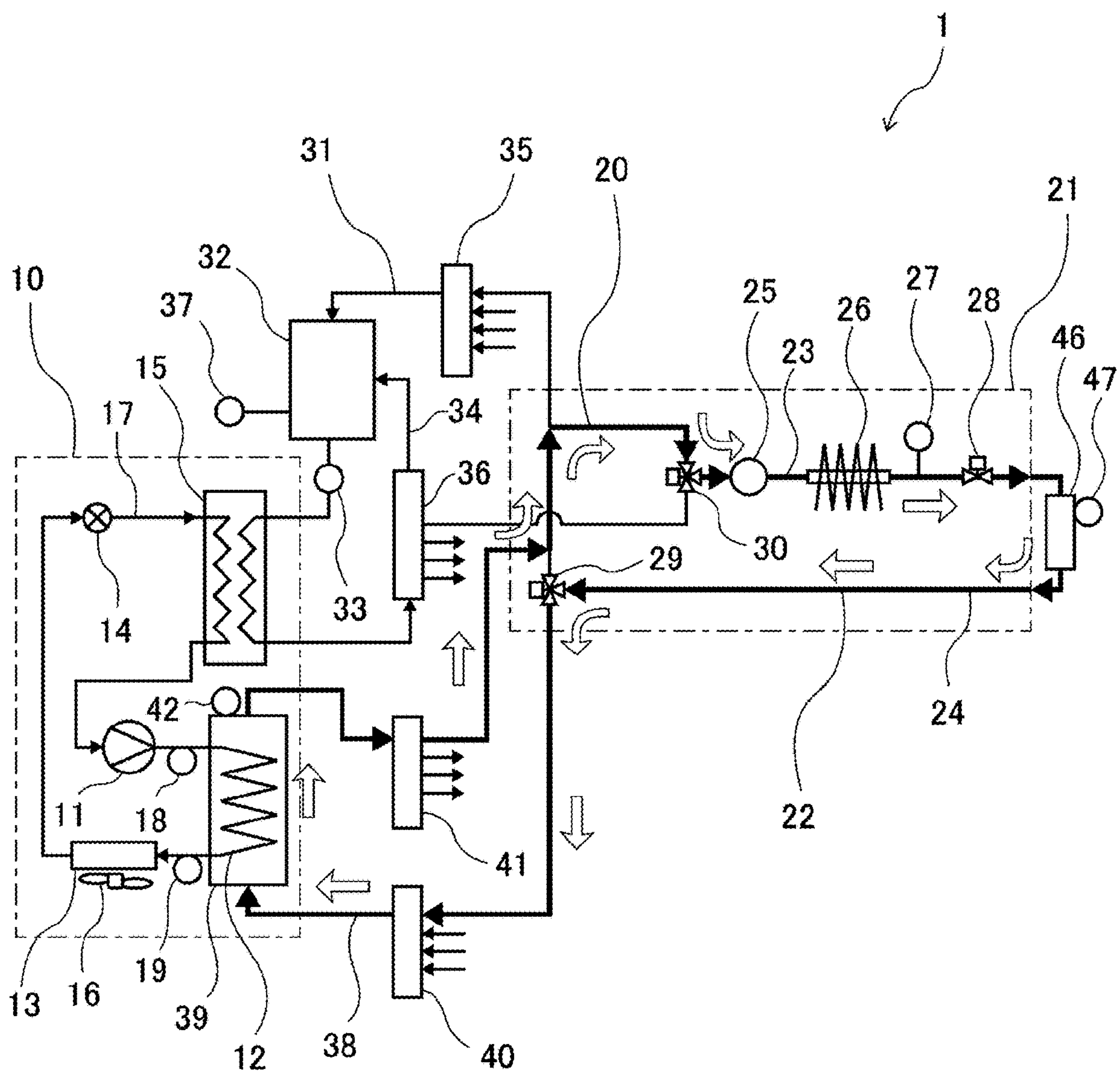
FIG. 6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COOLING AND HEATING DEVICE

TECHNICAL FIELD

[0001] The present invention relates to a cooling and heating apparatus, and particularly relates to a cooling and heating apparatus that is used to adjust, for example, various manufacturing apparatuses such as a semiconductor manufacturing apparatus and various measuring apparatuses to predetermined temperatures.

BACKGROUND ART

[0002] Generally, it is necessary for, for example, the manufacture of semiconductors to control the temperature of, for example, a manufacturing apparatus in such a manner that the temperature of, for example, a spot on a workpiece to be processed by the manufacturing apparatus or a spot to be measured reach a predetermined temperature in accordance with the manufacturing process. As an apparatus that performs such temperature control, a cooling and heating apparatus is conventionally known which includes a circulation path where a heating medium circulates, and cools or heats a control target whose temperature needs to be adjusted by use of the heating medium that circulates along the circulation path. This type of cooling and heating apparatus includes: for example, a chiller of the vapor-compression refrigeration cycle that cools a circulating heating medium; and, for example, a heating device that heats the cooled heating medium.

[0003] For example, Patent Literature 1 discloses a hybrid chiller of an area-based parameter control system that is used to control temperatures of, for example, various apparatuses such as a semiconductor manufacturing apparatus, and processes. The hybrid chiller of the area-based parameter control system disclosed in Patent Literature 1 includes: a circulation fluid circulation circuit that supplies, to a control target, circulation fluid cooled to a predetermined temperature by a refrigeration cycle; and a second circulation fluid circulation circuit that supplies, to the control target, the circulation fluid cooled to a predetermined temperature by a coolant cooled by a cooling tower. A circulation fluid supply path that feeds the circulation fluid to the control target is provided with a heater that heats the circulation fluid.

[0004] With such a configuration, the circulation fluid that is supplied to the control target is cooled, properly using a method that cools the circulation fluid by use of the refrigeration cycle and a method that cools the circulation fluid by use of the coolant of the cooling tower. The circulation fluid cooled by the refrigeration cycle or the cooling tower is heated to a predetermined temperature by the heating device such as a heater, and is supplied to the control target.

[0005] Moreover, for example, Patent Literature 2 discloses a cooling apparatus including: a first circulation system that circulates a first refrigerant in a condenser back to the condenser through a pump, a heating device, a throttle valve, and a vaporizer; and a second circulation system that includes a heat exchanger placed in the condenser, and circulates a second refrigerant that cools the first refrigerant.

[0006] The first circulation system cools a cooling target by use of the latent heat of vaporization of the first refrigerant that boils in the vaporizer. The second circulation system includes a compressor, a second condenser, an expansion valve, and the heat exchanger, and cools and condenses the first refrigerant by use of the latent heat of vaporization of the second refrigerant in the heat exchanger provided in the condenser of the first circulation system.

[0007] Moreover, Patent Literature 2 discloses that a second heat exchanger that heats the first refrigerant by condensing the second refrigerant is provided as the heating device of the first circulation system. The second refrigerant of the second circulation system is pressurized by the compressor, is fed to the second heat exchanger, and heats the first refrigerant of the first circulation system.

CITATION LIST

Patent Literature

[0008] Patent Literature 1: JP-A-2015-59726
[0009] Patent Literature 2: JP-A-2022-20088

SUMMARY OF INVENTION

Problems to be Solved by Invention

[0010] However, the above cooling and heating apparatus of the known technology needs some improvements in shortening the time required to adjust temperature and encouraging an increase in efficiency in a production process of, for example, a semiconductor manufacturing apparatus and in reducing the amount of energy consumed to adjust temperature and encouraging energy savings.

[0011] Specifically, in, for example, the manufacture of semiconductors, the temperature of a control target such as a manufacturing apparatus may be changed according to, for example, the processing process or measurement process. For example, a temperature setting for the control target may need to be changed to 130° C. after a process where temperature control is performed at a temperature setting of minus 40° C. In such a case, it takes a long time for the cooling and heating apparatus of the known technology to change the temperature of the control target to a predetermined temperature setting. In this manner, the time required to change the temperature of the control target is the loss of time in the manufacturing process.

[0012] In other words, the cooling and heating apparatus of the known technology needs to heat the circulation fluid with the heating device such as an electric heater for a long time to change a temperature setting for a control target and increase the temperature. A process of heating the circulation fluid with, for example, the heating device and increasing the temperature of the control target is performed until the temperature of the control target reaches a stable set temperature. The time required to heat the circulation fluid with, for example, the heating device and increase the temperature of the control target is waiting time during which, for example, a semiconductor manufacturing apparatus cannot perform, for example, a processing process or a measurement process.

[0013] Moreover, the cooling and heating apparatus of the known technology is configured in such a manner as to cool the circulation fluid with the evaporator of the refrigeration cycle circuit and then heat the cooled circulation fluid to a predetermined temperature with the heating device such as a heater. Hence, there are problems that, for example, energy that is consumed to heat the circulation fluid, that is, the amount of electric power consumed by, for example, the heating device increases.

[0014] In contrast, Patent Literature 2 discloses that the second refrigerant of the second circulation system that cools the first refrigerant of the first circulation system by use of the latent heat of evaporation heats the first refrigerant by use of the latent heat of condensation in the second heat exchanger. In this manner, the first refrigerant corresponding to the circulation fluid to be supplied to the control target is heated by use of the latent heat of condensation of the second refrigerant being the refrigerant of the refrigeration cycle; therefore, the amount of energy consumed by, for example, the heater that is required to heat the circulation fluid can be reduced.

[0015] However, a method that heats circulation fluid by use of the latent heat of condensation of a refrigerant that is condensed by a condenser of a refrigeration cycle circuit as in the cooling apparatus disclosed in Patent Literature 2 has difficulty in heating the circulation fluid to a high temperature. Hence, even when the circulation fluid is heated by use of the latent heat of condensation of the refrigerant, if a temperature setting for a control target is high and it is necessary to heat the circulation fluid to a high temperature, much heating with a heating device such as an electric heater is required, and the amount of heating of the heating device cannot be significantly reduced.

[0016] Moreover, also in terms of the configuration that uses the condenser of the refrigeration cycle circuit to heat the circulation fluid, if the temperature setting for the control target is changed to significantly increase the temperature of the circulation fluid, it takes time to change the temperature, which leads to the loss of time before the start of, for example, a processing process or a measuring process.

[0017] The present invention has been made to solve such problems as described above. An object of the present invention is to provide a cooling and heating apparatus that can increase productivity in, for example, the manufacture of semiconductors by shortening the time required to adjust temperature, for example, upon a change in temperature setting.

[0018] Moreover, another object of the present invention is to provide a cooling and heating apparatus that can encourage energy savings by reducing the amount of energy consumed in, for example, the manufacture of semiconductors.

Solution to Problems

[0019] The cooling and heating apparatus of the present invention including a refrigeration cycle circuit where a compression means, a gas cooler, a throttle means, and an evaporator are sequentially connected and a refrigerant circulates; and a circulation fluid circuit provided with a circulating pump and a heating device, in which circulation fluid that adjusts a temperature of a control target circulates, wherein the circulation fluid circuit includes: a freely openable and closable low-temperature path where the circulation fluid flows through the evaporator in such a manner that heat is exchangeable between the circulation fluid and the refrigerant, and a freely openable and closable high-temperature path where the circulation fluid flows through the gas cooler in such a manner that heat is exchangeable between the circulation fluid and the refrigerant, and the high-temperature path is provided with a high-temperature tank where the circulation fluid heated by the refrigerant in the gas cooler is stored.

Effects of Invention

[0020] The cooling and heating apparatus includes a refrigeration cycle circuit where a compression means, a gas cooler, a throttle means, and an evaporator are sequentially connected and a refrigerant circulates; and a circulation fluid circuit provided with a circulating pump and a heating device, in which circulation fluid that adjusts a temperature of a control target circulates, the circulation fluid circuit includes: a freely openable and closable low-temperature path where the circulation fluid flows through the evaporator in such a manner that heat is exchangeable between the circulation fluid and the refrigerant, and a freely openable and closable high-temperature path where the circulation fluid flows through the gas cooler in such a manner that heat is exchangeable between the circulation fluid and the refrigerant. Such a configuration allows the cooling and heating apparatus to adjust temperature with high efficiency by supplying the circulation fluid cooled or heated by the refrigerant of the refrigeration cycle circuit to the control target such as a semiconductor manufacturing apparatus.

[0021] Specifically, if the control target needs to be cooled, the low-temperature path of the circulation fluid circuit is opened to allow the circulation fluid to flow along the low-temperature path. The circulation fluid then flows along the low-temperature path and is cooled by use of the latent heat of the refrigerant that evaporates in the evaporator of the refrigeration cycle circuit. The circulation fluid cooled in the refrigeration cycle circuit is then heated to a predetermined temperature by the heating device of the circulation fluid circuit, and is supplied at the suitable temperature to the control target in such a manner that the control target reaches a set temperature.

[0022] Moreover, if the temperature of the circulation fluid returning from the control target is low and the temperature of the circulation fluid needs to be increased sharply, the high-temperature path of the circulation fluid circuit is opened to allow the circulation fluid to flow along the high-temperature path. Consequently, the cooling and heating apparatus can heat the circulation fluid by use of heat dissipated from the refrigerant flowing through the gas cooler of the refrigeration cycle circuit. The circulation fluid heated by the gas cooler of the refrigeration cycle circuit is then heated to a predetermined temperature by the heating device of the circulation fluid circuit, and is supplied at the suitable temperature to the control target in such a manner that the control target reaches an exact set temperature. In this manner, the circulation fluid can be heated by use of the heat dissipation of the gas cooler of the refrigeration cycle circuit. Therefore, the temperature can be adjusted with high efficiency while the amount of energy to be consumed by the heating device of the circulation fluid circuit is kept low.

[0023] In this manner, the cooling and heating apparatus of the present invention can adjust temperature with low loss of exhaust heat and with high efficiency by using both cold heat and hot heat, which are generated in the refrigeration cycle circuit.

[0024] The high-temperature path is provided with a high-temperature tank where the circulation fluid heated by the refrigerant in the gas cooler is stored. Consequently, for example, if a temperature setting for the control target is changed due to a change in, for example, a processing process to significantly increase the temperature of the circulation fluid, the temperature of the circulation fluid that circulates in the circulation fluid circuit can be quickly increased to a predetermined temperature in a short time by supplying, to the circulation fluid circuit, the high-temperature circulation fluid stored in the high-temperature tank. Hence, it is possible to significantly shorten the time required to change the temperature setting and reduce the loss of time accompanied by the change in temperature before the start of, for example, a processing process or a measurement process.

[0025] According to the cooling and heating apparatus of the present invention, the refrigerant may be carbon dioxide, and may heat the circulation fluid under supercritical pressure in the gas cooler. Consequently, it is possible to efficiently heat the circulation fluid to a high temperature.

[0026] Specifically, the cooling and heating apparatus of the present invention can heat the circulation fluid, with the gas cooler of the refrigeration cycle circuit, to a high-temperature region that is not achievable by a condenser of, for example, a chiller of a known technology using an HFC (hydrofluorocarbon)-based refrigerant, an HFO (hydrofluoroolefin)-based refrigerant, or a mixed refrigerant of them. Hence, for example, also if the temperature setting is changed to, for example, as high as 130° C. due to a change in, for example, a processing process, it is possible to increase the temperature of the circulation fluid to a high temperature in a short time. Hence, it is possible to reduce the loss of time caused by temperature adjustment and increase productivity of, for example, a semiconductor apparatus. Moreover, the amount of heating by the heating device of the circulation fluid circuit can be reduced. Therefore, it is possible to reduce the amount of energy consumed by the heating device and encourage energy savings.

[0027] According to the cooling and heating apparatus of the present invention, the refrigeration cycle circuit may include a second gas cooler that releases heat of the refrigerant to the outside, on a downstream side of the gas cooler. With such a configuration, in the refrigeration cycle circuit, heat can be dissipated from the refrigerant in the second gas cooler, and the circulation fluid in the low-temperature path can be cooled in the evaporator, even if the circulation fluid in the high-temperature tank is increased to a high temperature and there is no need to heat the circulation fluid in the high-temperature path with the refrigerant of the gas cooler. Hence, the circulation fluid is cooled by use of the refrigeration cycle to control temperature efficiently.

[0028] According to the cooling and heating apparatus of the present invention, the gas cooler may be provided in the high-temperature tank in such a manner that the refrigerant flows from up to down, and the refrigerant flowing through the gas cooler may heat the circulation fluid in the high-temperature tank. With such a configuration, the refrigerant flowing through the gas cooler can heat the circulation fluid in the high-temperature tank also in a state where the circulation fluid in the high-temperature path is not used as the circulation fluid to be supplied to the control target and is not flowing. In other words, the circulation fluid stored in the high-temperature tank can be heated to a high temperature by the gas cooler without providing, for example, a circulating pump that feeds the circulation fluid in the high-temperature path for heating with the gas cooler. Hence, when the refrigeration cycle circuit is performing operation in which the circulation fluid in the low-temperature path is cooled, exhaust heat from the gas cooler can be effectively used without circulating the circulation fluid in the high-temperature path.

[0029] According to the cooling and heating apparatus of the present invention, the low-temperature path may be provided with a low-temperature tank where the circulation fluid is stored, a low-temperature pump that feeds the circulation fluid, and a low-temperature circulation path that returns the circulation fluid to an inlet side of the low-temperature path without feeding the circulation fluid to the control target. The low-temperature tank is provided; therefore, if the temperature setting for the control target is changed due to a change in, for example, a processing process to significantly reduce the temperature of the circulation fluid, the temperature of the circulation fluid that circulates in the circulation fluid circuit can be quickly reduced to a predetermined temperature in a short time by supplying the low-temperature circulation fluid stored in the cold tank to the circulation fluid circuit. Hence, it is possible to significantly shorten the time required to change the temperature setting and reduce the loss of time accompanied by the change in temperature before the start of, for example, a processing process or a measurement process.

[0030] Moreover, the low-temperature path is provided with the low-temperature pump that feeds the circulation fluid, and the low-temperature circulation path that returns the circulation fluid from the outlet side to the inlet side of the low-temperature path. Hence, even if the circulation fluid in the low-temperature path is not used as the circulation fluid to be supplied to the control target, the circulation fluid can be cooled by the refrigerant flowing through the evaporator by circulating the circulation fluid in the low-temperature path. The refrigerant can be stored in the low-temperature tank. Moreover, even if the circulation fluid in the low-temperature path is not supplied to the control target, the circulation fluid in the high-temperature path can be heated by the refrigerant of the gas cooler by operating the refrigeration cycle circuit.

[0031] According to the cooling and heating apparatus of the present invention, the circulation fluid circuit may be provided with a three-way valve that switches between whether or not the circulation fluid returning from the control target is fed to the high-temperature path, and a mixing valve that is provided downstream of the three-way valve and mixes the circulation fluid that has passed through the low-temperature path with the circulation fluid to be supplied to the control target. With such a configuration, operation in which the circulation fluid heated by the gas cooler of the refrigeration cycle circuit is supplied to the control target and operation in which the circulation fluid cooled by the evaporator is supplied to the control target can be switched and executed by switching between the three-way valve and the mixing valve. Moreover, it is also possible to perform operation in which the mixing valve is adjusted to mix the circulation fluid cooled by the evaporator with the circulation fluid that has returned from the control target and make the temperature suitable. Furthermore, it is also possible to perform temperature adjustment operation in which the circulation fluid heated by the gas cooler and the circulation fluid cooled by the evaporator are not supplied to the control target, and only the circulation fluid that has returned from the control target is heated by the heating device, fed to the control target, and circulated. In this manner, it is possible to circulate the circulation fluid along a suitable path in accordance with the state of the control target and adjust the temperature of the control target efficiently with a little amount of energy consumed.

[0032] According to the cooling and heating apparatus of the present invention, there may be a plurality of the control targets, the circulation fluid circuit may be provided with a plurality of circuit modules connected to the low-temperature path and the high-temperature path via branch line pipes, and each of the plurality of circuit modules may include the circulating pump and the heating device, and may feed the circulation fluid to another control target. Consequently, it is possible to cool or heat control targets in, for example, a plurality of spots to be processed or measured with high efficiency by use of one refrigeration cycle circuit and adjust the control targets to their suitable temperatures.

BRIEF DESCRIPTION OF DRAWINGS

[0033] FIG. **1** is a diagram illustrating a cooling and heating apparatus according to an embodiment of the present invention.

[0034] FIG. **2** is a diagram illustrating a control system of the cooling and heating apparatus according to the embodiment of the present invention.

[0035] FIG. **3** is a diagram illustrating a circulation fluid flow path of the cooling and heating apparatus according to the embodiment of the present invention.

[0036] FIG. **4** is a diagram illustrating a circulation fluid flow path of the cooling and heating apparatus according to the embodiment of the present invention.

[0037] FIG. **5** is a diagram illustrating a circulation fluid flow path of the cooling and heating apparatus according to the embodiment of the present invention.

[0038] FIG. **6** is a diagram illustrating a circulation fluid flow path of the cooling and heating apparatus according to the embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0039] A cooling and heating apparatus **1** according to an embodiment of the present invention is described in detail below with appropriate reference to the drawings. Note that illustrated aspects do not limit the present invention, and are merely examples of the embodiment of the present invention.

[0040] FIG. **1** is a diagram illustrating a schematic configuration of the cooling and heating apparatus **1** according to the embodiment of the present invention. The cooling and heating apparatus **1** is an apparatus that is used to adjust a control target **46**, for example, various manufacturing apparatuses such as a semiconductor manufacturing apparatus, or various measuring apparatuses used in, for example, semiconductor manufacturing processes, to a predetermined temperature according to the process (refer to FIG. **1**).

[0041] The cooling and heating apparatus **1** includes a refrigeration cycle circuit **10** that configures a vapor-compression refrigeration cycle, and cools or heats circulation fluid with a refrigerant, and a circulation fluid circuit **20** that circulate the circulation fluid cooled or heated in the refrigeration cycle circuit **10** in such a manner as to feed the circulation fluid to the control target **46**, and adjust the temperature of the control target **46**.

[0042] Examples of the circulation fluid that circulates in the circulation fluid circuit **20** includes water. The circulation fluid is cooled or heated by the refrigerant of the refrigeration cycle circuit **10**, heated to a suitable temperature by a heating device **26** of the circulation fluid circuit **20**, and supplied to the control target **46** such as a semiconductor manufacturing apparatus. Consequently, the control target **46** is controlled in such a manner as to be cooled or heated by the circulation fluid adjusted to the suitable temperature and reach a suitable temperature adequate to, for example, each manufacturing process or measurement process.

[0043] Firstly, the configuration of the refrigeration cycle circuit **10** is described in detail. The refrigeration cycle circuit **10** is formed by sequentially connecting a compressor **11** as a compression means, a gas cooler **12**, a radiator **13** as a second gas cooler, an expansion valve **14** as a throttle means, and an evaporator **15** via refrigerant piping **17**. The refrigeration cycle circuit **10** configures a closed circuit where the refrigerant is circulated to perform vapor-compression refrigeration cycle operation.

[0044] The compressor **11** is a compression means for compressing the refrigerant and feeding the refrigerant to the gas cooler **12**. Compression devices of a rotary type, a scroll type, a reciprocating type, a screw type, and various other types can be adopted as the compressor **11**.

[0045] Particularly, the compressor **11** of the rotary type is suitable to construct the cooling and heating apparatus **1** that is made compact with low cooling capacity. Moreover, the compressor **11** may be of a two-stage compression type. The adoption of the two-stage compression type as the compressor **11** is suitable to compress a carbon dioxide refrigerant whose pressure becomes high.

[0046] The gas cooler **12** is a heat exchanger that exchanges heat between the refrigerant that has been compressed to a high pressure and a high temperature by the compressor **11** and the circulation fluid of the circulation fluid circuit **20**. The gas cooler **12**, for example, is provided in a high-temperature tank **39** where the circulation fluid is stored and includes a plurality of tubes where the refrigerant flows although its illustration is omitted. The tubes are, for example, steel tubes.

[0047] Specifically, the tubes of the gas cooler **12** each include an inlet in an upper part thereof and an outlet in a lower part thereof to allow the refrigerant to flow from up to down, are wound into, for example, an approximately spiral shape, and are provided in the high-temperature tank **39**. With such a configuration, the refrigerant that flows through the gas cooler **12** can heat the circulation fluid in the high-temperature tank **39** efficiently.

[0048] For example, even if the circulation fluid in the high-temperature tank **39** is not supplied to the control target **46**, that is, even if the circulation fluid does not flow along a high-temperature path **38** of the circulation fluid circuit **20** provided with the high-temperature tank **39**, the refrigerant flowing through the gas cooler **12** can heat the circulation fluid in the high-temperature tank **39**.

[0049] In other words, such a configuration allows the gas cooler **12** to heat the circulation fluid stored in the high-temperature tank **39** to a high temperature without providing, for example, a circulating pump that feeds the circulation fluid to the high-temperature path **38** of the circulation fluid circuit **20** to heat the circulation fluid with the gas cooler **12**.

[0050] Hence, when the refrigeration cycle circuit **10** is performing operation in which the circulation fluid is cooled by use of the latent heat of evaporation of the evaporator **15**, it is possible to heat the circulation fluid in the high-temperature tank **39** to a high temperature by effectively using exhaust heat from the gas cooler **12** without circulating the circulation fluid along the high-temperature path **38**.

[0051] Note that the gas cooler **12** may be provided outside the high-temperature tank **39** as long as it has a configuration that can exchange heat between the refrigerant and the circulation fluid. For example, heat exchangers of a plate type, a shell-and-tube type, a double-pipe type, and various other types may be adopted as the gas cooler **12**.

[0052] The radiator **13** is a second gas cooler that releases the heat of the refrigerant to the outside, and is provided downstream of the gas cooler **12**. The radiator **13** is, for example, an air-cooled heat exchanger to which air that exchanges heat with the refrigerant is delivered by an air-blowing fan **16**. For example, the radiator **13** may be a fin-and-tube heat exchanger although its illustration is omitted. In other words, the radiator **13** includes a plurality of tubes such as steel tubes where the refrigerant flows, and a plurality of aluminum fins provided parallel to each other. The tubes are inserted into holes formed in the fins.

[0053] Note that the radiator **13** may be a water-cooled heat exchanger. Moreover, heat exchangers of a plate type, a shell-and-tube type, a double-pipe type, and various other types can be adopted as the radiator **13**. Particularly, a heat exchanger of the plate type is preferable since the efficiency of heat exchange is high and the radiator **13** can be made compact.

[0054] The radiator **13** is provided downstream of the gas cooler **12**. Therefore, the refrigerant that has dropped in temperature due to heating of the circulation fluid in the gas cooler **12** can be cooled to a lower temperature. Moreover, also if the circulation fluid in the high-temperature tank **39** is increased to a high temperature and there is no need to heat the circulation fluid with the refrigerant flowing through the gas cooler **12**, the high-temperature refrigerant that has passed through the gas cooler **12** can reduce in temperature to a low temperature by heat dissipation of the radiator **13**. Consequently, the cooling capacity of the refrigeration cycle circuit **10**, that is, the ability to cool the circulation fluid by use of the latent heat of evaporation of the refrigerant in the evaporator **15**, is provided also in a state where the high-temperature tank **39** is filled with the high-temperature circulation fluid.

[0055] The expansion valve **14** is a throttle means for decompressing the high-pressure refrigerant that has reached a low temperature after passing through the gas cooler **12** and the radiator **13**. Moreover, the expansion valve **14** has a function of adjusting the flow of the refrigerant. Throttle means such as an electronic expansion valve, a thermostatic expansion valve, a capillary tube, and various other types can be adopted as the expansion valve **14**. If an electronic expansion valve is adopted as the expansion valve **14**, the cooling and heating of the circulation fluid in the refrigeration cycle circuit **10** can be controlled with high efficiency.

[0056] The evaporator **15** is a heat exchanger that evaporates the low-pressure liquid refrigerant and cools the circulation fluid with the latent heat of evaporation. Heat exchangers of a plate type, a double-pipe type, a tube contact type, a shell-and-tube type, and various other types may be adopted as the evaporator **15**.

[0057] Particularly, a heat exchanger of the plate type is preferable since the efficiency of heat exchange is high and the evaporator **15** can be made compact. Moreover, the double-pipe type and the tube contact type are excellent in easy manufacturing and processing and easy obtainability of suitable compressive strength.

[0058] The refrigerant piping **17** downstream of the evaporator **15** is connected to the compressor **11** via an unillustrated accumulator. With the above configuration, the closed circuit of the refrigeration cycle circuit **10** is formed in which the compressor **11**, the gas cooler **12**, the radiator **13**, the expansion valve **14**, and the evaporator **15** are sequentially connected.

[0059] The refrigerant used in the refrigeration cycle circuit **10** is carbon dioxide. The carbon dioxide refrigerant heats the circulation fluid under supercritical pressure in the gas cooler **12**. Consequently, the circulation fluid can be efficiently heated to a high temperature.

[0060] Specifically, the gas cooler **12** of the refrigeration cycle circuit **10** can heat the circulation fluid to a high-temperature region that is not achievable by a condenser of, for example, a chiller of a known technology using an HFC-based refrigerant, an HFO-based refrigerant, or a mixed refrigerant of them.

[0061] For example, the cooling and heating apparatus **1** can increase the temperature of the circulation fluid to a high temperature in a short time also if, for example, the temperature setting is changed to as high as 130° C. due to a change in, for example, a processing process. Hence, the cooling and heating apparatus **1** can reduce the loss of time caused by temperature adjustment and increase productivity of, for example, a semiconductor apparatus. Moreover, it is possible to reduce the amount of heating by the heating device **26** of the circulation fluid circuit **20**. Therefore, it is possible to reduce the amount of energy consumed by the heating device **26** and encourage energy savins in, for example, the manufacture of semiconductors.

[0062] Moreover, the refrigeration cycle circuit **10** is provided with, for example, a refrigerant temperature sensor **18** that measures the temperature of the refrigerant, and a pressure sensor **19** that measures the pressure of the refrigerant. A control device **43** (refer to FIG. **2**) controls the number of rotations of the compressor **11** and the degree of opening of the expansion valve **14** on the basis of, for example, the temperature of the refrigerant measured by the refrigerant temperature sensor **18** and the pressure of the refrigerant measured by the pressure sensor **19** in addition to the temperature setting and measured temperature information of the control target **46**.

[0063] Next, the circulation fluid circuit **20** is described in detail. The circulation fluid circuit **20** configures a closed circuit where the circulation fluid that cools or heats the control target **46** circulates. Specifically, the circulation fluid circuit **20** includes: a plurality of circuit modules **21** that are connected to the control targets **46** and circulate the circulation fluid; a low-temperature path **31** that is connected to the circuit modules **21** and in which the circulation fluid flows through the evaporator **15** in such a manner as to be able to exchange heat with the refrigerant; and the high-temperature path **38** that is connected to the circuit modules **21** and in which the circulation fluid flows through the gas cooler **12** in such a manner as to be able to exchange heat with the refrigerant.

[0064] Each of the circuit modules **21** is a device that supplies the circulation fluid to the control target **46** and adjusts the temperature of the control target **46**. The each of the circuit modules **21** is formed with a basic circulation path **22** that is a basic closed circuit that circulates the circulation fluid. Specifically, the each of the circuit modules **21** is formed with the basic circulation path **22** being a closed circuit where a feed path **23** that supplies the circulation fluid to the control target **46** such as a semiconductor manufacturing apparatus, and a return path **24** that returns the circulation fluid that has cooled or heated the control target **46** are connected.

[0065] The feed path **23** of the each of the circuit modules **21** is provided with a circulating pump **25** that feeds the circulation fluid to the control target **46**, the heating device **26** that heats the circulation fluid to be supplied to the control target **46** and adjusts the temperature, and a temperature sensor **27** that measure the temperature of the circulation fluid heated by the heating device **26**.

[0066] The heating device **26** is, for example, an electric heater of a resistance heating type, and is, for example, a sheathed heater that covers a Nichrome wire as a heating element with a metal pipe. Moreover, the heating device **26** may be a heating means of an induction heating type, and may be, for example, an induction coil connected to an unillustrated induction heating power supply.

[0067] The temperature sensor **27** is provided to the feed path **23** downstream of the heating device **26**, and measures the temperature of the circulation fluid heated by the heating device **26**. The circulating pump **25**, the heating device **26**, and the temperature sensor **27** are connected to the control device **43**. The control device **43** controls the circulating pump **25** and the heating device **26** in such a manner that the temperature of the circulation fluid measured by the temperature sensor **27** reaches a predetermined temperature. Consequently, the temperature of the control target **46** is controlled to a set temperature.

[0068] Moreover, the basic circulation path **22** of the each of the circuit modules **21** is provided with a solenoid valve **28** that opens and closes the feed path **23**. Consequently, if the control target **46** connected to the circuit module **21** does not require temperature control, the flow of the circulation fluid can be stopped by closing the solenoid valve **28**.

[0069] The low-temperature path **31** is a path for the refrigeration cycle circuit **10** to cool the circulation fluid. The low-temperature path **31** is connected on an inlet side thereof to a return path **24** side of the circuit module **21** and on an outlet side thereof to a feed path **23** side of the circuit module **21** in such a manner as to form a bypass path for the circulation fluid in the basic circulation path **22**.

[0070] In other words, the circulation fluid that circulates along the basic circulation path **22** of the circuit module **21** can flow into the low-temperature path **31** and also flow toward the feed path **23** without flowing into the low-temperature path **31**, at a branch point being the inlet of the low-temperature path **31**.

[0071] A junction of the outlet of the low-temperature path **31** and the basic circulation path **22** is provided with a mixing valve **30**. The mixing valve **30** is a valve that mixes the circulation fluid that has passed through the low-temperature path **31** with the circulation fluid to be supplied to the contract target **46** via the feed path **23** of the circuit module **21**. In other words, the mixing valve **30** can freely open and close the low-temperature path **31** and freely adjust the flow rate of the low-temperature path **31**.

[0072] The circulation fluid that has returned from the control target **46** is mixed with the circulation fluid cooled by the evaporation of the refrigerant by the evaporator **15** of the refrigeration cycle circuit **10** on the basis of adjustment by the mixing valve **30**. Therefore, operation that achieves a suitable temperature can be performed.

[0073] Moreover, it is also possible to perform operation that does not supply the circulation fluid cooled by the evaporator **15** to the control target **46** on the basis of adjustment by the mixing valve **30**. In other words, it is also possible to perform temperature adjustment operation in which only the circulation fluid that has returned from the control target **46**, or only the circulation fluid heated by the gas cooler **12**, is fed to the feed path **23**, heated by the heating device **26**, supplied to the control target **46**, and circulated.

[0074] Moreover, the low-temperature path **31** is provided with a low-temperature tank **32** where the circulation fluid is stored, a low-temperature pump **33** that feeds the circulation fluid, and a low-temperature circulation path **34** that returns the circulation fluid to the inlet side of the low-temperature path **31** without feeding the circulation fluid to the control target **46**.

[0075] Specifically, for example, the low-temperature tank **32** is provided on the inlet side of the low-temperature path **31**. The low-temperature pump **33** is provided downstream of the low-temperature tank **32**. The evaporator **15** is provided downstream of the low-temperature pump **33**. The low-temperature circulation path **34** may be provided in such a manner as to connect a branch line pipe **36** provided downstream of the evaporator **15** of the low-temperature path **31**, and the low-temperature tank **32** provided on the inlet side of the low-temperature path **31**.

[0076] The low-temperature tank **32** is provided with a low-temperature sensor **37** that measures the temperature of the circulation fluid in the low-temperature tank **32**. The low-temperature pump **33** and the low-temperature sensor **37** are connected to the control device **43**. The control device **43** may control, for example, operation of the circulating pump **25** and the low-temperature pump **33** and the adjustment of the degree of opening of the mixing valve **30** by using information on the temperature of the circulation fluid measured by the low-temperature sensor **37** to make a computation.

[0077] As described above, the low-temperature path **31** is provided with the low-temperature tank **32**, the low-temperature pump **33** that feeds the circulation fluid, and the low-temperature circulation path **34** that returns the circulation fluid from the outlet side to the inlet side of the low-temperature path **31**. Hence, even if the circulation fluid in the low-temperature path **31** is not used as the circulation fluid to be supplied to the control target **46**, the circulation fluid in the low-temperature path **31** can be cooled by the refrigerant flowing through the evaporator **15** by circulating the circulation fluid in the low-temperature path **31**.

[0078] The circulation fluid cooled by the refrigerant can be stored in the low-temperature tank **32**, and the stored low-temperature circulation fluid can be supplied to the circulation fluid circuit **20** if needed. For example, if the temperature setting for the control target **46** is changed due to a change in, for example, a processing process to significantly reduce the temperature of the circulation fluid, the low-temperature circulation fluid stored in the cold tank can be supplied to the circulation fluid circuit **20**.

[0079] Consequently, the temperature of the circulation fluid that circulates in the circulation fluid circuit **20** can be quickly reduced to a predetermined temperature in a short time. Hence, the time required to change the temperature setting is significantly shortened; therefore, the loss of time accompanied by the change of the temperature before the start of, for example, a processing process or a measurement process can be reduced.

[0080] Moreover, as described above, the low-temperature path **31** is provided with the low-temperature tank **32**, the low-temperature pump **33**, and the low-temperature circulation path **34**. Hence, even if the circulation fluid in the low-temperature path **31** is not supplied to the control target **46**, it is possible to operate the refrigeration cycle circuit **10** and heat the circulation fluid in the high-temperature path **38** with the refrigerant of the gas cooler **12**.

[0081] The high-temperature path **38** is a path for the refrigeration cycle circuit **10** to heat the circulation fluid. The high-temperature path **38** is connected on an inlet side thereof to the return path **24** side of the circuit module **21** and on an outlet side thereof to the feed path **23** side of the circuit module **21** in such a manner as to form a bypass path for the circulation fluid in the basic circulation path **22**.

[0082] Specifically, the basic circulation path **22** of the circulation fluid circuit **20** is provided with a three-way valve **29** upstream of the branch point to the low-temperature path **31**. The three-way valve **29** is a valve that switches between whether or not the circulation fluid returning from the control target **46** is fed to the high-temperature path **38**. In other words, the three-way valve **29** can freely open and close the high-temperature path **38**.

[0083] Specifically, the inlet of the high-temperature path **38** is connected to the three-way valve **29**. The outlet of the high-temperature path **38** is connected downstream of the three-way valve **29** of the basic circulation path **22** and upstream of the branch point to the low-temperature path **31**.

[0084] With such a configuration, the switching of the three-way valve **29** allows switching between operation in which the circulation fluid heated by the gas cooler **12** of the refrigeration cycle circuit **10** is supplied to the control target **46**, and operation in which the circulation fluid heated by the gas cooler **12** of the refrigeration cycle circuit **10** is not supplied to the control target **46**, and executing the operation.

[0085] The high-temperature path **38** is provided with the high-temperature tank **39** where the circulation fluid heated to a high temperature is stored, and a high-temperature sensor **42** that measures the temperature of the circulation fluid in the high-temperature tank **39**. The gas cooler **12** of the refrigeration cycle circuit **10** is provided in the high-temperature tank **39** in such a manner that the refrigerant can heat the circulation fluid.

[0086] The high-temperature tank **39** is formed with a circulation fluid inlet in a lower part thereof, and is formed with a circulation fluid outlet in an upper part thereof. Consequently, the high-temperature circulation fluid stored in the high-temperature tank **39** can be efficiently supplied to the control target **46**.

[0087] In other words, the low-temperature circulation fluid returning from the control target **46** flows into the high-temperature path **38** via the three-way valve **29**, and flows into the high-temperature tank **39** through the inlet formed in the lower part of the high-temperature tank **39**. The high-temperature circulation fluid stored in the high-temperature tank **39** is fed to the basic circulation path **22** through the outlet formed in the upper part of the high-temperature tank **39**, and is supplied to the control target **46**.

[0088] In this manner, the cooling and heating apparatus **1** includes the high-temperature tank **39**, and can feed the high-temperature circulation fluid stored in the high-temperature tank **39** to the basic circulation path **22**. Hence, for example, if the temperature setting for the control target **46** is changed due to a change in, for example, a processing process to significantly increase the temperature of the circulation fluid, the temperature can be changed with high efficiency.

[0089] In other words, it is possible to supply the high-temperature circulation fluid stored in the high-temperature tank **39** to the circulation fluid circuit **20** and quickly increase the temperature of the circulation fluid that circulates in the circulation fluid circuit **20** to a predetermined temperature in a short time. Hence, the cooling and heating apparatus **1** can significantly shorten the time required to change the temperature setting and reduce the loss of time accompanied by the change in temperature before the start of, for example, a processing process or a measurement process.

[0090] Note that the control device **43** may use information on the temperature of the circulation fluid in the high-temperature tank **39**, the temperature being measured by the high-temperature sensor **42**, to perform a computation for opening and closing control over the three-way valve **29**. Consequently, the flow in the high-temperature path **38** can be controlled according to the amount of the high-temperature circulation fluid stored in the high-temperature tank **39**. Hence, if the high-temperature circulation fluid stored in the high-temperature tank **39** is less than required, it is possible to prevent the loss of time in the change of temperature, which is caused by feeding the circulation fluid that is low in temperature to the basic circulation path **22**.

[0091] Moreover, the low-temperature path **31** and the high-temperature path **38** are provided with line junction pipes **35** and **40** and the branch line pipe **36** and a branch line pipe **41**, which connect the plurality of circuit modules **21**. Specifically, the low-temperature path **31** is provided on the inlet side with the line junction pipe **35** and on the outlet side with the branch line pipe **36**. The high-temperature path **38** is provided on the inlet side with the line junction pipe **40** and on the outlet side with the branch line pipe **41**.

[0092] Consequently, the plurality of circuit modules **21**, for example, two to eight, or more circuit modules **21**, can be connected to the low-temperature path **31** and the high-temperature path **38** via the line junction pipes **35** and **40** and the branch line pipes **36** and **41**.

[0093] Each of the plurality of circuit modules **21** includes the circulating pump **25** and the heating device **26**, and can circulate the circulation fluid to another control target **46**. Consequently, it is possible to cool or heat the control targets **46** in, for example, a plurality of spots to be processed or measured with high efficiency by use of one refrigeration cycle circuit **10** and adjust the control targets **46** to their suitable temperatures.

[0094] FIG. **2** is a block diagram illustrating a control system of the cooling and heating apparatus **1**. As illustrated in FIG. **2**, the cooling and heating apparatus **1** includes the control device **43** that controls the constituent equipment. The control device **43** is a control means including a microprocessor, and executes a predetermined computation to control the temperature of the control target **46** (refer to FIG. **1**).

[0095] Inputs of the control device **43** are connected to sensors such as the refrigerant temperature sensor **18** that detects the temperature of the refrigerant, the pressure sensor

19 that detects the pressure of the refrigerant, the temperature sensor **27** that detects the temperature of the circulation fluid to be supplied to the control target **46**, the low-temperature sensor **37** that detects the temperature of the circulation fluid in the low-temperature path **31**, the high-temperature sensor **42** that detects the temperature of the circulation fluid in the high-temperature path **38**, and a temperature sensor **47** that detects the temperature of the control target **46**.

[0096] Outputs of the control device **43** are connected to, for example, the compressor **11**, the expansion valve **14**, and the air-blowing fan **16** of the refrigeration cycle circuit **10**, and the circulating pump **25**, the heating device **26**, the solenoid valve **28**, the three-way valve **29**, the mixing valve **30**, and the low-temperature pump **33** of the circulation fluid circuit **20**.

[0097] Moreover, the control device **43** is provided with an input device **44** that inputs a temperature setting for the control target **46** and other pieces of operation information, and a display device **45** that displays information on the temperature of each portion and other pieces of control information.

[0098] Note that the control device **43** may be connected to, for example, other unillustrated sensors, information input equipment, display devices, control target equipment, and recording devices.

[0099] The control device **43** executes predetermined computations on the basis of inputs of, for example, the refrigerant temperature sensor **18**, the pressure sensor **19**, the temperature sensor **27**, the low-temperature sensor **37**, the high-temperature sensor **42**, the temperature sensor **47**, and the input device **44**, and controls, for example, the compressor **11**, the expansion valve **14**, the air-blowing fan **16**, the circulating pump **25**, the heating device **26**, the solenoid valve **28**, the three-way valve **29**, the mixing valve **30**, and the low-temperature pump **33**.

[0100] Next, a method for adjusting temperature with the cooling and heating apparatus **1** is described in detail with reference to FIGS. **3** to **6**.

[0101] FIG. **3** is a diagram illustrating a circulation fluid flow path, and illustrates an example where the circulation fluid cooled or heated in the refrigeration cycle circuit **10** is not used. Note that in FIG. **3**, the path where the circulation fluid flows is indicated by thick lines, and the flow direction is indicated by arrows.

[0102] As illustrated in FIG. **3**, the three-way valve **29** closes the high-temperature path **38**, and the mixing valve **30** closes the low-temperature path **31**. Therefore, it is also possible to not supply, to the control target **46**, the circulation fluid cooled by the evaporator **15** and the circulation fluid heated by the gas cooler **12**. In other words, the circulation fluid circulates along the basic circulation path **22** without flowing along the low-temperature path **31** and the high-temperature path **38**. In this manner, it is also possible to perform the temperature adjustment operation where the circulation fluid flowing along the low-temperature path **31** or the high-temperature path **38** is not fed to the feed path **23**, but only the circulation fluid that has returned from the control target **46** is fed directly to the feed path **23**, heated by the heating device **26**, fed to the control target **46**, and circulated.

[0103] FIG. **4** is a diagram illustrating a circulation fluid flow path in a case where the temperature adjustment operation is performed by use of the circulation fluid cooled in the refrigeration cycle circuit **10**. In FIG. **4**, the path where the circulation fluid flows is indicated by thick lines, and the flow direction is indicated by arrows. As illustrated in FIG. **4**, if the control target **46** needs to be cooled, the control device **43** (refer to FIG. **2**) controls the mixing valve **30**, and opens the low-temperature path **31** of the circulation fluid circuit **20** to allow the circulation fluid to flow along the low-temperature path **31**.

[0104] As a result, a part of the circulation fluid that has returned from the control target **46** flows along the low-temperature path **31**, and is cooled by use of the latent heat of the refrigerant that evaporates in the evaporator **15** of the refrigeration cycle circuit **10**. The circulation fluid cooled in the refrigeration cycle circuit **10** then merges with the circulation fluid in the basic circulation path **22** that has not flowed along the low-temperature path **31**, is heated to a predetermined temperature by the heating device **26**, and is supplied at the suitable temperature to the control target **46** in such a manner that the control target **46** reaches a set temperature.

[0105] FIG. **5** is a diagram illustrating another example of using the circulation fluid cooled in the refrigeration cycle circuit **10**. In FIG. **5**, the path where the circulation fluid flows is indicated by thick lines, and the flow direction is indicated by arrows. As illustrated in FIG. **5**, the mixing valve **30** may be controlled in such a manner as to open the low-temperature path **31** 100%. In other words, the circulation fluid returning from the control target **46** does not pass directly through the mixing valve **30**, but all the circulation fluid returning from the control target **46** passes through the low-temperature path **31**. Only the circulation fluid cooled by the refrigerant in the refrigeration cycle circuit **10** is then fed to the feed path **23** through the mixing valve **30**.

[0106] With such a flow path, it is possible to feed, to the circulation fluid circuit **20**, a large amount of circulation fluid cooled to a low temperature in the refrigeration cycle circuit **10** and stored in the low-temperature tank **32** and to quickly reduce the temperature of the circulation fluid to be supplied to the control target **46**. Hence, it is possible to reduce the loss of time in, for example, the process of changing the temperature setting and increase productivity of, for example, a semiconductor apparatus.

[0107] FIG. **6** is a diagram illustrating a circulation fluid flow path in a case where the temperature adjustment operation is performed by use of the circulation fluid heated in the refrigeration cycle circuit **10**. In FIG. **5**, the path where the circulation fluid flows is indicated by thick lines, and the flow direction is indicated by arrows.

[0108] If the temperature of the circulation fluid returning from the control target **46** is low and needs to be increased sharply, the control device **43** (refer to FIG. **2**) controls the three-way valve **29** to open the high-temperature path **38** of the circulation fluid circuit **20**. Consequently, the circulation fluid returning from the control target **46** flows along the high-temperature path **38**. The circulation fluid in the high-temperature tank **39** that has increased to a high temperature by use of the heat dissipated from the refrigerant flowing through the gas cooler **12** of the refrigeration cycle circuit **10** is then fed to the basic circulation path **22** (refer to FIG. **6**).

[0109] The circulation fluid heated in the refrigeration cycle circuit **10** is then fed to the feed path **23** via the mixing valve **30**, heated to a predetermined temperature by the heating device **26**, and supplied at the suitable temperature to the control target **46** in such a manner that the control target **46** reaches an exact set temperature.

[0110] In this manner, the heat dissipation of the gas cooler **12** of the refrigeration cycle circuit **10** is used to heat the circulation fluid. The circulation fluid is stored in the high-temperature tank **39**. The high-temperature circulation fluid stored in the high-temperature tank **39** is supplied to the basic circulation path **22**. Therefore, the temperature of the circulation fluid flowing along the basic circulation path **22** can be changed to a high temperature in a short time. Hence, it is possible to keep the amount of energy consumed by the heating device **26** of the circulation fluid circuit **20** low, and adjust temperature with high efficiency.

[0111] When the control device **43** opens the three-way valve **29**, the high-temperature circulation fluid stored in the high-temperature tank **39** is fed to the basic circulation path **22**. After the temperature of the circulation fluid circulating along the basic circulation path **22** increases to a predetermined temperature in a short time, the control device **43** may close the three-way valve **29** to perform normal temperature adjustment operation where the circulation fluid does not flow along the high-temperature path **38**, as illustrated in FIGS. **3**, **4**, and **5**.

[0112] In other words, as illustrated in FIG. **3**, the operation that adjusts temperature may be performed by only the heating device **26** heating the circulation fluid circulating along the basic circulation path **22** without using the refrigeration cycle circuit **10**. Moreover, as illustrated in FIG. **4**, the operation that adjusts temperature may be performed by mixing the refrigerant flowing along the low-temperature path **31** with the circulation fluid circulating along the basic circulation path **22**. Moreover, as illustrated in FIG. **5**, the temperature adjustment operation may be performed in which the mixing valve **30** opens the low-temperature path **31** 100%, and all the circulation fluid circulating along the basic circulation path **22** is fed to the feed path **23** via the low-temperature path **31**.

[0113] In other words, as illustrated in FIG. **6**, after the temperature is changed with a large temperature difference due to a change in, for example, a processing process, the temperature can be adjusted by use of cooling capacity and heating capacity as small as matching the amount of heat dissipated and the amount of heat absorbed from the control target **46**, as illustrated in FIGS. **3**, **4**, and **5**.

[0114] In this manner, the cooling and heating apparatus **1** can change a temperature setting efficiently in a short time by circulating the circulation fluid along a suitable path according to the state of the control target **46**, and can adjust the temperature of the control target **46** efficiently with a little amount of energy consumed.

[0115] As described above, the cooling and heating apparatus **1** according to the embodiment can adjust the temperature of the control target **46** such as a semiconductor manufacturing apparatus with high efficiency and with little loss of exhaust heat by use of both cold heat and hot heat, which are generated in the refrigeration cycle circuit **10**.

[0116] Note that the present invention is not limited to the above embodiment. The present invention can undergo various modifications and implementations within the scope that does not depart from the gist of the present invention.

LIST OF REFERENCE NUMBERS

[0117] **1** Cooling and heating apparatus
[0118] **10** Refrigeration cycle circuit
[0119] **11** Compressor
[0120] **12** Gas cooler
[0121] **13** Radiator
[0122] **14** Expansion valve
[0123] **15** Evaporator
[0124] **16** Air-blowing fan
[0125] **17** Refrigerant piping
[0126] **18** Refrigerant temperature sensor
[0127] **19** Pressure sensor
[0128] **20** Circulation fluid circuit
[0129] **21** Circuit module
[0130] **22** Basic circulation path
[0131] **23** Feed path
[0132] **24** Return path
[0133] **25** Circulating pump
[0134] **26** Heating device
[0135] **27** Temperature sensor
[0136] **28** Solenoid valve
[0137] **29** Three-way valve
[0138] **30** Mixing valve
[0139] **31** Low-temperature path
[0140] **32** Low-temperature tank
[0141] **33** Low-temperature pump
[0142] **34** Low-temperature circulation path
[0143] **35** Line junction pipe
[0144] **36** Branch line pipe
[0145] **37** Low-temperature sensor
[0146] **38** High-temperature path
[0147] **39** High-temperature tank
[0148] **40** Line junction pipe
[0149] **41** Branch line pipe
[0150] **42** High-temperature sensor
[0151] **43** Control device
[0152] **44** Input device
[0153] **45** Display device
[0154] **46** Control target
[0155] **47** Temperature sensor

1. A cooling and heating apparatus comprising:

a refrigeration cycle circuit where a compression means, a gas cooler, a throttle means, and an evaporator are sequentially connected and a refrigerant circulates; and

a circulation fluid circuit provided with a circulating pump and a heating device, in which circulation fluid that adjusts a temperature of a control target circulates, wherein

the circulation fluid circuit includes:

a freely openable and closable low-temperature path where the circulation fluid flows through the evaporator in such a manner that heat is exchangeable between the circulation fluid and the refrigerant, and

a freely openable and closable high-temperature path where the circulation fluid flows through the gas cooler in such a manner that heat is exchangeable between the circulation fluid and the refrigerant, and

the high-temperature path is provided with a high-temperature tank where the circulation fluid heated by the refrigerant in the gas cooler is stored.

2. The cooling and heating apparatus according to claim **1**, wherein the refrigerant is carbon dioxide, and heats the circulation fluid under supercritical pressure in the gas cooler.

3. The cooling and heating apparatus according to claim **1**, wherein the refrigeration cycle circuit includes a second gas cooler that releases heat of the refrigerant to the outside, on a downstream side of the gas cooler.

4. The cooling and heating apparatus according to claim **1**, wherein

the gas cooler is provided in the high-temperature tank in such a manner that the refrigerant flows from up to down, and

the refrigerant flowing through the gas cooler heats the circulation fluid in the high-temperature tank.

5. The cooling and heating apparatus according to claim **1**, wherein the low-temperature path is provided with a low-temperature tank where the circulation fluid is stored, a low-temperature pump that feeds the circulation fluid, and a low-temperature circulation path that returns the circulation fluid to an inlet side of the low-temperature path without feeding the circulation fluid to the control target.

6. The cooling and heating apparatus according to claim **1**, wherein the circulation fluid circuit is provided with a three-way valve that switches between whether or not the circulation fluid returning from the control target is fed to the high-temperature path, and a mixing valve that is provided downstream of the three-way valve and mixes the circulation fluid that has passed through the low-temperature path with the circulation fluid to be supplied to the control target.

7. The cooling and heating apparatus according to claim **1**, wherein

there are a plurality of the control targets,

the circulation fluid circuit is provided with a plurality of circuit modules connected to the low-temperature path and the high-temperature path via branch line pipes, and

each of the plurality of circuit modules includes the circulating pump and the heating device, and feeds the circulation fluid to another control target.

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