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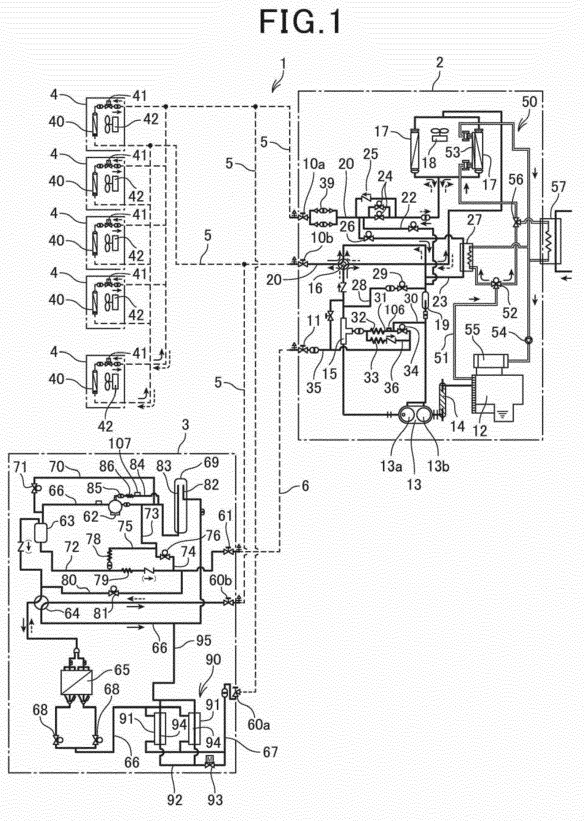
(54) AIR CONDITIONER

(57) There is provided an air conditioner in which when one outdoor unit is performing a cooling operation, oil of the operating outdoor unit can be kept, and burn-in of a compressor due to oil exhaustion during the operation can be prevented. When the cooling operation is performed only by one GHP outdoor unit 2 in the GHP outdoor unit 2 and an EHP outdoor unit 3 and the other EHP outdoor unit 3 is stopped, a GHP control section 100 or an EHP control section 101 determines whether or not an oil level lowers below a certain level, on a basis of a detection value from a GHP oil level sensor 106 of the operating GHP outdoor unit 2, and when the control section determines that the oil level lowers below the certain level, the control section executes control to open an oil return valve 34 of the operating GHP outdoor unit 2.

FIG.1



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an air conditioner, and more particularly to an air conditioner 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] Heretofore, an outdoor unit is provided with an oil return pipe that connects a discharge side of a compressor to a suction side thereof. In the oil return pipe, an oil return valve is provided which adjusts a flow rate of oil to be returned. Furthermore, when the oil return valve is opened, a part of the oil on the discharge side of the compressor is sent through the oil return pipe to the suction side of the compressor due to a pressure difference.

[0005] However, in the above conventional air conditioner, one outdoor unit performs a cooling operation, and the other outdoor unit is stopped. In this case, when a high pressure is applied from the operating outdoor unit to the discharge side of the oil return valve of the stopped outdoor unit, the oil return valve opens. Therefore, there is a problem that refrigerant and oil are accumulated in the stopped outdoor unit.

[0006] Thus, when the refrigerant and oil are accumulated in the stopped outdoor unit, an oil level of the compressor during the operation cannot be kept immediately. Consequently, there is concern that a failure occurs due to burn-in.

[0007] The present invention has been developed in view of the above respect, and an object thereof is to provide an air conditioner in which when one outdoor unit is performing a cooling operation, oil of the operating outdoor unit can be kept, and burn-in of a compressor due to oil exhaustion during the operation can be prevented.

SUMMARY OF THE INVENTION

[0008] To achieve the above object, according to one aspect of the present invention, there is provided an air conditioner in which each of a plurality of outdoor units is connected to an indoor unit via an interunit pipe, each outdoor unit is operated, and indoor air conditioning is performed by the indoor unit, the air conditioner including an oil return pipe that returns oil on a discharge side of a compressor provided in the outdoor unit back to a suction side of the compressor, an oil return valve provided in an intermediate portion of the oil return pipe, an oil level sensor that detects an oil level of the outdoor unit, and a control section that controls the outdoor unit, wherein when a cooling operation is performed only by one outdoor unit of the outdoor units and the other outdoor unit is stopped, the control section determines whether or not the oil level lowers below a certain level, on a basis of a detection value from the oil level sensor of the operating outdoor unit, and when the control section determines that the oil level lowers below the certain level, the control section executes control to open the oil return valve of the operating outdoor unit.

[0009] According to this aspect, when the oil return valve is opened, any high pressure is not applied to a discharge side of an oil return valve of the stopped outdoor unit. Consequently, refrigerant and oil can be prevented from being accumulated in the stopped outdoor unit. Furthermore, the refrigerant and oil accumulated in the stopped outdoor unit can be sent to the suction side of the compressor of the outdoor unit that is performing the cooling operation.

[0010] According to an air conditioner of the present invention, when an oil return valve is opened, any high pressure is not applied to a discharge side of the oil return valve of a stopped outdoor unit. Consequently, refrigerant and oil can be prevented from being accumulated in the stopped outdoor unit. Furthermore, the refrigerant and oil accumulated in the stopped outdoor unit can be sent to a suction side of a compressor of an outdoor unit that is performing a cooling operation. As a result, the oil of the compressor that is performing the cooling operation can be sufficiently kept, and burn-in can be prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

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

Fig. 2 is a block diagram showing a control configuration of the present embodiment; and

Fig. 3 is a flowchart showing an operation of the present embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0012] In a first aspect of the invention, there is provided an air conditioner in which each of a plurality of outdoor units is connected to an indoor unit via an interunit pipe, each outdoor unit is operated and indoor air conditioning is performed by the indoor unit, the air conditioner including an oil return pipe that returns oil on a discharge side of a compressor provided in the outdoor unit back to a suction side of the compressor, an oil return valve provided in an intermediate portion of the oil return pipe, an oil level sensor that detects an oil level of the outdoor unit, and a control section that controls the outdoor unit, wherein when a cooling operation is performed only by one outdoor unit of the outdoor units and the other outdoor unit is stopped, the control section determines whether or not the oil level lowers below a certain level, on a basis of a detection value from the oil level sensor of the operating outdoor unit, and when the control section determines that the oil level lowers below the certain level, the control section executes control to open the oil return valve of the operating outdoor unit.

[0013] According to this aspect, when the oil return valve is opened, any high pressure is not applied to a discharge side of an oil return valve of the stopped outdoor unit. Consequently, refrigerant and oil can be prevented from being accumulated in the stopped outdoor unit. Furthermore, the refrigerant and oil accumulated in the stopped outdoor unit can be sent to the suction side of the compressor of the outdoor unit that is performing the cooling operation. As a result, the oil of the compressor that is performing the cooling operation can be sufficiently kept, and burn-in can be prevented.

[0014] In a second aspect of the invention, the control section ends the control to open the oil return valve, in either one of a state where two or more of the outdoor units are operated, a state where the oil level based on the detection value from the oil level sensor rises above the certain level, or a state where a protection control operation is performed.

[0015] According to this aspect, when the oil of the compressor can be kept, the control to open the oil return valve is ended. Consequently, unnecessary supply of oil can be stopped.

[0016] In a third aspect of the invention, the plurality of outdoor units include a GHP outdoor unit including a GHP compressor that is driven by an engine and an EHP outdoor unit including an EHP compressor that is driven by a commercial power source.

[0017] According to this aspect, the plurality of outdoor units can be constituted of the GHP outdoor unit and the EHP outdoor unit. When one of the GHP outdoor unit or the EHP outdoor unit is performing the cooling operation, any high pressure is not applied to the discharge side of the oil return valve of the stopped outdoor unit, and the refrigerant and oil can be prevented from being accumulated in the stopped outdoor unit. Furthermore, the refrigerant and oil accumulated in the stopped outdoor unit can be sent to the suction side of the compressor of the outdoor unit that is performing the cooling operation. As a result, the oil of the compressor that is performing the cooling operation can be sufficiently kept, and the burn-in can be prevented.

[0018] Hereinafter, description will be made as to an embodiment of the present invention with reference to the drawings.

[0019] Fig. 1 is a configuration diagram showing the embodiment of an air conditioner according to the present invention.

[0020] As shown in Fig. 1, an air conditioner 1 includes a GHP outdoor unit 2 (a second outdoor unit) including a GHP compressor 13 that is driven as a high capacity compressor by a gas engine, an EHP outdoor unit 3 (a first outdoor unit) including an EHP compressor 62 that is driven as a low capacity compressor by a commercial power source, and a plurality of indoor units 4. The GHP outdoor unit 2, the EHP outdoor unit 3 and the respective indoor units 4 are connected via an interunit pipe 5 and an oil balance pipe 6. Consequently, a refrigeration cycle circuit to perform an air conditioning operation is constituted.

[0021] 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.

[0022] In the GHP outdoor unit 2, there are provided the gas engine 12 as an engine, 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.

[0023] The gas engine 12 burns a mixed gas of a fuel such as a gas supplied through a fuel regulating valve (not shown) and air supplied through a throttle valve (not shown) to generate the drive force.

[0024] 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.

[0025] 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.

[0026] 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.

[0027] 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.

[0028] 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.

[0029] 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 compressor 13 due to a pressure difference.

[0030] In the bypass pipe 28, a bypass valve 29 that regulates a flow rate of the bypass pipe 28 is provided. The bypass valve 29 is an electric valve that can open and close stepwise.

[0031] 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.

[0032] 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.

[0033] The first return pipe 31 includes a capillary tube 32.

[0034] 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.

[0035] 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.

[0036] 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.

[0037] The external connection valve 10a connected to the refrigerant pipe 20 is connected to one end of an indoor heat exchanger 40 of each indoor unit 4 via the interunit pipe 5. An expansion valve 41 is provided in a middle portion of the interunit pipe 5.

[0038] In each indoor unit 4, an indoor fan 42 is provided to exchange heat between the indoor heat exchanger 40 and indoor air.

[0039] Furthermore, the other end of each indoor heat exchanger 40 is connected via the interunit pipe 5 to the external connection valve 10b connected to the refrigerant pipe 20.

[0040] Furthermore, the GHP outdoor unit 2 includes a cooling water circuit 50 of the gas engine 12.

[0041] 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.

[0042] 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.

[0043] In the radiator 53, heat is exchanged between the outdoor air and the cooling water.

[0044] Furthermore, in the plate type heat exchanger 27, the electric valve 26 is operated so that the refrigerant that returns to the GHP compressor 13 is heated by the cooling water that flows through the cooling water pipe 51. Consequently, a low pressure of the refrigerant rises, and a heating efficiency improves.

[0045] 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.

[0046] 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.

[0047] 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.

[0048] Next, description will be made as to the EHP outdoor unit 3.

[0049] 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.

[0050] 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.

[0051] 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.

[0052] A supercooling heat exchanger 90 is provided between the outdoor heat exchanger 65 and the external connection valve 60a.

[0053] 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.

[0054] 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.

[0055] 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.

[0056] 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.

[0057] The other external connection valve 60b 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.

[0058] 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.

[0059] 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.

[0060] 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.

[0061] 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.

[0062] 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.

[0063] 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 this 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 indoor unit 4. 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 this 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 indoor unit 4.

[0064] 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.

[0065] Then, when a cooling operation is performed, the refrigerant flows as shown by a solid arrow line in Fig. 1, and when a heating operation is performed, the refrigerant flows as shown by a broken line in Fig. 1.

[0066] In the present embodiment, a GHP oil level sensor 106 is provided in the first return pipe 31 of the GHP outdoor unit 2. Furthermore, an EHP oil level sensor 107 is provided in the overflow pipe 84 of the EHP outdoor unit 3.

[0067] 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.

[0068] 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. Furthermore, each of the indoor units 4 includes an indoor control section 102.

[0069] 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, the EHP outdoor unit 3 and the indoor unit 4.

[0070] The controller 110 includes a controller control section 111 to generally control the GHP control section 100, the EHP control section 101 and the indoor control section 102.

[0071] Each of the GHP control section 100, the EHP control section 101, the indoor control section 102 and the controller control section 111 includes, for example, a computation processing circuit such as a CPU, memories such as a ROM and a RAM, and others, and executes a predetermined program to perform predetermined control.

[0072] 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.

[0073] 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.

[0074] The indoor control section 102 is configured to perform drive control of the indoor fan 42 of each indoor unit 4, and to perform opening degree control of the expansion valve 41 of the indoor unit 4.

[0075] These control operations of the GHP control section 100, the EHP control section 101 and the indoor control section 102 are performed based on the control instruction signal sent from the controller control section 111.

[0076] At this time, in the present embodiment, the GHP control section 100 is set to a master, and the EHP control section 101 and the indoor control section 102 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 102.

[0077] In the present embodiment, each of the GHP outdoor unit 2 and the EHP outdoor unit 3 regulates 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.

[0078] The controller control section 111 controls the GHP outdoor unit 2, the EHP outdoor unit 3 and the indoor unit 4 based on a number of the indoor units 4 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, the EHP control section 101 and the indoor control section 102 so that an operation of the GHP outdoor unit 2 and an operation of the EHP outdoor unit 3 save energy most. In consequence, it is configured that the GHP control section 100 efficiently controls the operation of the GHP outdoor unit 2, the EHP control section 101 efficiently controls the operation of the EHP outdoor unit 3, and the indoor control section 102 efficiently controls the operation of the indoor unit 4.

[0079] In this case, in the present embodiment, when the cooling operation is performed only by one outdoor unit of the GHP outdoor unit 2 or the EHP outdoor unit 3 and the other outdoor unit is stopped, the GHP control section 100 or the EHP control section 101 determines whether or not the oil level lowers below a certain level, on a basis of a detection value from the oil level sensor of the operating outdoor unit. When it is determined that the oil level lowers below the certain level, the oil return valve 34 or 76 of the operating outdoor unit is controlled to open.

[0080] Specifically, for example, when only the GHP outdoor unit 2 performs the cooling operation and the EHP outdoor unit 3 is stopped, the GHP control section 100 determines whether or not the oil level in the GHP outdoor unit 2 lowers below the certain level, on the basis of the detection value from the GHP oil level sensor 106. When it is determined that the oil level lowers below the certain level, the control section executes control to open the oil return valve 34 of the GHP outdoor unit 2.

[0081] Furthermore, for example, when only the EHP

outdoor unit 3 performs the cooling operation and the GHP outdoor unit 2 is stopped, the EHP control section 101 determines whether or not the oil level in the EHP outdoor unit 3 lowers below a certain level, on the basis of the detection value from the EHP oil level sensor 107. When the control section determines that the oil level lowers below the certain level, the control section executes control to open the oil return valve 76 of the EHP outdoor unit 3.

[0082] Additionally, in the GHP control section 100 or the EHP control section 101, two of the GHP outdoor unit 2 and the EHP outdoor unit 3 start the cooling operation from a state where one of the GHP outdoor unit 2 or the EHP outdoor unit 3 performs the cooling operation, or the oil level based on the detection value from the oil level sensor of the operating outdoor unit rises above the certain level from a state where one of the GHP outdoor unit 2 or the EHP outdoor unit 3 performs the cooling operation. In this case, the GHP control section 100 or the EHP control section 101 ends the control to open the oil return valve 34 or 76.

[0083] Furthermore, in the present embodiment, also when there is a protection control operation, the GHP control section 100 or the EHP control section 101 ends the control to open the oil return valve 34 or 76.

[0084] Here, an example of the protection control operation is another preferential control operation or the like.

[0085] Next, an operation of the present embodiment will be described with reference to a flowchart shown in Fig. 3.

[0086] Fig. 3 is a flowchart showing the operation of the present embodiment.

[0087] As shown in Fig. 3, in the present embodiment, the GHP outdoor unit 2 or the EHP outdoor unit 3 is first driven by the GHP control section 100 or the EHP control section 101 in accordance with an instruction signal of the controller control section 111, to start the cooling operation (ST1).

[0088] Then, when in this state, for example, only the GHP outdoor unit 2 is operated and the EHP outdoor unit 3 is stopped (ST2: YES), the GHP control section 100 determines whether or not the oil level lowers below the certain level, on the basis of the detection value from the GHP oil level sensor 106 (ST3).

[0089] When the GHP control section 100 determines that the oil level lowers below the certain level (ST4: YES), the control section executes control to open the oil return valve 34 (ST5).

[0090] By this control, the oil connection valves 11 and 61 communicate via the oil balance pipe 6. Consequently, any high pressure is not applied to the discharge side of the oil return valve 76 of the EHP outdoor unit 3, and the refrigerant and oil can be prevented from being accumulated in the EHP outdoor unit 3. Furthermore, the refrigerant and oil accumulated in the oil pipe 72 and the high pressure refrigerant pipe 80 of the EHP outdoor unit 3 can be sent to the suction side of the GHP compressor 13 via the oil pipe 35 and the oil return valve 34.

[0091] Then, when the EHP outdoor unit 3 is started and the cooling operation is performed in the GHP outdoor unit 2 and the EHP outdoor unit 3 (ST6: YES), the GHP control section 100 of the GHP outdoor unit 2 ends the control to open the oil return valve 34 (ST9).

[0092] Furthermore, when the GHP control section 100 monitors the oil level and determines that the oil level rises above the certain level on the basis of the detection value from the GHP oil level sensor 106 (ST7: YES), the GHP control section 100 ends the control to open the oil return valve 34 (ST9).

[0093] Additionally, also when the protection control operation is performed (ST8: YES), the GHP control section 100 ends the control to open the oil return valve 34 (ST9).

[0094] Thus, the control is executed because pressure is balanced between the GHP outdoor unit 2 and the EHP outdoor unit 3, when two units of the GHP outdoor unit 2 and the EHP outdoor unit 3 are operated. Consequently, there is not any concern that the oil is accumulated in one of the GHP outdoor unit 2 or the EHP outdoor unit 3.

[0095] Furthermore, when the oil level rises above the certain level, there is not any concern of burn-in. When the protection control operation is performed, the control of the burn-in has priority over the control of the accumulation of the oil. Consequently, it is necessary to preferentially control the burn-in.

[0096] Note that in the description of the operation of the above embodiment, description has been made as to the example where only the GHP outdoor unit 2 is operated. However, also when only the EHP outdoor unit 3 is operated, the EHP control section 101 detects the oil level on the basis of the detection value of the EHP oil level sensor 107, and executes control to open the oil return valve 76. Consequently, it is possible to execute similar control.

[0097] As described above, in the present embodiment, the air conditioner includes the oil return pipe 30 or 73 that returns the oil on the discharge side of the compressor provided in each of the GHP outdoor unit 2 and the EHP outdoor unit 3 back to the suction side of the compressor, the oil return valve 34 or 76 provided in the intermediate portion of the oil return pipe 30 or 73, the oil level sensor that detects the oil level of each of the GHP outdoor unit 2 and the EHP outdoor unit 3, and the GHP control section 100 and the EHP control section 101 that control the GHP outdoor unit 2 and the EHP outdoor unit 3. When the cooling operation is performed only by one GHP outdoor unit 2 (EHP outdoor unit 3) in the GHP outdoor unit 2 and the EHP outdoor unit 3 and the other EHP outdoor unit 3 (GHP outdoor unit 2) is stopped, the GHP control section 100 or the EHP control section 101 determines whether or not the oil level lowers below the certain level, on the basis of the detection value from the GHP oil level sensor 106 (the EHP oil level sensor 107) of the operating GHP outdoor unit 2 (EHP outdoor unit 3). When the control section determines that

the oil level lowers below the certain level, the control section executes control to open the oil return valve 34 (76) of the operating GHP outdoor unit 2 (EHP outdoor unit 3).

[0098] According to this embodiment, when the oil return valve 34 (76) is opened, the GHP outdoor unit 2 (the EHP outdoor unit 3) that is performing the cooling operation communicates with the stopped EHP outdoor unit 3 (GHP outdoor unit 2) via the oil balance pipe 6. Any high pressure is not applied to the discharge side of the oil return valve 76 (34) of the stopped EHP outdoor unit 3 (GHP outdoor unit 2). Consequently, the refrigerant and oil can be prevented from being accumulated in the EHP outdoor unit 3 (the GHP outdoor unit 2). Furthermore, the refrigerant and oil accumulated in the stopped EHP outdoor unit 3 (GHP outdoor unit 2) can be sent to the suction side of the GHP compressor 13 (the EHP compressor 62) of the GHP outdoor unit 2 (the EHP outdoor unit 3) that is performing the cooling operation. As a result, the oil of the GHP compressor 13 (the EHP compressor 62) that is performing the cooling operation can be sufficiently kept, and the burn-in can be prevented.

[0099] Furthermore, in the present embodiment, the GHP control section 100 or the EHP control section 101 ends the control to open the oil return valve 34 (76), in either one of a state where two or more units of the GHP outdoor unit 2 and the EHP outdoor unit 3 are operated, a state where the oil level based on the detection value from the GHP oil level sensor 106 or the EHP oil level sensor 107 rises above the certain level, or a state where the protection control operation is performed.

[0100] According to this embodiment, when the oil of the GHP compressor 13 (the EHP compressor 62) can be kept, the control to open the oil return valve 34 (76) is ended. Consequently, unnecessary supply of oil can be stopped.

[0101] 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.

[0102] In the above embodiment, there has been described the example where the plurality of outdoor units are constituted of the GHP outdoor unit 2 and the EHP outdoor unit 3, but the present invention is not limited to this example. For example, the outdoor units may only include a plurality of GHP outdoor units 2 or may only include a plurality of EHP outdoor units 3.

[0103] Furthermore, 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 transmitted to the EHP control section 101.

[0104] Furthermore, without setting the master or the slave, the GHP control section 100, the EHP control section 101 and the indoor control section 102 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 102.

[0105] As described above, in the air conditioner according to the present invention, when the cooling operation is performed by one outdoor unit, any high pressure is not applied to the discharge side of the oil return valve of the stopped outdoor unit. The refrigerant and oil can be prevented from being accumulated in the stopped outdoor unit. Furthermore, the oil accumulated in the stopped outdoor unit can be supplied to the outdoor unit that is performing the cooling operation. The air conditioner can be suitably used as an air conditioner that can sufficiently keep the oil of the compressor that is performing the cooling operation and can prevent the burn-in.

1	air conditioner
2	GHP outdoor unit
3	EHP outdoor unit
4	indoor unit
12	gas engine
13	GHP compressor
15	oil separator
17 and 65	outdoor heat exchanger
30 and 73	oil return pipe
34 and 76	oil return valve
40	indoor heat exchanger
62	EHP compressor
100	GHP control section
101	EHP control section
102	indoor control section
106	GHP oil level sensor
107	EHP oil level sensor
110	controller
111	controller control section

Claims

1. An air conditioner in which each of a plurality of outdoor units (2, 3) is connected to an indoor unit (4) via an interunit pipe (5), each outdoor unit is operated and indoor air conditioning is performed by the indoor unit, the air conditioner **characterized by** comprising:

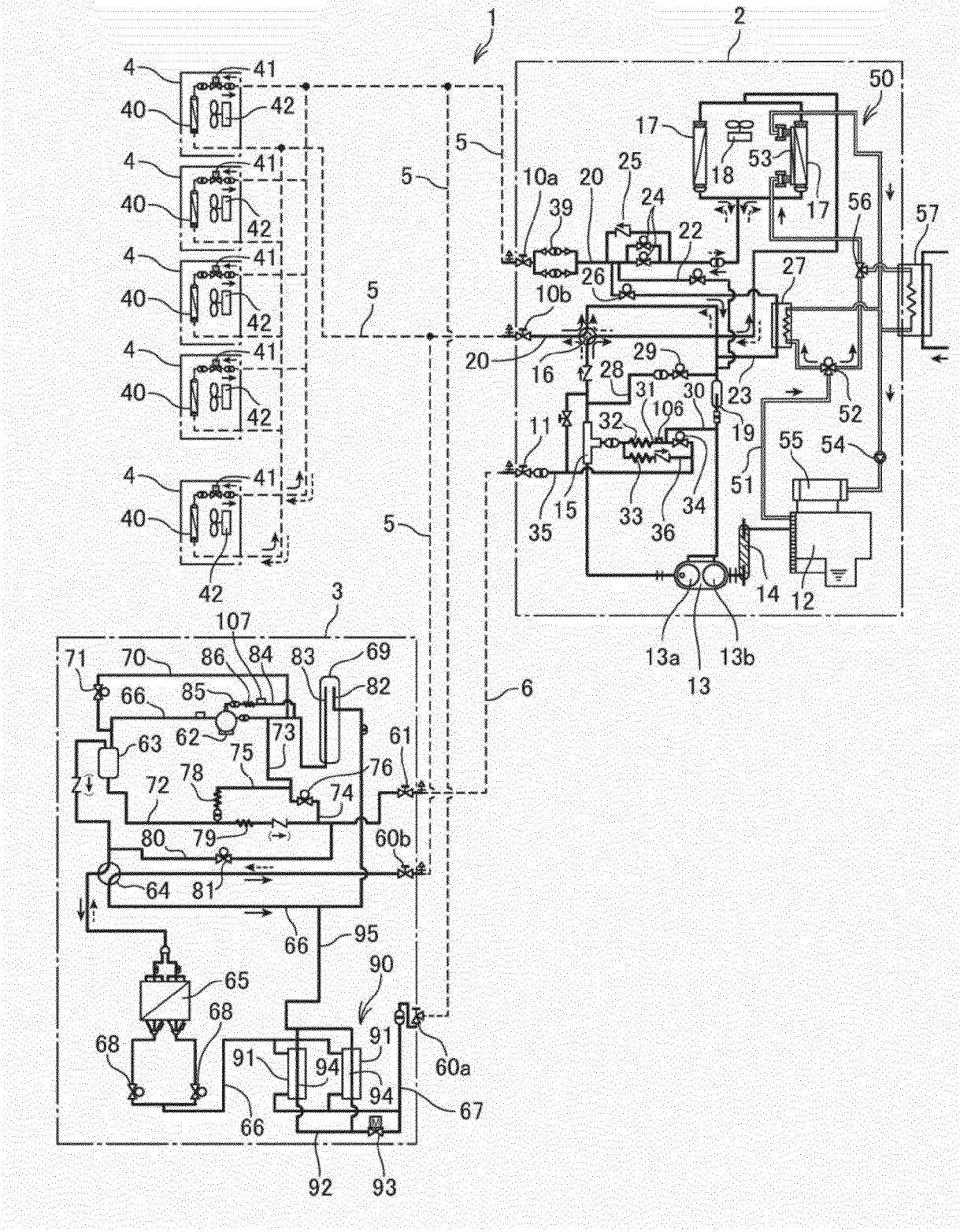
   an oil return pipe (30, 73) that returns oil on a discharge side of a compressor (13, 62) provided in the outdoor unit back to a suction side of the compressor,
   an oil return valve (34, 76) provided in an intermediate portion of the oil return pipe,
   an oil level sensor (106, 107) that detects an oil level of the outdoor unit, and
   a control section (111) that controls the outdoor unit, wherein when a cooling operation is per-

formed only by one outdoor unit of the outdoor units and the other outdoor unit is stopped, the control section determines whether or not the oil level lowers below a certain level, on a basis of a detection value from the oil level sensor of the operating outdoor unit, and when the control section determines that the oil level lowers below the certain level, the control section executes control to open the oil return valve of the operating outdoor unit.

2. The air conditioner according to claim 1, wherein the control section ends the control to open the oil return valve, in either one of a state where two or more of the outdoor units are operated, a state where the oil level based on the detection value from the oil level sensor rises above the certain level, or a state where a protection control operation is performed.

3. The air conditioner according to claim 1 or 2, wherein the plurality of outdoor units comprise a GHP outdoor unit (2) including a GHP compressor (13) that is driven by an engine (12) and an EHP outdoor unit (3) including an EHP compressor (62) that is driven by a commercial power source.

FIG.1


1
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10a
10b
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13a
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60a
60b
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73
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94
95
106
107

FIG.2

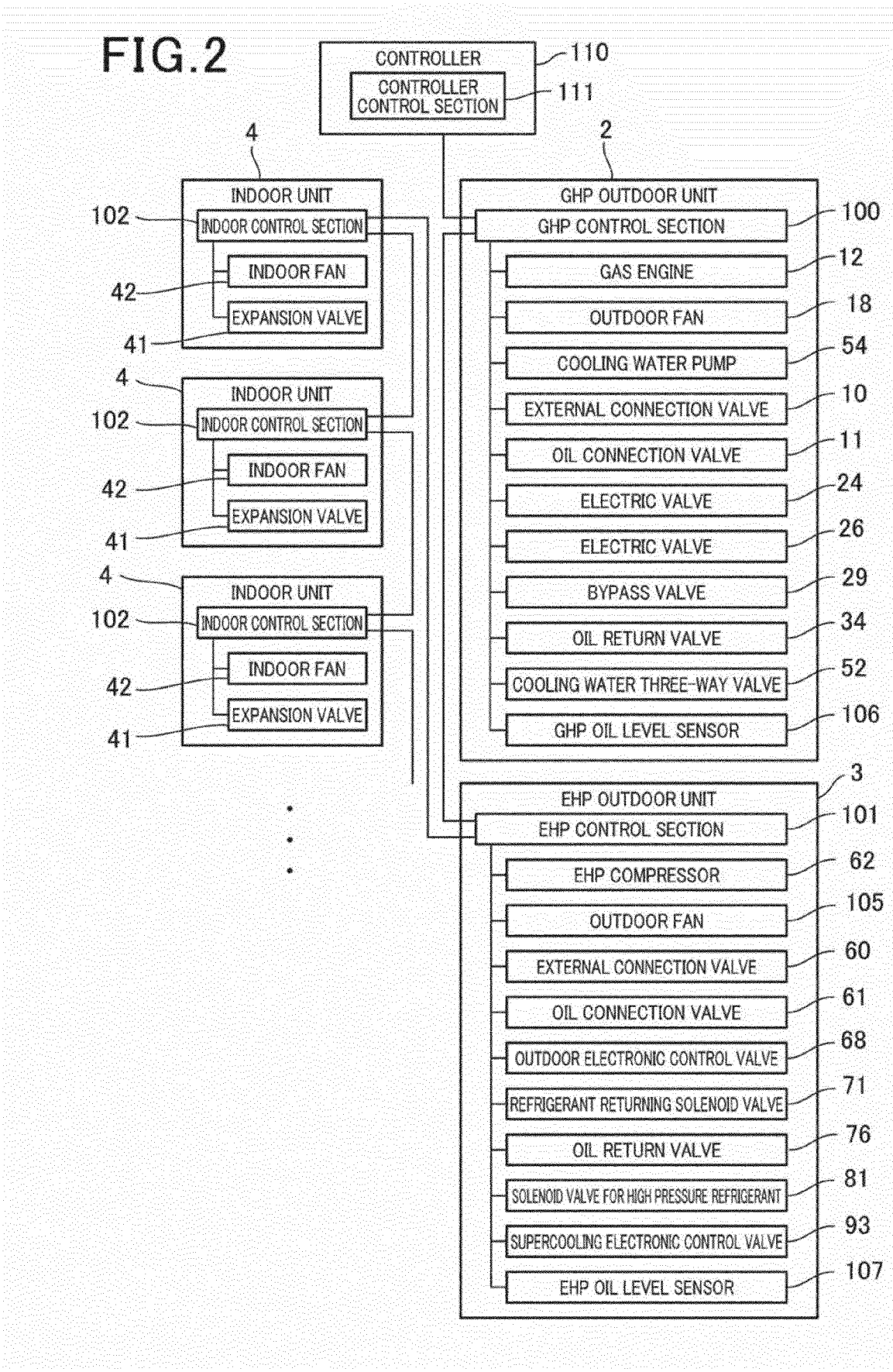
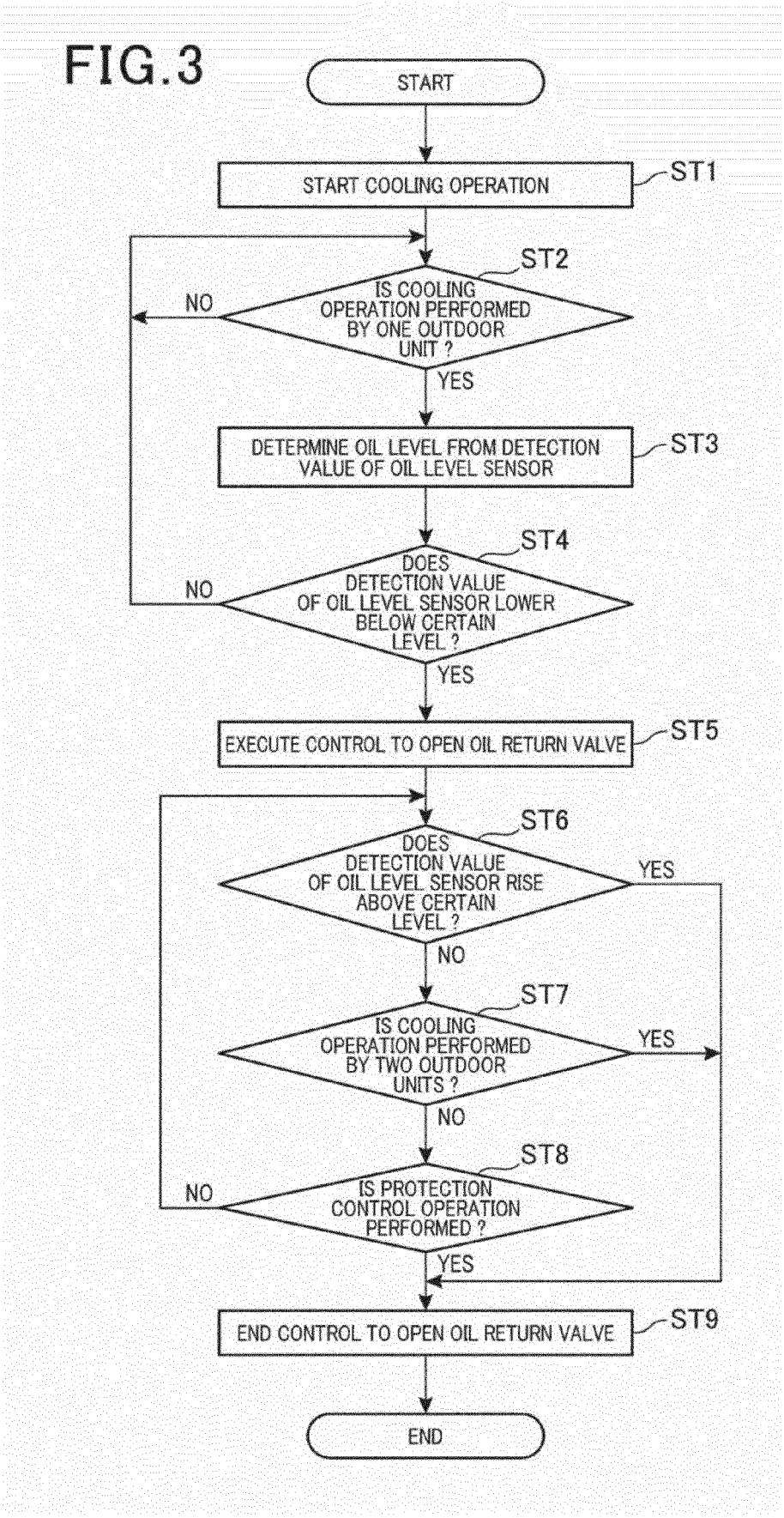

CONTROLLER
110
CONTROLLER CONTROL SECTION
111
4
2
INDOOR UNIT
102
INDOOR CONTROL SECTION
INDOOR FAN
42
EXPANSION VALVE
41
GHP OUTDOOR UNIT
GHP CONTROL SECTION
100
GAS ENGINE
12
OUTDOOR FAN
18
COOLING WATER PUMP
54
EXTERNAL CONNECTION VALVE
10
OIL CONNECTION VALVE
11
ELECTRIC VALVE
24
ELECTRIC VALVE
26
BYPASS VALVE
29
OIL RETURN VALVE
34
COOLING WATER THREE-WAY VALVE
52
GHP OIL LEVEL SENSOR
106
EHP OUTDOOR UNIT
3
EHP CONTROL SECTION
101
EHP COMPRESSOR
62
OUTDOOR FAN
105
EXTERNAL CONNECTION VALVE
60
OIL CONNECTION VALVE
61
OUTDOOR ELECTRONIC CONTROL VALVE
68
REFRIGERANT RETURNING SOLENOID VALVE
71
OIL RETURN VALVE
76
SOLENOID VALVE FOR HIGH PRESSURE REFRIGERANT
81
SUPERCOOLING ELECTRONIC CONTROL VALVE
93
EHP OIL LEVEL SENSOR
107

FIG.3


START
START COOLING OPERATION
ST1
ST2
IS COOLING OPERATION PERFORMED BY ONE OUTDOOR UNIT ?
NO
YES
DETERMINE OIL LEVEL FROM DETECTION VALUE OF OIL LEVEL SENSOR
ST3
ST4
DOES DETECTION VALUE OF OIL LEVEL SENSOR LOWER BELOW CERTAIN LEVEL ?
NO
YES
EXECUTE CONTROL TO OPEN OIL RETURN VALVE
ST5
ST6
DOES DETECTION VALUE OF OIL LEVEL SENSOR RISE ABOVE CERTAIN LEVEL ?
YES
NO
ST7
IS COOLING OPERATION PERFORMED BY TWO OUTDOOR UNITS ?
YES
NO
ST8
IS PROTECTION CONTROL OPERATION PERFORMED ?
NO
YES
END CONTROL TO OPEN OIL RETURN VALVE
ST9
END

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EUROPEAN SEARCH REPORT

Application Number
EP 19 18 5117

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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X	JP 3 143141 B2 (SANYO ELECTRIC CO) 7 March 2001 (2001-03-07) * paragraph [0006] - paragraph [0034]; figure 119 *	1-3	
X	JP 2004 144339 A (SANYO ELECTRIC CO; SANYO ELECTRIC AIR CONDITION) 20 May 2004 (2004-05-20) * figures 1,2 *	1-3	
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F25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 September 2019	Gasper, Ralf

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02-09-2019

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