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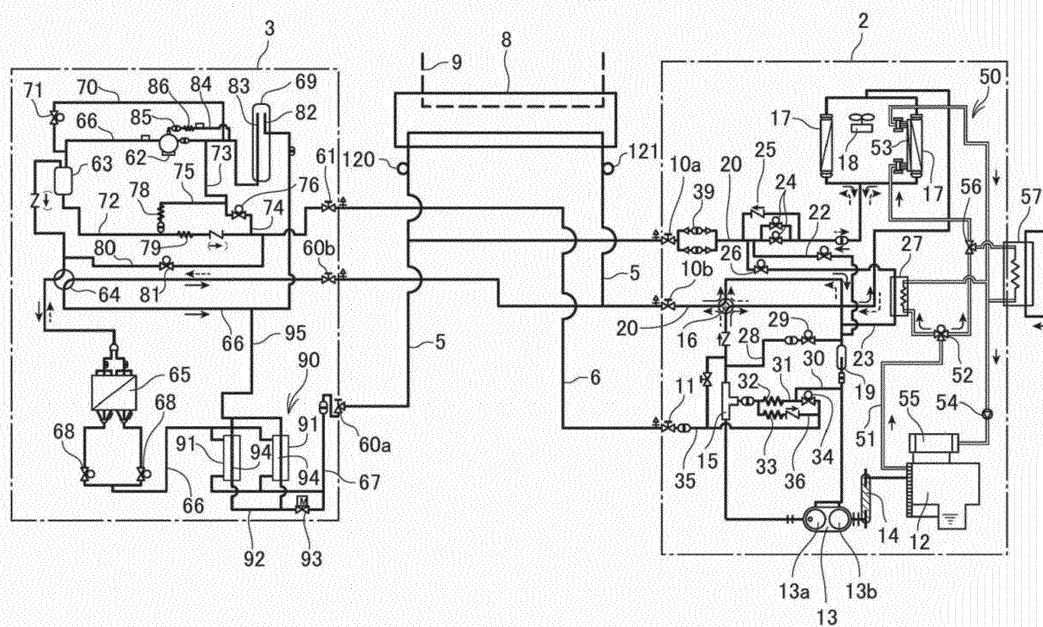
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(54) **HYBRID CHILLER SYSTEM**

(57) There is provided a hybrid chiller system in which a chiller system can be constructed and entrapment of a refrigerant in the chiller system can be prevented. The system includes a GHP outdoor unit 2 including a GHP compressor 13 to be driven by a gas engine 12, an EHP outdoor unit 3 including a compressor to be driven by a commercial power source, and a water heat ex-

changer 8 that exchanges heat between a refrigerant and cold and hot water that are sent from the GHP outdoor unit 2 and the EHP outdoor unit 3. This can construct the chiller system in which the water heat exchanger 8 exchanges heat with the cold and hot water by use of the GHP outdoor unit 2 and the EHP outdoor unit 3.

FIG. 1



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a hybrid chiller system, and more particularly relates to a hybrid chiller system in which a GHP outdoor unit and an EHP outdoor unit are for combined use.

Description of the Related Art

[0002] In general, there is known an air conditioner in which an indoor unit performs air conditioning by use of an outdoor unit in which a compressor to be driven by a gas engine or the like is mounted and an outdoor unit in which a compressor to be driven by electricity is mounted.

[0003] As this air conditioner, there has been heretofore disclosed, for example, an air conditioner including a second outdoor unit including a high-capacity compressor, a four-way valve and an outdoor heat exchanger, a first outdoor unit including a low-capacity compressor, a four-way valve and an outdoor heat exchanger, and an indoor unit connected to these outdoor units via one refrigerant system (e.g., see Japanese Patent Laid-Open No. 2017-150687).

[0004] However, the above conventional air conditioner is an air heat exchange air conditioning system in which a GHP outdoor unit and an EHP outdoor unit are connected to an indoor unit, to exchange heat between a refrigerant and indoor air, thereby performing air conditioning.

[0005] On the other hand, in recent years, there has been demand for a chiller system in which a GHP outdoor unit and an EHP outdoor unit are connected to a water heat exchanger, and heat is exchanged with a refrigerant by this water heat exchanger, to produce cold and hot water.

[0006] Furthermore, when the chiller system is constructed, there is concern that a problem of entrapment of the refrigerant or deviation of the refrigerant occurs, because a heat exchange volume is not large and a refrigerant pipe is comparatively short differently from the air heat exchange air conditioner system.

[0007] The present invention has been developed in view of the above described respects, and an object thereof is to provide a hybrid chiller system in which a chiller system can be constructed, and entrapment of a refrigerant or the like in the chiller system can be prevented.

SUMMARY OF THE INVENTION

[0008] To achieve the above object, according to one aspect of the present invention, there is provided a hybrid chiller system including a GHP outdoor unit including a GHP compressor to be driven by a gas engine, an EHP

outdoor unit including a compressor to be driven by a commercial power source, and a water heat exchanger that exchanges heat between a refrigerant and cold and hot water that are sent from the GHP outdoor unit and the EHP outdoor unit.

[0009] According to this system, there can be constructed the chiller system in which the water heat exchanger exchanges heat between the refrigerant and the cold and hot water by use of the GHP outdoor unit and the EHP outdoor unit.

[0010] According to a hybrid chiller system of the present invention, there can be constructed a chiller system in which a water heat exchanger exchanges heat with cold and hot water, by use of a GHP outdoor unit and an EHP outdoor unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Fig. 1 is a configuration diagram of an air conditioner according to an embodiment of the present invention; and

Fig. 2 is a block diagram showing a functional configuration of the air conditioner.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] In a first aspect of the present invention, a hybrid chiller system includes a GHP outdoor unit including a GHP compressor to be driven by a gas engine, an EHP outdoor unit including a compressor to be driven by a commercial power source, and a water heat exchanger that exchanges heat between a refrigerant and cold and hot water that are sent from the GHP outdoor unit and the EHP outdoor unit.

[0013] According to this system, it is possible to construct the chiller system in which the water heat exchanger exchanges heat with the cold and hot water by use of the GHP outdoor unit and the EHP outdoor unit.

[0014] In a second aspect of the present invention, the hybrid chiller system includes a GHP control section that controls the GHP outdoor unit, an EHP control section that controls the EHP outdoor unit, and a controller control section that transmits a control instruction signal to each of the GHP control section and the EHP control section.

[0015] According to this system, based on the control instruction signal from the controller control section, the GHP control section can control the GHP outdoor unit, and the EHP control section can control the EHP outdoor unit.

[0016] In a third aspect of the present invention, the controller control section sets an upper limit horsepower based on an operation state of each of the GHP outdoor unit and the EHP outdoor unit, and transmits an instruction signal of this upper limit horsepower to each of the

GHP control section and the EHP control section. In a case where air heat exchange air conditioning is performed, when an operation horsepower of the EHP outdoor unit does not satisfy an upper limit horsepower instruction of the EHP outdoor unit, the EHP control section notifies the GHP control section of the upper limit horsepower instruction not being satisfied, and the GHP control section performs control to lower rotation of the gas engine of the GHP outdoor unit. When chiller air conditioning is performed and a heating operation is performed, the GHP control section executes control so that the control to lower the rotation of the gas engine of the GHP outdoor unit is not performed.

[0017] According to this system, when the chiller air conditioning is performed and the heating operation is performed, the GHP control section executes the control so that the control to lower the rotation of the gas engine of the GHP outdoor unit is not performed. Consequently, a water temperature fluctuation in the water heat exchanger can be decreased, and a stabilized operation can be performed.

[0018] In a fourth aspect of the present invention, when air heat exchange air conditioning is performed and a heating operation is performed, the GHP control section controls an opening degree of an electric valve based on a discharge temperature of the refrigerant of the GHP compressor. When chiller air conditioning is performed and the heating operation is performed, the GHP control section sets a threshold value of the discharge temperature of the refrigerant of the GHP compressor to be lower than when the air heat exchange air conditioning is performed, to execute the control.

[0019] According to this system, when the chiller air conditioning is performed and the heating operation is performed, the threshold value of the discharge temperature of the refrigerant is set to be lower. Consequently, the opening degree of the electric valve can be controlled in such a tendency that the valve opens earlier. Furthermore, when the opening degree of the electric valve is controlled so that the valve opens earlier, rise of a high pressure or liquid seal can be prevented.

[0020] In a fifth aspect of the present invention, in a case where chiller air conditioning is performed and a cooling operation is performed by the GHP outdoor unit and the EHP outdoor unit, when receiving an instruction signal of an upper limit horsepower of the EHP outdoor unit which is transmitted from the controller control section, the EHP control section raises the upper limit horsepower of the EHP outdoor unit to control the EHP outdoor unit.

[0021] According to this system, the EHP control section controls and raises the upper limit horsepower of the EHP outdoor unit. Consequently, stagnation of the refrigerant can be prevented, and the GHP outdoor unit can be prevented from running out of gas.

[0022] In a sixth aspect of the present invention, in a case where chiller air conditioning is performed and a cooling operation is performed by the GHP outdoor unit,

when the GHP control section judges that gas runs out, the EHP control section controls and starts the EHP outdoor unit. The GHP control section opens an oil return valve of the GHP outdoor unit, and the EHP control section controls and opens a solenoid valve for a high pressure refrigerant, until the EHP outdoor unit starts. After the EHP outdoor unit starts, rotation of the gas engine of the GHP outdoor unit is controlled and inhibited.

[0023] According to this system, the EHP control section controls and starts the EHP outdoor unit. The GHP control section opens the oil return valve of the GHP outdoor unit, and the EHP control section controls and opens the solenoid valve for the high pressure refrigerant, until the EHP outdoor unit starts. After the EHP outdoor unit starts, the rotation of the gas engine of the GHP outdoor unit is controlled and inhibited. Consequently, refrigerant pressure balance between the GHP outdoor unit and the EHP outdoor unit can be acquired. The refrigerant that stagnates in the EHP outdoor unit can be supplied to the GHP outdoor unit, and the running out of the gas in the GHP outdoor unit can be solved.

[0024] In a seventh aspect of the present invention, in a case where chiller air conditioning is performed and a cooling operation is performed, when a temperature difference between an inlet side temperature and an outlet side temperature of the water heat exchanger is small, the GHP control section controls and maintains or lowers a rotation speed of the gas engine. When the temperature difference between the inlet side temperature and the outlet side temperature of the water heat exchanger is large, control to increase the rotation speed of the gas engine is inhibited.

[0025] According to this system, when the temperature difference between the inlet side temperature and the outlet side temperature of the water heat exchanger is large, the control to increase the rotation speed of the gas engine is inhibited. Consequently, the temperature of the water heat exchanger can be prevented from extremely dropping during the cooling operation. As a result, delay in control to start the stopped EHP outdoor unit can be prevented, and the GHP outdoor unit can be prevented from running out of gas.

[0026] Hereinafter, description will be made as to an embodiment of the present invention with reference to the drawing.

[0027] Fig. 1 is a configuration diagram showing an embodiment of an air conditioner to which a hybrid chiller system according to the present invention is applied.

[0028] As shown in Fig. 1, an air conditioner 1 includes a GHP outdoor unit 2 including a GHP compressor 13 to be driven as a high capacity compressor by a gas engine 12, an EHP outdoor unit 3 including an EHP compressor 62 to be driven as a low capacity compressor by a commercial power source, and a water heat exchanger 8. The GHP outdoor unit 2, the EHP outdoor unit 3 and the water heat exchanger 8 are connected via an interunit pipe 5 and an oil balance pipe 6. Consequently, a refrigeration cycle circuit to perform an air conditioning oper-

ation is constituted.

[0029] The GHP outdoor unit 2 includes two external connection valves 10a and 10b to be connected to the external interunit pipe 5, and an oil connection valve 11 to be connected to the oil balance pipe 6.

[0030] In the GHP outdoor unit 2, there are provided the gas engine 12, and a GHP compressor 13 that compresses a refrigerant by a drive force of the gas engine 12. The GHP compressor 13 is constituted of a first GHP compressor 13a and a second GHP compressor 13b that are provided in parallel.

[0031] The gas engine 12 burns a mixed gas of a fuel such as a gas supplied through a fuel adjustment valve (not shown) and air supplied through a throttle valve (not shown) to generate the drive force.

[0032] A drive belt 14 is bridged between an output shaft of the gas engine 12 and a driven shaft of the GHP compressor 13, and the drive force of the gas engine 12 is transmitted via the drive belt 14, to drive the GHP compressor 13.

[0033] An oil separator 15, a four-way valve 16 and two outdoor heat exchangers 17 and 17 are successively connected to a discharge side of the GHP compressor 13, and each outdoor heat exchanger 17 is connected to one external connection valve 10a via a refrigerant pipe 20. An outdoor fan 18 to exchange heat between the outdoor heat exchanger 17 and outdoor air is provided in the vicinity of the outdoor heat exchanger 17.

[0034] Furthermore, the other external connection valve 10b is connected to the refrigerant pipe 20. A middle portion of this refrigerant pipe 20 is connected to a suction side of the GHP compressor 13 via the four-way valve 16 and an accumulator 19.

[0035] Electric valves 24 and a check valve 25 are connected in parallel with the middle portion of the refrigerant pipe 20, and the refrigerant pipe 20 is connected to a liquid pipe 22 connected to an inflow side of the accumulator 19. A dry core 39 is provided between the outdoor heat exchanger 17 and the external connection valve 10a.

[0036] Furthermore, a heat exchange refrigerant pipe 23 that connects the suction side of the GHP compressor 13 to the refrigerant pipe 20 is connected between the suction side of the GHP compressor 13 and the refrigerant pipe 20, and in this heat exchange refrigerant pipe 23, an electric valve 26 is provided. A plate type heat exchanger 27 is provided between the electric valve 26 of the heat exchange refrigerant pipe 23 and the suction side of the GHP compressor 13.

[0037] The GHP outdoor unit 2 includes a bypass pipe 28 that connects a discharge side of the GHP compressor 13 to the suction side thereof. One end of the bypass pipe 28 is connected between the oil separator 15 and the four-way valve 16, and the other end of the bypass pipe 28 is connected between the accumulator 19 and the four-way valve 16. A part of the refrigerant on the discharge side of the GHP compressor 13 flows through the bypass pipe 28 to the suction side of the GHP com-

pressor 13 due to a pressure difference.

[0038] In the bypass pipe 28, a bypass valve 29 that adjusts a flow rate of the bypass pipe 28 is provided. The bypass valve 29 is an electric valve that can open and close stepwise.

[0039] The GHP outdoor unit 2 includes an oil return pipe 30 that connects the oil separator 15 to the suction side of the GHP compressor 13. Lubricating oil stored in the oil separator 15 flows through the oil return pipe 30 to the suction side due to the pressure difference between the discharge side and the suction side of the GHP compressor 13.

[0040] The oil return pipe 30 includes a first return pipe 31 that connects an oil outflow port of the oil separator 15 to the suction side of the GHP compressor 13, and a second return pipe 36 provided in parallel to the first return pipe 31.

[0041] The first return pipe 31 includes a capillary tube 32.

[0042] The second return pipe 36 is connected to the first return pipe 31 to pass by the capillary tube 32. One end of the second return pipe 36 is connected to an upstream side of the capillary tube 32 in the first return pipe 31, and the other end of the second return pipe 36 is connected to a downstream side of the capillary tube 32 in the first return pipe 31.

[0043] The second return pipe 36 includes a capillary tube 33, and an oil return valve 34 provided on a downstream side of the capillary tube 33.

[0044] The oil connection valve 11 is connected to an oil pipe 35. A middle portion of the oil pipe 35 is branched, so that one oil pipe is connected to the downstream side from the oil separator 15 of the refrigerant pipe 20, and the other oil pipe is connected between the capillary tube 33 of the second return pipe 36 and the oil return valve 34.

[0045] The external connection valve 10a connected to the refrigerant pipe 20 is connected to one end of the water heat exchanger 8 via the interunit pipe 5. Furthermore, the other end of the water heat exchanger 8 is connected to the external connection valve 10b connected to the refrigerant pipe 20 via the interunit pipe 5.

[0046] The water heat exchanger 8 is connected to a cold and hot water pipe, and the water heat exchanger 8 exchanges heat between the refrigerant sent from the GHP outdoor unit 2 and cold and hot water that flows through the cold and hot water pipe.

[0047] A cold and hot water pipe 9 connected to the water heat exchanger 8 is connected to an unshown indoor unit, and configured to supply the cold and hot water to the indoor unit.

[0048] That is, the air conditioner 1 of the present embodiment includes a so-called hybrid outdoor unit including the GHP outdoor unit 2 and the EHP outdoor unit 3, and is considered as an air conditioner of the hybrid chiller system in which a chiller system performs the air conditioning by use of the GHP outdoor unit 2 and the EHP outdoor unit 3.

[0049] Furthermore, in the refrigerant pipe connected

to the water heat exchanger 8, there are provided an inlet temperature sensor 120 that detects an inlet side temperature of the refrigerant and an outlet temperature sensor 121 that detects an outlet side temperature of the refrigerant.

[0050] Furthermore, the GHP outdoor unit 2 includes a cooling water circuit 50 of the gas engine 12.

[0051] The cooling water circuit 50 includes a cooling water three-way valve 52, the plate type heat exchanger 27, a radiator 53 disposed close to the one outdoor heat exchanger 17, a cooling water pump 54, and an exhaust gas heat exchanger 55 of the gas engine 12, which are connected in order from the gas engine 12 via a cooling water pipe 51. The cooling water pump 54 is driven, to circulate cooling water through this circuit.

[0052] The cooling water pipe 51 of the cooling water circuit 50 is shown by a double line in Fig. 1, and flow of the cooling water is shown by a solid arrow line.

[0053] In the radiator 53, heat is exchanged between the outdoor air and the cooling water.

[0054] Furthermore, in the plate type heat exchanger 27, the electric valve 26 is operated to heat the refrigerant that returns to the GHP compressor 13 with the cooling water that flows through the cooling water pipe 51. Consequently, a low pressure of the refrigerant rises, and a heating efficiency improves.

[0055] The cooling water circuit 50 can form a first route in which the cooling water flows in order from the gas engine 12 through the cooling water three-way valve 52, the radiator 53, the cooling water pump 54, and the exhaust gas heat exchanger 55 to the gas engine 12.

[0056] Furthermore, the cooling water circuit 50 can form a second route in which the cooling water flows in order from the gas engine 12 through the cooling water three-way valve 52, the plate type heat exchanger 27, the cooling water pump 54 and the exhaust gas heat exchanger 55 to the gas engine 12.

[0057] In a middle of the first route that connects the radiator 53 to the cooling water three-way valve 52, a hot water three-way valve 56 is provided. The hot water three-way valve 56 is connected to a hot water heat exchanger 57 that exchanges heat between the cooling water and hot water, and the cooling water that flows through the hot water heat exchanger 57 is returned to an upstream side of the cooling water pump 54.

[0058] Next, description will be made as to the EHP outdoor unit 3.

[0059] The EHP outdoor unit 3 includes two external connection valves 60 to be connected to the external interunit pipe 5 and an oil connection valve 61 to be connected to the oil balance pipe 6.

[0060] The EHP outdoor unit 3 includes the EHP compressor 62 to be driven by the commercial power source. It is considered that an example of this EHP compressor 62 is an inverter type compressor that can vary an output.

[0061] A discharge side of the EHP compressor 62 is connected to an oil separator 63, a four-way valve 64 and two outdoor heat exchangers 65 and 65 in order,

and the outdoor heat exchanger 65 is connected to one external connection valve 60a via a refrigerant pipe 66. In the vicinity of the outdoor heat exchanger 65, an outdoor fan 105 (see Fig. 2) is provided to exchange heat between the outdoor heat exchanger 65 and the outdoor air.

[0062] A supercooling heat exchanger 90 is provided between the outdoor heat exchanger 65 and the external connection valve 60a.

[0063] Two systems of pipe lines are formed in the outdoor heat exchanger 65, and the refrigerant pipe 66 on a four-way valve 64 side and the refrigerant pipe 66 on a supercooling heat exchanger 90 side are respectively branched and connected to the outdoor heat exchanger 65. Furthermore, outdoor electronic control valves 68 and 68 are provided in the refrigerant pipe 66 on the supercooling heat exchanger 90 side of the outdoor heat exchanger 65.

[0064] The supercooling heat exchanger 90 includes two heat exchange units 91 and 91. The refrigerant pipe 66 on an outdoor heat exchanger 65 side and a refrigerant pipe 67 on an external connection valve 60a side are respectively branched and connected to each heat exchange unit 91 of the supercooling heat exchanger 90.

[0065] In the present embodiment, each heat exchange unit 91 is a double pipe type heat exchanger. Outer pipes of the heat exchange units 91 are connected to the refrigerant pipe 66 on the outdoor heat exchanger 65 side and the refrigerant pipe 67 on the external connection valve 60a side, respectively.

[0066] A middle portion of the refrigerant pipe 67 that connects the supercooling heat exchanger 90 to the external connection valve 60a is connected to a supercooling branch pipe 92. A middle portion of this supercooling branch pipe 92 is connected to an inner pipe 94 of each heat exchange unit 91 via a supercooling electronic control valve 93. The refrigerant that flows through the inner pipe 94 of the heat exchange unit 91 is returned to the refrigerant pipe 66 between the four-way valve 64 and an accumulator 69 via a supercooling refrigerant pipe 95.

[0067] An external connection valve 60b on the other side is connected to a suction side of the EHP compressor 62 via the refrigerant pipe 66, and the four-way valve 64 and the accumulator 69 are provided in a middle portion of the refrigerant pipe 66.

[0068] Furthermore, a middle portion of the refrigerant pipe 66 which is between the EHP compressor 62 and the oil separator 63 is provided with a refrigerant return pipe 70 branched and connected to the refrigerant pipe 66 between the EHP compressor 62 and the accumulator 69. A refrigerant returning solenoid valve 71 is provided in a middle portion of the refrigerant return pipe 70. Then, when the refrigerant returning solenoid valve 71 is opened, a part of the refrigerant does not circulate in a refrigeration cycle and is guided to the suction side of the EHP compressor 62.

[0069] Additionally, a lower portion of the oil separator 63 is connected to an oil pipe 72, and a middle portion

of the oil pipe 72 is connected to an oil return pipe 73 connected to the suction side of the EHP compressor 62. The oil return pipe 73 includes two branch pipes 74 and 75 that branch from the oil pipe 72, one branch pipe 74 is provided with an oil return valve 76, and the other branch pipe 75 is provided with a capillary tube 78. Furthermore, a capillary tube 79 is provided between connection portions of the oil pipe 72 to the respective branch pipes 74 and 75.

[0070] A middle portion of the refrigerant pipe 66 which is between the oil separator 63 and the four-way valve 64 is connected to a high pressure refrigerant pipe 80 midway branched and connected to a middle portion of the oil pipe 72. A middle portion of the high pressure refrigerant pipe 80 is provided with a solenoid valve 81 for a high pressure refrigerant.

[0071] Furthermore, the accumulator 69 includes an inflow pipe 82 into which the refrigerant of the refrigerant pipe 66 flows, and an outflow pipe 83 that sends an inner gas refrigerant of the accumulator 69 to the EHP compressor 62. The outflow pipe 83 is configured to open in an inner upper portion of the accumulator 69, and to send, to the EHP compressor 62, a gas refrigerant accumulated in the inner upper portion of the accumulator 69.

[0072] Additionally, the EHP compressor 62 is connected to an overflow pipe 84 connected to the suction side of the EHP compressor 62. In this overflow pipe 84, a strainer 85 and a throttle 86 to decompress oil are incorporated.

[0073] The external connection valve 60a of the EHP outdoor unit 3 is connected to one end of the interunit pipe 5, and the other end of the interunit pipe 5 is connected to a middle portion of the interunit pipe 5 which connects the external connection valve 10a of the GHP outdoor unit 2 to the water heat exchanger 8. The external connection valve 60b connected to a refrigerant pipe of the EHP outdoor unit 3 is connected to one end of the interunit pipe 5, and the other end of the interunit pipe 5 is connected to a middle portion of the interunit pipe 5 which connects the external connection valve 10b of the GHP outdoor unit 2 to the water heat exchanger 8.

[0074] Furthermore, the oil connection valve 61 of the EHP outdoor unit 3 is connected to the oil connection valve 11 of the GHP outdoor unit 2 via the oil balance pipe 6. Consequently, the GHP compressor 13 of the GHP outdoor unit 2 and the EHP compressor 62 of the EHP outdoor unit 3 can supply the oil to each other via the oil balance pipe 6, and balance of an oil amount can be held between the GHP compressor 13 of the GHP outdoor unit 2 and the EHP compressor 62 of the EHP outdoor unit 3.

[0075] Then, when the cooling operation is performed, the refrigerant flows as shown by a solid arrow line in Fig. 1, and when the heating operation is performed, the refrigerant flows as shown by a broken arrow line in Fig. 1.

[0076] Note that the refrigerant is supplied to an indoor heat exchanger of the indoor unit from the GHP outdoor unit 2 and the EHP outdoor unit 3 in place of the water

heat exchanger 8. Consequently, an air conditioning system by air heat exchange can be constructed. Hereinafter, the air conditioning that is performed by this air heat exchange is referred to as the air heat exchange air conditioning.

[0077] Next, description will be made as to a control configuration of the air conditioner of the present embodiment. Fig. 2 is a block diagram showing the control configuration in the present embodiment.

[0078] As shown in Fig. 2, in the present embodiment, the GHP outdoor unit 2 includes a GHP control section 100 as a control section, and the EHP outdoor unit 3 includes an EHP control section 101 as a control section.

[0079] Furthermore, in the present embodiment, the air conditioner includes a controller 110 that sends a control instruction signal to each of the GHP outdoor unit 2 and the EHP outdoor unit 3.

[0080] The controller 110 includes a controller control section 111 to generally control the GHP control section 100 and the EHP control section 101.

[0081] Each of the GHP control section 100, the EHP control section 101 and the controller control section 111 includes, for example, a computation processing circuit such as a CPU, storage means such as ROM and RAM, and others, and executes a predetermined program to perform predetermined control.

[0082] The GHP control section 100 is configured to perform drive control of the gas engine 12, the outdoor fan 18 and the cooling water pump 54 of the GHP outdoor unit 2, and to perform opening and closing control or opening degree control of the external connection valves 10a and 10b, the oil connection valve 11, the electric valve 24, the electric valve 26, the bypass valve 29, the oil return valve 34 and the cooling water three-way valve 52 of the GHP outdoor unit 2.

[0083] The EHP control section 101 is configured to perform drive control of the EHP compressor 62 and the outdoor fan 105 of the EHP outdoor unit 3, and to perform opening and closing control or opening degree control of the external connection valves 60a and 60b, the oil connection valve 61, the outdoor electronic control valve 68, the refrigerant returning solenoid valve 71, the oil return valve 76, the solenoid valve 81 for the high pressure refrigerant and the supercooling electronic control valve 93 of the EHP outdoor unit 3.

[0084] These control operations of the GHP control section 100 and the EHP control section 101 are performed based on the control instruction signal sent from the controller control section 111.

[0085] At this time, in the present embodiment, the GHP control section 100 is set to a master, and the EHP control section 101 and an indoor control section are set to slaves. The control instruction signal from the controller control section 111 is first transmitted to the GHP control section 100, and this control instruction signal is sequentially transmitted from the GHP control section 100 to the EHP control section 101 and the indoor control section.

[0086] In the present embodiment, each of the GHP outdoor unit 2 and the EHP outdoor unit 3 adjusts an output in accordance with a cooling load. For example, when the cooling load is a low load, the EHP outdoor unit 3 is driven, and as the cooling load increases, the EHP outdoor unit 3 is stopped, and the GHP outdoor unit 2 is started. When the cooling load is a high load, the GHP outdoor unit 2 is driven, and additionally the EHP outdoor unit 3 is driven.

[0087] The controller 110 controls the GHP outdoor unit 2 and the EHP outdoor unit 3 based on a number of indoor units to be operated, a set temperature, an outdoor air temperature, and the like. Consequently, a control signal is output to each of the GHP control section 100 and the EHP control section 101 so that an operation of the GHP outdoor unit 2 and an operation of the EHP outdoor unit 3 save energy most. In consequence, the GHP control section 100 efficiently controls the operation of the GHP outdoor unit 2, and the EHP control section 101 efficiently controls the operation of the EHP outdoor unit 3.

[0088] Next, description will be made as to the control in the present embodiment in detail.

[Upper Limit Horsepower Instruction Control]

[0089] When the air heat exchange air conditioning is performed, the controller control section 111 sets an upper limit horsepower based on an operation state of each of the GHP outdoor unit 2 and the EHP outdoor unit 3, transmits an instruction signal of this upper limit horsepower to the GHP control section 100, and transmits the signal to the EHP control section via the GHP control section 100. Then, each of the GHP control section 100 and the EHP control section 101 controls the operation in accordance with the upper limit horsepower set by the controller control section 111.

[0090] In this case, when the GHP control section 100 judges that an operation horsepower of the EHP outdoor unit 3 does not satisfy an upper limit horsepower instruction of the EHP outdoor unit 3, the GHP control section 100 performs control to lower rotation of the gas engine 12 of the GHP outdoor unit 2.

[0091] Specifically, when the operation horsepower of the EHP outdoor unit 3 does not satisfy the upper limit horsepower, the rotation of the gas engine 12 of the GHP outdoor unit 2 is lowered. Consequently, the horsepower of the EHP outdoor unit 3 is easy to rise, and the operation of each of the GHP outdoor unit 2 and the EHP outdoor unit 3 can be more efficiently performed.

[0092] Furthermore, when chiller air conditioning is performed and a heating operation is performed, the GHP control section 100 performs control so that the above described control to lower the rotation of the gas engine 12 of the GHP outdoor unit 2 is not performed.

[0093] In this case, when the chiller air conditioning is performed and the heating operation is performed, the control to lower the rotation of the gas engine 12 of the

GHP outdoor unit 2 is performed. Then, a water temperature fluctuation in the water heat exchanger 8 increases, and the operation is not stabilized.

5 [Electric Valve Control of Outdoor Unit during Heating]

[0094] When the air heat exchange air conditioning is performed, during the heating operation, the GHP control section 100 controls an opening degree of the electric valve 24. That is, the GHP control section 100 controls suction super heat or discharge super heat based on a discharge temperature of the refrigerant of the GHP compressor 13.

10 **[0095]** Furthermore, when the chiller air conditioning is performed and the heating operation is performed, the GHP control section 100 sets a threshold value of the discharge temperature of the refrigerant of the GHP compressor 13 to be lower than when the air heat exchange air conditioning is performed, to execute the control.

15 **[0096]** In consequence, when the chiller air conditioning is performed and the heating operation is performed, the threshold value is set to be lower. Consequently, the opening degree of the electric valves 24 can be controlled in such a tendency that the valve opens earlier. Therefore, when the chiller air conditioning is performed, the output is to be raised to acquire a necessary capacity. However, when the opening degree of the electric valve 24 is small, there is concern that a high pressure rises or that liquid seal of the water heat exchanger 8 is generated. However, when the opening degree of the electric valve 24 is controlled so that the valve opens earlier, the rise of the high pressure or the liquid seal can be prevented.

25 **[0097]** In this case, when the air heat exchange air conditioning is performed, a place where the GHP outdoor unit 2 and the EHP outdoor unit 3 are installed is often distant from a place where the indoor unit is installed. When the refrigerant pipe lengthens, the pipe reaches several hundred meters sometimes. Therefore, it is possible to sufficiently acquire a place where a surplus refrigerant stagnates.

30 **[0098]** On the other hand, when the chiller air conditioning is performed, a distance from the installation place of the GHP outdoor unit 2 and the EHP outdoor unit 3 to the installation place of the water heat exchanger 8 is comparatively short. Additionally, in the present embodiment, for example, a receiver tank to store the surplus refrigerant is not installed in the EHP outdoor unit 3. Therefore, when the chiller air conditioning is performed, a place to store the surplus refrigerant cannot be acquired, and hence there is a tendency that the refrigerant is easy to accumulate in the water heat exchanger 8.

35 **[0099]** As described above, when the chiller air conditioning is performed and the heating operation is performed, the GHP control section 100 controls the opening degree of the electric valve 24 so that the valve opens earlier. Consequently, the rise of the high pressure or the liquid seal can be prevented.

[Upper Limit Horsepower Control of EHP Outdoor Unit]

[0100] In a case where the chiller air conditioning is performed and the GHP outdoor unit 2 and the EHP outdoor unit 3 perform the cooling operation, when receiving the instruction signal of the upper limit horsepower of the EHP outdoor unit 3 which is transmitted from the controller control section 111 via the GHP control section 100, the EHP control section 101 raises the upper limit horsepower of the EHP outdoor unit 3 to control the EHP outdoor unit 3.

[0101] That is, when the GHP outdoor unit 2 and the EHP outdoor unit 3 operate during the chiller air conditioning, and when the operation horsepower of the EHP outdoor unit 3 is suppressed, the refrigerant may stagnate in the EHP outdoor unit 3. There is also concern that the GHP outdoor unit 2 runs out of gas. As in the present embodiment, the EHP control section 101 controls and raises the upper limit horsepower of the EHP outdoor unit 3. Consequently, the refrigerant is prevented from stagnating, and the GHP outdoor unit 2 can be prevented from running out of gas.

[0102] The upper limit horsepower of the EHP outdoor unit 3 is controlled and uniformly raised, for example, as much as a predetermined percentage set in advance.

[Gas Running-out Control during Cooling]

[0103] When the air heat exchange air conditioning is performed, during the cooling operation, the GHP outdoor unit 2 runs out of gas, and oil runs short. In this case, the GHP control section 100 sends a start instruction to the EHP control section 101, and the EHP control section 101 starts the EHP outdoor unit 3, and controls the GHP outdoor unit 2 and the EHP outdoor unit 3 to operate.

[0104] Furthermore, when the chiller air conditioning is performed and the GHP outdoor unit 2 performs the cooling operation, the GHP control section 100 judges that the gas runs out. In this case, the GHP control section 100 sends the start instruction to the EHP control section 101, and the EHP control section 101 controls and starts the EHP outdoor unit 3. The GHP control section 100 opens the oil return valve 34 of the GHP outdoor unit 2, and the EHP control section 101 controls and opens the solenoid valve 81 for the high pressure refrigerant, until the EHP outdoor unit 3 starts.

[0105] When the GHP control section 100 judges that the EHP outdoor unit 3 starts, the GHP control section 100 controls and inhibits the rotation of the gas engine 12 of the GHP outdoor unit 2. Such control can acquire balance in refrigerant pressure between the GHP outdoor unit 2 and the EHP outdoor unit 3. The refrigerant that stagnates in the EHP outdoor unit 3 can be supplied to the GHP outdoor unit 2, and the running out of the gas in the GHP outdoor unit 2 can be solved.

[0106] Note that it is determined that the GHP outdoor unit 2 runs out of gas, based on a temperature difference between the inlet side temperature and the outlet side

temperature of the water heat exchanger 8 and an opening degree of a water heat exchanging valve. That is, when the opening degree of the water heat exchanging valve is large and the temperature difference between the inlet side temperature and the outlet side temperature is large, it is determined that the gas runs out.

[Output Rise Control during Cooling]

[0107] In the case where the chiller air conditioning is performed, during the cooling operation, the temperature difference is small between the inlet side temperature and the outlet side temperature of the water heat exchanger 8 which are detected by the inlet temperature sensor 120 and the outlet temperature sensor 121. In this case, the GHP control section 100 controls and maintains or lowers a rotation speed of the gas engine 12.

[0108] Furthermore, when the temperature difference between the inlet side temperature and the outlet side temperature of the water heat exchanger 8 is large, the GHP control section 100 inhibits control to increase the rotation speed of the gas engine 12.

[0109] Such control can prevent the temperature of the water heat exchanger 8 from extremely dropping during the cooling operation. As a result, delay in control to start the stopped EHP outdoor unit 3 can be prevented, and the GHP outdoor unit 2 can be prevented from running out of gas.

[0110] As described above, in the present embodiment, the hybrid chiller system includes the GHP outdoor unit 2 including the GHP compressor 13 to be driven by the gas engine 12, the EHP outdoor unit 3 including the compressor to be driven by the commercial power source, and the water heat exchanger 8 that exchanges heat between the refrigerant and the cold and hot water that are sent from the GHP outdoor unit 2 and the EHP outdoor unit 3.

[0111] According to this system, it is possible to construct the chiller system in which the water heat exchanger 8 exchanges heat with the cold and hot water by use of the GHP outdoor unit 2 and the EHP outdoor unit 3.

[0112] Furthermore, in the present embodiment, the hybrid chiller system includes the GHP control section 100 that controls the GHP outdoor unit 2, the EHP control section 101 that controls the EHP outdoor unit 3, and the controller control section 111 that transmits the control instruction signal to each of the GHP control section 100 and the EHP control section 101.

[0113] According to this system, based on the control instruction signal from the controller control section 111, the GHP control section 100 can control the GHP outdoor unit 2, and the EHP control section 101 can control the EHP outdoor unit 3.

[0114] Additionally, in the present embodiment, the controller control section 111 sets the upper limit horsepower based on the operation state of each of the GHP outdoor unit 2 and the EHP outdoor unit 3, and transmits the instruction signal of this upper limit horsepower to

each of the GHP control section 100 and the EHP control section. In a case where the air heat exchange air conditioning is performed, when the operation horsepower of the EHP outdoor unit 3 does not satisfy the upper limit horsepower instruction of the EHP outdoor unit 3, the EHP control section 101 notifies the GHP control section 100 of the upper limit horsepower instruction not being satisfied, and the GHP control section 100 performs control to lower the rotation of the gas engine 12 of the GHP outdoor unit 2. When the chiller air conditioning is performed and the heating operation is performed, the GHP control section 100 executes control so that the control to lower the rotation of the gas engine 12 of the GHP outdoor unit 2 is not performed.

[0115] According to this system, when the chiller air conditioning is performed and the heating operation is performed, the GHP control section 100 executes the control so that the control to lower the rotation of the gas engine 12 of the GHP outdoor unit 2 is not performed. Consequently, a water temperature fluctuation in the water heat exchanger 8 can be decreased, and a stabilized operation can be performed.

[0116] Furthermore, in the present embodiment, when the air heat exchange air conditioning is performed and the heating operation is performed, the GHP control section 100 controls the opening degree of the electric valve 24 based on the discharge temperature of the refrigerant of the GHP compressor 13. When the chiller air conditioning is performed and the heating operation is performed, the GHP control section 100 sets the threshold value of the discharge temperature of the refrigerant of the GHP compressor 13 to be lower than when the air heat exchange air conditioning is performed, to execute the control.

[0117] According to this system, when the chiller air conditioning is performed and the heating operation is performed, the threshold value of the discharge temperature of the refrigerant is set to be lower. Consequently, the opening degree of the electric valve 24 can be controlled in such a tendency that the valve opens earlier. Furthermore, when the opening degree of the electric valve 24 is controlled so that the valve opens earlier, the rise of the high pressure or the liquid seal can be prevented.

[0118] Additionally, in the present embodiment, in the case where the chiller air conditioning is performed and the cooling operation is performed by the GHP outdoor unit 2 and the EHP outdoor unit 3, when receiving the instruction signal of the upper limit horsepower of the EHP outdoor unit 3 which is transmitted from the controller control section 111, the EHP control section 101 raises the upper limit horsepower of the EHP outdoor unit 3 to control the EHP outdoor unit 3.

[0119] According to this system, the EHP control section 101 controls and raises the upper limit horsepower of the EHP outdoor unit 3. Consequently, the stagnation of the refrigerant can be prevented, and the GHP outdoor unit 2 can be prevented from running out of gas.

[0120] Furthermore, in the present embodiment, in the case where the chiller air conditioning is performed and the GHP outdoor unit 2 performs the cooling operation, when the GHP control section 100 judges that the gas runs out, the EHP control section 101 controls and starts the EHP outdoor unit 3. The GHP control section 100 opens the oil return valve 34 of the GHP outdoor unit 2, and the EHP control section 101 controls and opens the solenoid valve 81 for the high pressure refrigerant, until the EHP outdoor unit 3 starts. After the EHP outdoor unit 3 starts, the rotation of the gas engine 12 of the GHP outdoor unit 2 is controlled and inhibited.

[0121] According to this system, the EHP control section 101 controls and starts the EHP outdoor unit 3. The GHP control section 100 opens the oil return valve 34 of the GHP outdoor unit 2, and the EHP control section 101 controls and opens the solenoid valve for the high pressure refrigerant, until the EHP outdoor unit 3 starts. After the EHP outdoor unit 3 starts, the rotation of the gas engine 12 of the GHP outdoor unit 2 is controlled and inhibited. Consequently, the refrigerant pressure balance between the GHP outdoor unit 2 and the EHP outdoor unit 3 can be acquired. The refrigerant that stagnates in the EHP outdoor unit 3 can be supplied to the GHP outdoor unit 2, and the running out of gas in the GHP outdoor unit 2 can be solved.

[0122] Additionally, in the present embodiment, in the case where the chiller air conditioning is performed and the cooling operation is performed, when the temperature difference between the inlet side temperature and the outlet side temperature of the water heat exchanger 8 is small, the GHP control section 100 controls and maintains or lowers the rotation speed of the gas engine 12. When the temperature difference between the inlet side temperature and the outlet side temperature of the water heat exchanger 8 is large, the control to increase the rotation speed of the gas engine 12 is inhibited.

[0123] According to this system, when the temperature difference between the inlet side temperature and the outlet side temperature of the water heat exchanger 8 is large, the control to increase the rotation speed of the gas engine 12 is inhibited. Consequently, the temperature of the water heat exchanger 8 can be prevented from extremely dropping during the cooling operation. As a result, delay in control to start the stopped EHP outdoor unit 3 can be prevented, and the GHP outdoor unit 2 can be prevented from running out of gas.

[0124] Note that the above embodiment illustrates one aspect to which the present invention is applied, and the present invention is not limited to the above embodiment.

[0125] In the above embodiment, there has been described the example where the GHP control section 100 is set to the master, and the EHP control section 101 is set to the slave, but the present invention is not limited to this example. For example, the EHP control section 101 may be set to a master, the GHP control section 100 may be set to a slave, and the control instruction signal from the controller control section 111 may be first trans-

mitted to the EHP control section 101.

[0126] Furthermore, without setting the master and the slave, the GHP control section 100, the EHP control section 101 and the indoor control section may be connected in parallel to the controller control section 111, and the controller control section 111 may individually transmit control instruction signals to the GHP control section 100, the EHP control section 101 and the indoor control section.

[0127] Additionally, in the above embodiment, the case where the air conditioning is performed by using the chiller system has been described, but the air conditioning is not restrictive. For example, the present invention can be also applied to process cooling, heating application or the like.

Industrial Applicability

[0128] As described above, the hybrid chiller system according to the present invention can construct the chiller system, and can be preferably utilized as the hybrid chiller system that can prevent stagnation of the refrigerant in the chiller system.

Reference Signs List

[0129]

1	air conditioner
2	GHP outdoor unit
3	EHP outdoor unit
8	water heat exchanger
12	gas engine
13	GHP compressor
15	oil separator
17, 65	outdoor heat exchanger
62	EHP compressor
71	refrigerant returning solenoid valve
100	GHP control section
101	EHP control section
110	controller
111	controller control section
120	inlet temperature sensor
121	outlet temperature sensor

Claims

1. A hybrid chiller system **characterized by** comprising:

a GHP outdoor unit (2) including a GHP compressor (13) to be driven by a gas engine (12); an EHP outdoor unit (3) including a compressor to be driven by a commercial power source; and a water heat exchanger (8) that exchanges heat between a refrigerant and cold and hot water that are sent from the GHP outdoor unit and the

EHP outdoor unit.

2. The hybrid chiller system according to claim 1, comprising:

a GHP control section (100) that controls the GHP outdoor unit;
an EHP control section (101) that controls the EHP outdoor unit; and
a controller control section (111) that transmits a control instruction signal to each of the GHP control section and the EHP control section.

3. The hybrid chiller system according to claim 2, wherein the controller control section sets an upper limit horsepower based on an operation state of each of the GHP outdoor unit and the EHP outdoor unit, and transmits an instruction signal of this upper limit horsepower to each of the GHP control section and the EHP control section,

in a case where air heat exchange air conditioning is performed, when an operation horsepower of the EHP outdoor unit does not satisfy an upper limit horsepower instruction of the EHP outdoor unit, the EHP control section notifies the GHP control section of the upper limit horsepower instruction not being satisfied, and the GHP control section performs control to lower rotation of the gas engine of the GHP outdoor unit, and
when chiller air conditioning is performed and a heating operation is performed, the GHP control section executes control so that the control to lower the rotation of the gas engine of the GHP outdoor unit is not performed.

4. The hybrid chiller system according to claim 2 or 3, wherein when air heat exchange air conditioning is performed and a heating operation is performed, the GHP control section controls an opening degree of an electric valve (24) based on a discharge temperature of the refrigerant of the GHP compressor, and when chiller air conditioning is performed and the heating operation is performed, the GHP control section sets a threshold value of the discharge temperature of the refrigerant of the GHP compressor to be lower than when the air heat exchange air conditioning is performed, to execute the control.

5. The hybrid chiller system according to any one of claims 2 to 4, wherein in a case where chiller air conditioning is performed and a cooling operation is performed by the GHP outdoor unit and the EHP outdoor unit, when receiving an instruction signal of an upper limit horsepower of the EHP outdoor unit which is transmitted from the controller control section, the EHP control section raises the upper limit horsepower of the EHP outdoor unit to control the EHP outdoor unit.

6. The hybrid chiller system according to any one of claims 2 to 5, wherein in a case where chiller air conditioning is performed and a cooling operation is performed by the GHP outdoor unit, when the GHP control section judges that gas runs out, the EHP control section controls and starts the EHP outdoor unit; the GHP control section opens an oil return valve (34) of the GHP outdoor unit, and the EHP control section controls and opens a solenoid valve (81) for a high pressure refrigerant, until the EHP outdoor unit starts; and after the EHP outdoor unit starts, rotation of the gas engine of the GHP outdoor unit is controlled and inhibited.
7. The hybrid chiller system according to any one of claims 2 to 6, wherein in a case where chiller air conditioning is performed and a cooling operation is performed, when a temperature difference between an inlet side temperature and an outlet side temperature of the water heat exchanger is small, the GHP control section controls and maintains or lowers a rotation speed of the gas engine; and when the temperature difference between the inlet side temperature and the outlet side temperature of the water heat exchanger is large, control to increase the rotation speed of the gas engine is inhibited.

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FIG.1

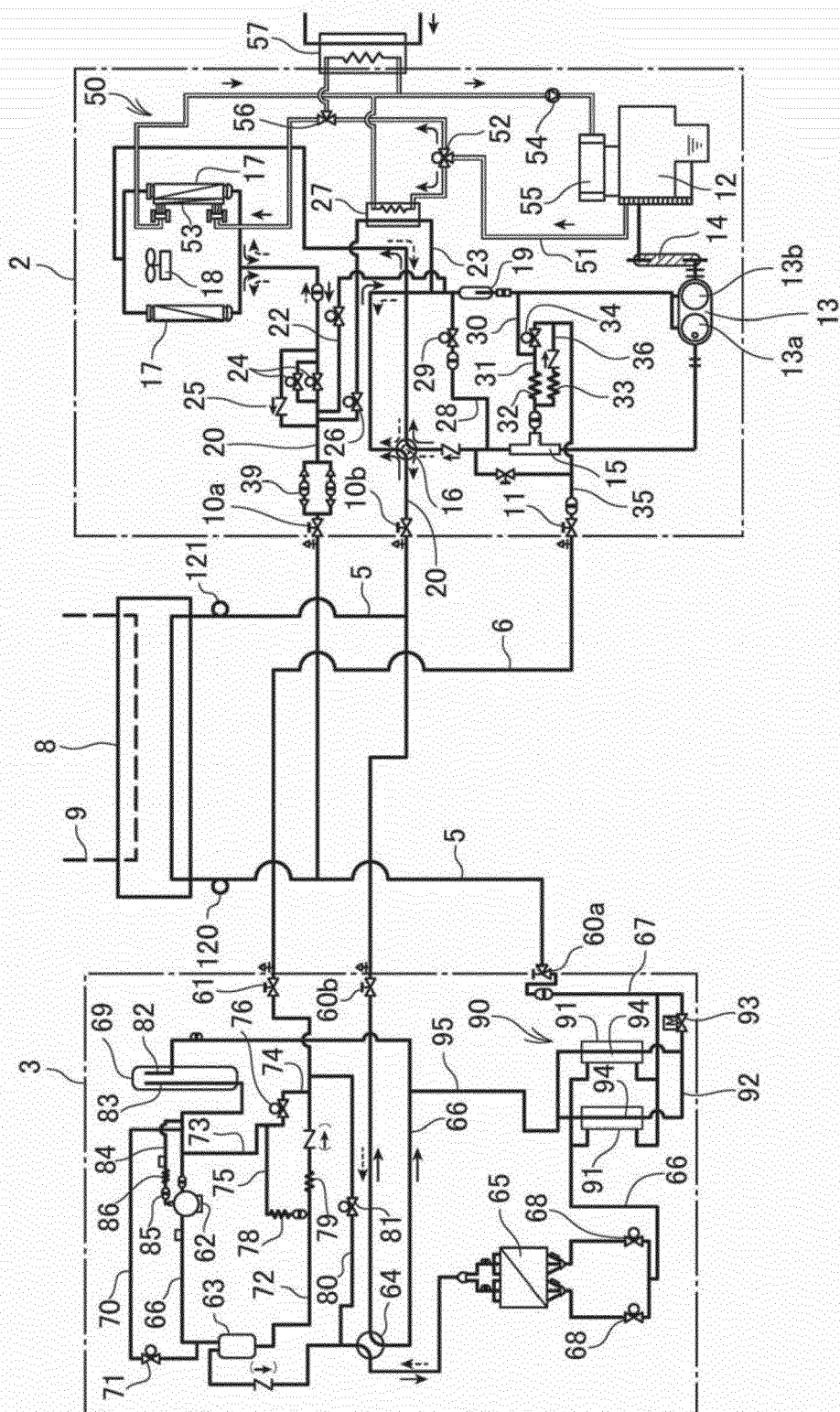
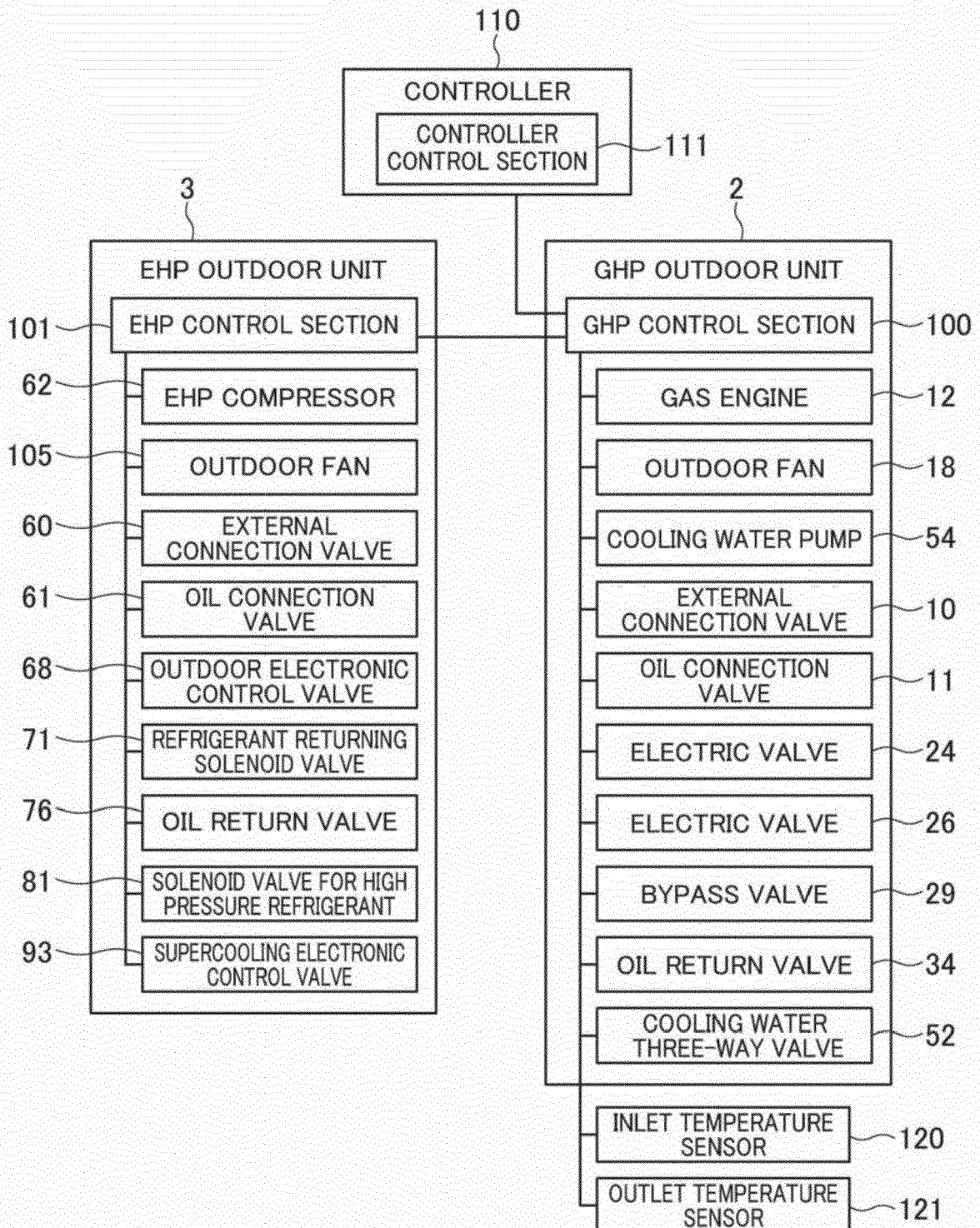


FIG.2





EUROPEAN SEARCH REPORT

Application Number
EP 19 18 5716

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