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(54) **REFRIGERATION DEVICE**

(57) A refrigeration apparatus (1) further has a second suction pipe (22d), which is connected to a second compressor (22), and a second branch pipe (36). Here, the second branch pipe (36) has a junction-side open portion (36a) that opens in a predetermined direction and two branch-side open portions (36b, 36c) that open in substantially the opposite direction to that of the junction-side open portion (36a), with a second low-pressure pipe (32) being connected to the junction-side open portion (36a) and with an interconnecting low-pressure pipe (33) and the second suction pipe (22d) being connected to the two branch-side open portions (36b, 36c).

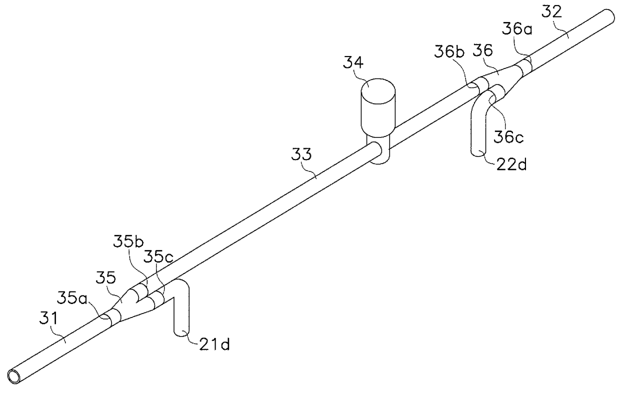

FIG. 4

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Description

TECHNICAL FIELD

[0001] The present invention relates to a refrigeration apparatus, and particularly a refrigeration apparatus having first and second compressors, a heat-source side heat exchanger, first and second utilization-side heat exchangers, a first low-pressure pipe for communicating the first compressor to the first utilization-side heat exchanger, a second low-pressure pipe for communicating the second compressor to the second utilization-side heat exchanger or the heat source-side heat exchanger, and an interconnecting low-pressure pipe that has a control valve capable of opening degree control and is for intercommunicating the first low-pressure pipe and the second low-pressure pipe.

BACKGROUND ART

[0002] Conventionally, there is a refrigeration apparatus that has plural types of utilization-side heat exchangers such as described in patent document 1 (JP-ANo. 2014-70822). In this refrigeration apparatus, as the plural types of utilization-side heat exchangers, a refrigerating heat exchanger (a first utilization-side heat exchanger) for refrigerating a refrigerator such as a showcase and a room heat exchanger (a second utilization-side heat exchanger) for performing cooling and heating (air-conditioning) of a room are provided. This refrigeration apparatus has plural compressors and a heat source-side heat exchanger. The plural compressors include a first compressor, which sucks in and compresses refrigerant that has evaporated in the first utilization-side heat exchanger, and a second compressor, which sucks in and compresses refrigerant that has evaporated in the second utilization-side heat exchanger or the heat source-side heat exchanger. A first low-pressure pipe for communicating the first compressor to the first utilization-side heat exchanger is connected to the first compressor. A second low-pressure pipe for communicating the second compressor to the second utilization-side heat exchanger or the heat source-side heat exchanger is connected to the second compressor. The first low-pressure pipe and the second low-pressure pipe communicate with each other via an interconnecting low-pressure pipe that has a control valve capable of opening degree control.

SUMMARY OF INVENTION

[0003] In the refrigeration apparatus of patent document 1, the first low-pressure pipe can be communicated to the second low-pressure pipe by switching the control valve in the interconnecting low-pressure pipe to an open state, so the refrigerant flowing through the second low-pressure pipe can be sucked into the second compressor and can also be sucked into the first compressor. For this reason, for example, in a case where the air-conditioning load (i.e., the flow rate of the refrigerant corresponding to this air-conditioning load) in the second utilization-side heat exchanger cannot be processed by just the second compressor, part of the air-conditioning load (i.e., the flow rate of the refrigerant corresponding to this part of the air-conditioning load) in the second utilization-side heat exchanger can be processed also by the first compressor. At this time, the flow rate of the refrigerant that becomes sucked into the first compressor can be finely controlled by, for example, controlling the opening degree of the control valve.

[0004] However, when performing this operation of switching the control valve in the interconnecting low-pressure pipe to an open state, it is desired to reduce as much as possible flow resistance when the refrigerant returns through these low-pressure pipes to the compressors. Furthermore, in the refrigeration apparatus, refrigerating machine oil is filled together with the refrigerant to lubricate the compressors, so when performing this operation of switching the control valve in the interconnecting low-pressure pipe to an open state, it is desired to reduce as much as possible imbalance in the refrigerating machine oil when the refrigerant returns through these low-pressure pipes to the compressors.

[0005] It is an object of the present invention to reduce as much as possible, in a refrigeration apparatus where a first low-pressure pipe for communicating a first compressor to a first utilization-side heat exchanger and a second low-pressure pipe for communicating a second compressor to a second utilization-side heat exchanger or a heat source-side heat exchanger communicate with each other via an interconnecting low-pressure pipe that has a control valve capable of opening degree control, flow resistance and imbalance in refrigerating machine oil when refrigerant returns through these low-pressure pipes to the compressors.

[0006] A refrigeration apparatus pertaining to a first aspect has a first compressor and a second compressor, a heat source-side heat exchanger, a first utilization-side heat exchanger and a second utilization-side heat exchanger, a first low-pressure pipe, a second low-pressure pipe, and an interconnecting low-pressure pipe. The first low-pressure pipe communicates the first compressor to the first utilization-side heat exchanger. The second low-pressure pipe communicates the second compressor to the second utilization-side heat exchanger or the heat source-side heat exchanger. The interconnecting low-pressure pipe has a control valve capable of opening degree control and intercommunicates the first low-pressure pipe and the second low-pressure pipe. Additionally, here, the refrigeration apparatus further has a second suction pipe, which is connected to the second compressor, and a second branch pipe Here, the second branch pipe has a junction-side open portion that opens in a predetermined direction and two branch-side open portions that open in substantially the opposite direction to that of the junction-side open portion, with the second low-pressure pipe being connected to the junction-side open portion and with the interconnecting low-pressure pipe and the second suction pipe being connected to the two branch-side open portions.

[0007] Here, the connection configuration between the second low-pressure pipe, the second compressor (the second suction pipe), and the interconnecting low-pressure pipe is characterized in that the second branch pipe having the junction-side open portion that opens in a predetermined direction and the two branch-side open portions that open in substantially the opposite direction to that of the junction-side open portion is interposed, the second low-pressure pipe is connected to the junction-side open portion, and the interconnecting low-pressure pipe and the second suction pipe are connected to the two branch-side open portions as described above. Here, as described above, the branch-side open portions of the second branch pipe open in substantially the opposite direction to that of the junction-side open portion, so fluid inflowing from the junction-side open portion side can be smoothly flowed to the branch-side open portions side. In this connection configuration between the second low-pressure pipe, the second compressor (the second suction pipe), and the interconnecting low-pressure pipe using the second branch pipe, when performing the operation of switching the control valve in the interconnecting low-pressure pipe to an open state, refrigerant flowing through the second low-pressure pipe and refrigerating machine oil flowing together with the refrigerant can be smoothly distributed via the second branch pipe to the second suction pipe (the second compressor side) and the interconnecting low-pressure pipe (the first compressor side).

[0008] Because of this, here, flow resistance and imbalance in the refrigerating machine oil when the refrigerant returns through the second low-pressure pipe and the interconnecting low-pressure pipe to the compressors can be reduced as much as possible.

[0009] A refrigeration apparatus pertaining to a second aspect is the refrigeration apparatus pertaining to the first aspect, wherein the second branch pipe is disposed in such a way that refrigerant inflowing from the junction-side open portion is distributed in a horizontal direction and flows out from the two branch-side open portions.

[0010] Here, the distribution of the refrigerant and the refrigerating machine oil in the second branch pipe can be made excellent because of the horizontal disposition of the second branch pipe described above.

[0011] A refrigeration apparatus pertaining to a third aspect is the refrigeration apparatus pertaining to the first or second aspect, further having a first suction pipe, which is connected to the first compressor, and a first branch pipe. Here, the first branch pipe has a junction-side open portion that opens in a predetermined direction and two branch-side open portions that open in substantially the opposite direction to that of the junction-side open portion, with the first low-pressure pipe being connected to the junction-side open portion and with the interconnecting low-pressure pipe and the first suction pipe being connected to the two branch-side open portions.

[0012] Here, the connection configuration between the first low-pressure pipe, the first compressor (the first suction pipe), and the interconnecting low-pressure pipe is characterized in that the first branch pipe having the junction-side open portion that opens in a predetermined direction and the two branch-side open portions that open in substantially the opposite direction to that of the junction-side open portion is interposed, the first low-pressure pipe is connected to the junction-side open portion, and the interconnecting low-pressure pipe and the first suction pipe are connected to the two branch-side open portions as described above. Here, as described above, the branch-side open portions of the first branch pipe open in substantially the opposite direction to that of the junction-side open portion, so fluid inflowing from the junction-side open portion side can be smoothly flowed to the branch-side open portions side. In this connection configuration between the first low-pressure pipe, the first compressor (the first suction pipe), and the interconnecting low-pressure pipe using the first branch pipe, when causing the refrigerant flowing through the first low-pressure pipe to be sucked into the first compressor, the refrigerant flowing through the first low-pressure pipe and the refrigerating machine oil flowing together with the refrigerant can be smoothly flowed via the first branch pipe to the first suction pipe.

[0013] Because of this, here, flow resistance and imbalance in the refrigerating machine oil when the refrigerant returns through the first low-pressure pipe to the compressors can be reduced as much as possible.

[0014] A refrigeration apparatus pertaining to a fourth aspect is the refrigeration apparatus pertaining to the third aspect, wherein the first branch pipe is disposed in such a way that refrigerant inflowing from the junction-side open portion is distributed in a horizontal direction and flows out from the two branch-side open portions.

[0015] A refrigeration apparatus pertaining to a fifth aspect is the refrigeration apparatus pertaining to the third or fourth aspect, further having a third compressor and a third suction pipe connected to the third compressor. Here, the third suction pipe is connected to a portion of the interconnecting low-pressure pipe on the first branch pipe side of the control valve.

[0016] Here, the refrigeration apparatus is characterized in that it is further provided with the third compressor and in that the third suction pipe of the third compressor is connected to the portion of the interconnecting low-pressure pipe on the first branch pipe side of the control valve. In this configuration where the third compressor is further connected to the portion of the interconnecting low-pressure pipe on the first branch pipe side of the control valve, the refrigerant flowing through the first low-pressure pipe can be sucked into the first compressor and also the third compressor, and at this time the refrigerant flowing through the first low-pressure pipe and the refrigerating machine oil flowing together with the refrigerant can be smoothly distributed via the first branch pipe to the first suction pipe (the first compressor side) and the interconnecting low-pressure pipe (the third compressor side). Moreover, by horizontally disposing the first branch pipe, the distribution of the refrigerant and the refrigerating machine oil in the first branch pipe can be made excellent. Furthermore, in this configuration, by switching the control valve in the interconnecting low-pressure pipe to an open state, the refrigerant flowing through the second low-pressure pipe can be sucked into the second compressor and also the third compressor, and at this time the refrigerant flowing through the second low-pressure pipe and the refrigerating machine oil flowing together with the refrigerant can be smoothly distributed via the second branch pipe to the second suction pipe (the second compressor side) and the interconnecting low-pressure pipe (the third compressor side).

[0017] Because of this, here, it can be made possible for the refrigerant flowing through the first low-pressure pipe to be sucked into the first compressor and also the third compressor and for the refrigerant flowing through the second low-pressure pipe to be sucked into the second compressor and also the third compressor, and flow resistance and imbalance in the refrigerating machine oil when the refrigerant returns through the first low-pressure pipe, the second low-pressure pipe, and the interconnecting low-pressure pipe to the compressors can be reduced as much as possible.

[0018] A refrigeration apparatus pertaining to a sixth aspect is the refrigeration apparatus pertaining to the fifth aspect, further having a third branch pipe. Here, the third branch pipe has a junction-side open portion that opens in a predetermined direction and two branch-side open portions that open in substantially the opposite direction to that of the junction-side open portion, with the third suction pipe being connected to the junction-side open portion. Furthermore, the interconnecting low-pressure pipe has a first interconnecting low-pressure pipe that interconnects the branch-side open portion of the first branch pipe and one of the two branch-side open portions of the third branch pipe, a second interconnecting low-pressure pipe that interconnects the branch-side open portion of the second branch pipe and the control valve, and a third interconnecting low-pressure pipe that interconnects the control valve and the other of the two branch-side open portions of the third branch pipe.

[0019] Here, the connection configuration between the third compressor (the third suction pipe) and the interconnecting low-pressure pipe (the first and third interconnecting low-pressure pipes) is characterized in that the third branch pipe having the junction-side open portion that opens in a predetermined direction and the two branch-side open portions that open in substantially the opposite direction to that of the junction-side open portion is interposed, the third suction pipe is connected to the junction-side open portion, and the first interconnecting low-pressure pipe and the third interconnecting low-pressure pipe are connected to the two branch-side open portions as described above. Here, as described above, the branch-side open portions of the third branch pipe open in substantially the opposite direction to that of the junction-side open portion, so fluid inflowing from both the branch-side open portion sides can be smoothly flowed to the junction-side open portion side. In this connection configuration between the third suction pipe and the first and third interconnecting low-pressure pipes using the third branch pipe, both when causing the refrigerant flowing through the first low-pressure pipe to be sucked into the third compressor and when causing the refrigerant flowing through the second low-pressure pipe to be sucked into the third compressor, the refrigerant flowing through the first and second low-pressure pipes and the refrigerating machine oil flowing together with the refrigerant can be smoothly flowed via the third branch pipe to the third suction pipe.

[0020] Because of this, here, flow resistance and imbalance in the refrigerating machine oil when the refrigerant returns through the interconnecting low-pressure pipe to the compressors can be reduced as much as possible.

[0021] A refrigeration apparatus pertaining to a seventh aspect is the refrigeration apparatus pertaining to the first or the second aspect, further having a junction low-pressure pipe connected to the first low-pressure pipe and the interconnecting low-pressure pipe, a first suction pipe connected to the first compressor, a third compressor, a third suction pipe connected to the third compressor, and a fourth branch pipe. The fourth branch pipe has a junction-side open portion that opens in a predetermined direction and two branch-side open portions that open in substantially the opposite direction to that of the junction-side open portion, with the junction low-pressure pipe being connected to the junction-side open portion and with the first suction pipe and the third suction pipe being connected to the two branch-side open portions.

[0022] Here, the refrigeration apparatus is characterized in that it is further provided with the third compressor and in that the first suction pipe of the first compressor and the third suction pipe of the third compressor are connected to the junction low-pressure pipe connected to the first low-pressure pipe and the interconnecting low-pressure pipe. In this configuration where the first and third compressors are connected to the junction low-pressure pipe, the refrigerant flowing through the first low-pressure pipe can be sucked through the junction low-pressure pipe into the first compressor and also the third compressor. Furthermore, in this configuration, by switching the control valve in the interconnecting low-pressure pipe to an open state, the refrigerant flowing through the second low-pressure pipe can be sucked into the second compressor and can also be sucked through the interconnecting low-pressure pipe and the junction low-pressure pipe into the third compressor, and at this time the refrigerant flowing through the second low-pressure pipe and the refrigerating machine oil flowing together with the refrigerant can be smoothly distributed via the second branch pipe to the second suction pipe (the second compressor side) and the interconnecting low-pressure pipe and the junction low-pressure pipe (the third compressor side). Moreover, here, the connection configuration between the junction low-pressure pipe, the first compressor (the first suction pipe), and the third compressor (the third suction pipe) is characterized in that the fourth branch pipe having the junction-side open portion that opens in a predetermined direction and the two branch-side open portions that open in substantially the opposite direction to that of the junction-side open portion is interposed, the junction low-pressure pipe is connected to the junction-side open portion, and the first suction pipe and the third suction pipe are connected to the two branch-side open portions as described above. Here, as described above, the branch-side open portions of the fourth branch pipe open in substantially the opposite direction to that of the junction-side open portion, so fluid (the refrigerant and the refrigerating machine oil) inflowing from the junction-side open portion side can be smoothly flowed to the branch-side open portions side. In this connection configuration between the junction low-pressure pipe, the first suction pipe, and the third suction pipe using the fourth branch pipe, the refrigerant flowing through the first low-pressure pipe and the second low-pressure pipe and the refrigerating machine oil flowing together with the refrigerant can be smoothly distributed via the junction low-pressure pipe and the fourth branch pipe to the first suction pipe (the first compressor side) and the third suction pipe (the third compressor side).

[0023] Because of this, here, it can be made possible for the refrigerant flowing through the first low-pressure pipe to be sucked into the first compressor and also the third compressor and for the refrigerant flowing through the second low-pressure pipe to be sucked into the second compressor and also the third compressor, and flow resistance and imbalance in the refrigerating machine oil when the refrigerant returns through the first low-pressure pipe, the second low-pressure pipe, the interconnecting low-pressure pipe, the junction low-pressure pipe, and the fourth branch pipe to the compressors can be reduced as much as possible.

[0024] A refrigeration apparatus pertaining to an eighth aspect is the refrigeration apparatus pertaining to the seventh aspect, wherein the fourth branch pipe is disposed in such a way that refrigerant inflowing from the junction-side open portion is distributed in a horizontal direction and flows out from the two branch-side open portions.

[0025] Here, the distribution of the refrigerant and the refrigerating machine oil in the fourth branch pipe can be made excellent because of the horizontal disposition of the fourth branch pipe described above.

[0026] A refrigeration apparatus pertaining to a ninth aspect is the refrigeration apparatus pertaining to the seventh or eighth aspect, further having a fifth branch pipe. Here, the fifth branch pipe has a junction-side open portion that opens in a predetermined direction and two branch-side open portions that open in substantially the opposite direction to that of the junction-side open portion, with the junction low-pressure pipe being connected to the junction-side open portion and with the first low-pressure pipe and the interconnecting low-pressure pipe being connected to the two branch-side open portions.

[0027] Here, the connection configuration between the first low-pressure pipe, the first and third compressors (the junction low-pressure pipe), and the interconnecting low-pressure pipe is characterized in that the fifth branch pipe having the junction-side open portion that opens in a predetermined direction and the two branch-side open portions that open in substantially the opposite direction to that of the junction-side open portion is interposed, the junction low-pressure pipe is connected to the junction-side open portion, and the first low-pressure pipe and the interconnecting low-pressure pipe are connected to the two branch-side open portions. Here, as described above, the branch-side open portions of the fifth branch pipe open in substantially the opposite direction to that of the junction-side open portion as described above, so fluid inflowing from both the branch-side open portion sides can be smoothly flowed to the junction-side open portion side. In this connection configuration between the first low-pressure pipe, the junction low-pressure pipe, and the interconnecting low-pressure pipe using the fifth branch pipe, both when causing the refrigerant flowing through the first low-pressure pipe to be sucked into the third compressor and when causing the refrigerant flowing through the interconnecting low-pressure pipe to be sucked into the third compressor, the refrigerant flowing through the first low-pressure pipe and the interconnecting low-pressure pipe and the refrigerating machine oil flowing together with the refrigerant can be smoothly flowed via the fifth branch pipe to the junction low-pressure pipe.

[0028] Because of this, here, flow resistance and imbalance in the refrigerating machine oil when the refrigerant returns through the junction low-pressure pipe to the compressors can be reduced as much as possible.

BRIEF DESCRIPTION OF DRAWINGS

[0029]

FIG. 1 is a general configuration diagram of a refrigeration apparatus pertaining to a first embodiment of the invention.

FIG. 2 is a diagram showing a flow of refrigerant in a refrigerating and cooling operation.

FIG. 3 is a diagram showing a flow of refrigerant in a refrigerating and heating operation.

FIG. 4 is a drawing showing a connection configuration between low-pressure pipes and suction pipes.

FIG. 5 is a sectional view of a branch pipe.

FIG. 6 is a general configuration diagram of a refrigeration apparatus pertaining to a second embodiment of the invention.

FIG. 7 is a diagram showing a flow of refrigerant in a refrigerating and cooling operation.

FIG. 8 is a diagram showing a flow of refrigerant in a refrigerating and heating operation.

FIG. 9 is a drawing showing a connection configuration between low-pressure pipes and suction pipes.

FIG. 10 is a drawing showing a connection configuration between low-pressure pipes and suction pipes in an example modification of the second embodiment.

FIG. 11 is a general configuration diagram of a refrigeration apparatus pertaining to another embodiment of the invention.

DESCRIPTION OF EMBODIMENTS

[0030] Embodiments of a refrigeration apparatus pertaining to the invention will be described below on the basis of the drawings. It will be noted that the specific configurations of the embodiments of the refrigeration apparatus pertaining to the invention are not limited to those in the following embodiments and example modifications thereof and can be changed in a range that does not depart from the spirit of the invention.

(1) First Embodiment

<Configuration of Refrigeration Apparatus>

[0031] FIG. 1 is a general configuration diagram of a refrigeration apparatus 1 pertaining to a first embodiment of the invention. The refrigeration apparatus 1 is a apparatus configured to simultaneously perform, by means of a vapor compression refrigeration cycle, refrigeration of a refrigerator such as a showcase in a store, such as a convenience store, and cooling and heating (air-conditioning) of a room such as the interior of the store. The refrigeration apparatus 1 mainly has a heat source unit 2, a first utilization unit 6 for refrigerating the refrigerator, a second utilization unit 7 for air-conditioning the room, a first liquid refrigerant communication pipe 8 and a first gas refrigerant communication pipe 9 that interconnect the heat source unit 2 and the first utilization unit 6, a second liquid refrigerant communication pipe 10 and a second gas refrigerant communication pipe 11 that interconnect the heat source unit 2 and the second utilization unit 7, and a control unit 12 that controls constituent devices of the refrigeration apparatus 1. Additionally, a vapor compression refrigerant circuit 13 of the refrigeration apparatus 1 is configured by interconnecting the heat source unit 2 and the utilization units 6, 7 via the refrigerant communication pipes 8 to 11, and refrigerant filled in the refrigerant circuit 13 circulates therein.

-First Utilization Unit-

[0032] The first utilization unit 6 is, as described above, connected to the heat source unit 2 via the first liquid refrigerant communication pipe 8 and the first gas refrigerant communication pipe 9 and configures part of the refrigerant circuit 13.

[0033] Next, the configuration of the first utilization unit 6 will be described.

[0034] The first utilization unit 6 mainly has a first utilization-side expansion valve 61, a first utilization-side heat exchanger 62, and a first utilization-side on-off valve 63.

[0035] The first utilization-side expansion valve 61 is a thermostatic expansion valve capable of opening degree control that reduces the pressure of the refrigerant at a high pressure in the refrigeration cycle. One end of the first utilization-side expansion valve 61 is connected to the first utilization-side on-off valve 63, and the other end of the first utilization-side expansion valve 61 is connected to the liquid-side end of the first utilization-side heat exchanger 62.

[0036] The first utilization-side heat exchanger 62 is a heat exchanger that functions as an evaporator of the refrigerant at a low pressure (a first low pressure suited to refrigerating the refrigerator) in the refrigeration cycle to refrigerate the refrigerator air. The liquid side end of the first utilization-side heat exchanger 62 is connected to the first utilization-side expansion valve 61, and the gas-side end of the first utilization-side heat exchanger 62 is connected to the first gas refrigerant communication pipe 9. Here, the first utilization unit 6 has a first utilization-side fan 64 for sucking the refrigerator air into the first utilization unit 6, causing the refrigerator air to exchange heat with the refrigerant in the first utilization-side heat exchanger 62, and supplying the air to the refrigerator. The first utilization-side fan 64 is driven by a first utilization-side fan motor 65.

[0037] The first utilization-side on-off valve 63 is an electromagnetic valve capable of on-off control. One end of the first utilization-side on-off valve 63 is connected to the first liquid refrigerant communication pipe 8, and the other end of the first utilization-side on-off valve 63 is connected to the first utilization-side expansion valve 61.

-Second Utilization Unit-

[0038] The second utilization unit 7 is, as described above, connected to the heat source unit 2 via the second liquid refrigerant communication pipe 10 and the second gas refrigerant communication pipe 11 and configures part of the refrigerant circuit 13.

[0039] Next, the configuration of the second utilization unit 7 will be described.

[0040] The second utilization unit 7 mainly has a second utilization-side expansion valve 71 and a second utilization-side heat exchanger 72.

[0041] The second utilization-side expansion valve 71 is an electrically powered expansion valve capable of opening degree control that reduces the pressure of the refrigerant at the high pressure in the refrigeration cycle. One end of the second utilization-side expansion valve 71 is connected to the second liquid refrigerant communication pipe 10, and the other end of the second utilization-side expansion valve 71 is connected to the liquid-side end of the second utilization-side heat exchanger 72.

[0042] The second utilization-side heat exchanger 72 is a heat exchanger that functions as an evaporator of the refrigerant at a low pressure (a second low pressure higher than the first low pressure and suited for cooling the room) in the refrigeration cycle to cool the room air or functions as a radiator of the refrigerant at the high pressure in the refrigeration cycle to heat the room air. The liquid-side end of the second utilization-side heat exchanger 72 is connected to the second utilization-side expansion valve 71, and the gas-side end of the second utilization-side heat exchanger 72 is connected to the second gas refrigerant communication pipe 11. Here, the second utilization unit 7 has a second utilization-side fan 73 for sucking the room air into the second utilization unit 7, causing the room air to exchange heat with the refrigerant in the second utilization-side heat exchanger 72, and supplying the air to the room. The second utilization-side fan 73 is driven by a second utilization-side fan motor 74.

-Heat Source Unit-

[0043] The heat source unit 2 is, as described above, connected to the utilization units 6, 7 via the refrigerant communication pipes 8 to 11 and configures part of the refrigerant circuit 13.

[0044] Next, the configuration of the heat source unit 2 will be described.

[0045] The heat source unit 2 mainly has a first compressor 21, a second compressor 22, a heat source-side heat exchanger 24, a first switching mechanism 25, a second switching mechanism 26, a receiver 27, a subcooling heat exchanger 28, and an injection pipe 29.

[0046] The first compressor 21 and the second compressor 22 are compressors that compress the refrigerant to the high pressure in the refrigeration cycle. Here, as the first compressor 21 and the second compressor 22, compressors with closed structures in which rotary-type or scroll-type positive-displacement compression elements (not shown in the drawings) are driven by compressor motors 21a, 22a are used. Furthermore, the compression elements of the first compressor 21 and the second compressor 22 are provided with intermediate ports 21b, 22b that open to positions at an intermediate pressure in the refrigeration cycle. Furthermore, the compressor motors 21a, 22a are capable of having their rotational speeds (operating frequencies) controlled by an inverter, whereby capacity control of the first compressor 21 and the second compressor 22 is possible.

[0047] A first discharge pipe 21c is connected to the discharge side of the first compressor 21. The first discharge pipe 21c is connected to a first port 25a of the first switching mechanism 25. A first suction pipe 21d is connected to the suction side of the first compressor 21. The first suction pipe 21d communicates with a first low-pressure pipe 31 for communicating the first compressor 21 to the first utilization-side heat exchanger 62 via the first gas refrigerant communication pipe 9, etc. The refrigerant at the first low pressure in the refrigeration cycle flows in, and the first gas refrigerant communication pipe 9 is connected via a first gas-side stop valve 41 to, the first low-pressure pipe 31. The first gas-side stop valve 41 is a manual valve provided in the portion of the heat source unit 2 that is connected to the first gas refrigerant communication pipe 9.

[0048] A second discharge pipe 22c is connected to the discharge side of the second compressor 22. The second discharge pipe 22c is connected to the first port 25a of the first switching mechanism 25. A second suction pipe 22d is connected to the suction side of the second compressor 22. The second suction pipe 22d communicates with a second low-pressure pipe 32 for communicating the second compressor 22 to the second utilization-side heat exchanger 72 or the heat source-side heat exchanger 24 via the first switching mechanism 25, the second switching mechanism 26, and the second gas refrigerant communication pipe 11, etc. The refrigerant at the second low pressure in the refrigeration cycle flows in, and a second port 26b of the second switching mechanism 26 is connected to, the second low-pressure pipe 32.

[0049] The first low-pressure pipe 31 and the second low-pressure pipe 32 are communicable with each other via an interconnecting low-pressure pipe 33. A control valve 34 capable of opening degree control is provided in the interconnecting low-pressure pipe 33.

[0050] The heat source-side heat exchanger 24 is a heat exchanger that functions as a radiator of the refrigerant at the high pressure in the refrigeration cycle or functions as an evaporator of the refrigerant at the second low pressure in the refrigeration cycle. The gas-side end of the heat source-side heat exchanger 24 is connected to a third port 25c of the first switching mechanism 25, and the liquid-side end of the heat source-side heat exchanger 24 is connected to the receiver 25 via a first liquid refrigerant pipe 45. Here, the heat source unit 2 has a heat source-side fan 46 for sucking outdoor air into the heat source unit 2, causing the outdoor air to exchange heat with the refrigerant in the heat source-side heat exchanger 24, and discharging the air to the outside. The heat source-side fan 46 is driven by a heat source-side fan motor 47.

[0051] The first switching mechanism 25 and the second switching mechanism 26 include four-way switching valves. The first switching mechanism 25 has the first port 25a that is connected to the first and second discharge pipes 21c, 22c, a second port 25b that is connected to a fourth port 26d of the second switching mechanism 26, the third port 25c that is connected to the gas-side end of the heat source-side heat exchanger 24, and a fourth port 25d that is connected to a second gas-side stop valve 43, which is a manual valve provided in the portion of the heat source-unit 2 that is connected to the second gas refrigerant communication pipe 11. The second switching mechanism 26 has a first port 26a that is connected to the first and second discharge pipes 21c, 22c, the second port 26b that is connected to the second low-pressure pipe 32, a third port 26c that is sealed off, and the fourth port 26d that is connected to the second port 25b of the first switching mechanism 25.

[0052] The first switching mechanism 25 and the second switching mechanism 26 are configured to be switchable between a first state (the state indicated by the solid lines in FIG. 1), in which their respective first ports and third ports communicate with each other and their respective second ports and fourth ports communicate with each other, and a second state (the state indicated by the dashed lines in FIG. 1), in which their respective first ports and fourth ports communicate with each other and their respective second ports and third ports communicate with each other. Because of this, the first switching mechanism 25 and the second switching mechanism 26 configure a switching mechanism for switching between a state in which the second low-pressure pipe 32 communicates with the second utilization-side heat exchanger 72 and a state in which the second low-pressure pipe 32 communicates with the heat source-side heat exchanger 24.

[0053] The receiver 27 is a vessel that accumulates surplus refrigerant inside. The first liquid refrigerant pipe 45 and a second liquid refrigerant pipe 46 are connected to the receiver 27. One end of the first liquid refrigerant pipe 45 is connected to the liquid-side end of the heat source-side heat exchanger 24, and the other end of the first liquid refrigerant pipe 45 is connected to the upper portion of the receiver 27. A first check valve 45a, which allows the refrigerant to flow in the direction of the receiver 27 and prohibits the refrigerant from flowing in the opposite direction, and a first on-off valve 45b, which includes an electromagnetic valve capable of on-off control, are provided in the first liquid refrigerant pipe 45. One end of the second liquid refrigerant pipe 46 is connected to the lower portion of the receiver 27, and the other end of the second liquid refrigerant pipe 46 is connected to the subcooling heat exchanger 28. One end of a third liquid refrigerant pipe 47 is connected to an intermediate portion of the second liquid refrigerant pipe 46. The other end of the third liquid refrigerant pipe 47 is connected to the second liquid refrigerant communication pipe 10 via a second liquid-side stop valve 44. The second liquid-side stop valve 44 is a manual valve provided in the portion of the heat source unit 2 that is connected to the second liquid refrigerant communication pipe 10. A third check valve 47a that allows the refrigerant to flow in the direction of the second liquid-side stop valve 44 and prohibits the refrigerant from flowing in the opposite direction is provided in the third liquid refrigerant pipe 47. One end of a fourth liquid refrigerant pipe 48 is connected to the portion of the third liquid refrigerant pipe 47 that is downstream of the third check valve 47a. The other end of the fourth liquid refrigerant pipe 48 is connected to the portion of the first liquid refrigerant pipe 45 that is downstream of the first on-off valve 45b. A fourth check valve 48a that allows the refrigerant to flow in the direction of the first liquid refrigerant pipe 45 and prohibits the refrigerant from flowing in the opposite direction is provided in the fourth liquid refrigerant pipe 48.

[0054] The subcooling heat exchanger 28 is a heat exchanger that refrigerates the refrigerant supplied to the first utilization unit 6 and has a high-pressure-side heat exchange flow passage 28a and an intermediate-pressure-side heat exchange flow passage 28b that performs heat exchange with the refrigerant flowing through the high-pressure-side heat exchange flow passage 28a. One end of the high-pressure-side heat exchange flow passage 28a is connected to the second liquid refrigerant pipe 46, and the other end of the high-pressure-side heat exchange flow passage 28a is connected to a fifth liquid refrigerant pipe 49. Both ends of the intermediate-pressure-side heat exchange flow passage 28b are connected to an inflow-side injection pipe 29a and an outflow-side injection pipe 29b that configure the injection pipe 29.

[0055] The injection pipe 29 is a refrigerant pipe that branches the refrigerant at the high pressure in the refrigeration cycle from the fifth liquid refrigerant pipe 49, reduces its pressure to the intermediate pressure, and injects it into the intermediate ports 21b, 22b of the first compressor 21 and the second compressor 22. The injection pipe 29 has the inflow-side injection pipe 29a and the outflow-side injection pipe 29b. One end of the inflow-side injection pipe 29a is connected to the fifth liquid refrigerant pipe 49, and the other end of the inflow-side injection pipe 29a is connected to one end of the intermediate-pressure-side heat exchange flow passage 28b. An inflow-side injection expansion valve 29c for reducing the pressure of the refrigerant at the high pressure in the refrigeration cycle to the intermediate pressure is provided in the inflow-side injection pipe 29a. The inflow-side injection expansion valve 29c is an electrically powered expansion valve capable of opening degree control. One end of the outflow-side injection pipe 29b is connected to the other end of the intermediate-pressure-side heat exchange flow passage 28b, and the other end of the outflow-side injection pipe 29b branches in two and is connected to the intermediate ports 21b, 22b of the first compressor 21 and the second compressor 22. Outflow-side injection expansion valves 30a, 30b for controlling the flow rate of the refrigerant that becomes injected into the intermediate ports 21b, 22b are provided in the outflow-side injection pipe 29b. The outflow-side injection expansion valves 30a, 30b includes electrically powered expansion valves capable of opening degree control. The other end of the fifth liquid refrigerant pipe 49 is connected to the first liquid refrigerant communication pipe 8 via a first liquid-side stop valve 42. The first liquid-side stop valve 42 is a manual valve provided in the portion of the heat source unit 2 that is connected to the first liquid refrigerant communication pipe 8. One end of a sixth liquid refrigerant pipe 50 is connected to an intermediate portion of the fourth liquid refrigerant pipe 49. The other end of the sixth liquid refrigerant pipe 50 is connected to the first liquid refrigerant pipe 45. A sixth check valve 50a, which allows the refrigerant to flow in the direction of the first liquid refrigerant pipe 45 and prohibits the refrigerant from flowing in the opposite direction, and a heat source-side expansion valve 50b, which includes an electrically powered expansion valve capable of opening degree control, are provided in the sixth liquid refrigerant pipe 50. One end of a seventh liquid refrigerant pipe 51 is connected to the portion of the sixth liquid refrigerant pipe 50 between the sixth check valve 50a and the heat source-side expansion valve 50b. The other end of the seventh liquid refrigerant pipe 51 is connected to the portion of the first liquid refrigerant pipe 45 that is downstream of the first on-off valve 45b. A seventh check valve 51a that allows the refrigerant to flow in the direction of the first liquid refrigerant pipe 45 and prohibits the refrigerant from flowing in the opposite direction is provided in the seventh liquid refrigerant pipe 51.

<Actions of Refrigeration Apparatus>

[0056] Next, the actions of the refrigeration apparatus 1 will be described using FIG. 2 and FIG. 3.

[0057] The refrigeration apparatus 1 is configured to be able to perform operations in which a refrigerating operation and an air-conditioning operation (the cooling operation or the heating operation) are combined. Here, of these kinds of operations, a refrigerating and cooling operation and a refrigerating and heating operation will be described. It will be noted that these operations are performed by the control unit 12 that controls the constituent devices of the refrigeration apparatus 1.

-Refrigerating and Cooling Operation-

[0058] The refrigerating and cooling operation is an operation where the refrigerator is refrigerated by the first utilization unit 6 and cooling of the room is performed by the second utilization unit 7. For this reason, in the refrigerating and cooling operation, the heat source-side heat exchanger 24 functions as a radiator of the refrigerant, the first utilization-side heat exchanger 62 functions as an evaporator of the refrigerant, and the second utilization-side heat exchanger 72 functions as an evaporator of the refrigerant.

[0059] First, in the refrigerating and cooling operation, the first switching mechanism 25 and the second switching mechanism 26 are set to the first state (the state indicated by the solid lines in FIG. 2), the first on-off valve 45b and the first utilization-side on-off valve 63 are set to an open state, the heat source-side expansion valve 50b is set to a completely closed state, and the control valve 34, the inflow-side injection expansion valve 29c, the outflow-side injection expansion valves 30a, 30b, the first utilization-side expansion valve 61, and the second utilization-side expansion valve 71 are controlled to predetermined opening degrees. Furthermore, in the refrigerating and cooling operation, the first compressor 21, the second compressor 22, the heat source-side fan 46, the first utilization-side fan 64, and the second utilization-side fan 73 are driven.

[0060] Then, as shown in FIG. 2, gas refrigerant at the high pressure in the refrigeration cycle that has been compressed in the first compressor 21 and the second compressor 22 is sent through the first switching mechanism 25 to the heat source-side heat exchanger 24. In the heat source-side heat exchanger 24, the gas refrigerant at the high pressure exchanges heat with the outdoor air and radiates heat (condenses). The liquid refrigerant at the high pressure that has radiated heat in the heat source-side heat exchanger 24 flows in the order of the first liquid refrigerant pipe 45, the receiver 27, and the second liquid refrigerant pipe 46. Some of the liquid refrigerant at the high pressure flowing through the second liquid refrigerant pipe 46 flows through the high-pressure-side heat exchange flow passage 28a of the subcooling heat exchanger 28, while the rest is sent through the third liquid refrigerant pipe 47 to the second liquid refrigerant communication pipe 10. In the subcooling heat exchanger 28, the liquid refrigerant at the high pressure flowing through the high-pressure-side heat exchange flow passage 28a exchanges heat with the refrigerant at the intermediate pressure in the refrigeration cycle flowing through the intermediate-pressure-side heat exchange flow passage 28b and is refrigerated. The liquid refrigerant at the high pressure that has been refrigerated in the high-pressure-side heat exchange flow passage 28a flows through the fifth liquid refrigerant pipe 49. Some of the liquid refrigerant at the high pressure flowing through the fifth liquid refrigerant pipe 49 is branched to the inflow-side injection pipe 29a of the injection pipe 29, while the rest is sent to the first liquid refrigerant communication pipe 8. The liquid refrigerant at the high pressure that has been branched to the inflow-side injection pipe 29a is reduced in pressure to the intermediate pressure by the inflow-side injection expansion valve 29c and thereafter flows through the intermediate-pressure-side heat exchange flow passage 28b of the subcooling heat exchanger 28. The refrigerant at the intermediate pressure flowing through the intermediate-pressure-side heat exchange flow passage 28b exchanges heat with the liquid refrigerant at the high pressure flowing through the high-pressure-side heat exchange flow passage 28a and evaporates. The refrigerant at the intermediate pressure that has evaporated in the intermediate-pressure-side heat exchange flow passage 28b flows through the outflow-side injection pipe 29b of the injection pipe 29. The refrigerant at the intermediate pressure flowing through the outflow-side injection pipe 29b is branched in two and is injected through the outflow-side injection expansion valves 30a, 30b into the intermediate ports 21b, 22b of the first compressor 21 and the second compressor 22.

[0061] The liquid refrigerant at the high pressure that has been sent to the first liquid refrigerant communication pipe 8 is reduced in pressure to the first low pressure in the refrigeration cycle by the first utilization-side expansion valve 61 and thereafter is sent to the first utilization-side heat exchanger 62. In the first utilization-side heat exchanger 62, the refrigerant at the first low pressure exchanges heat with the refrigerator air and evaporates. The gas refrigerant at the first low pressure that has evaporated in the first utilization-side heat exchanger 62 is sent through the first gas refrigerant communication pipe 9 to the first low-pressure pipe 31. The gas refrigerant at the first low pressure flowing through the first low-pressure pipe 31 is sucked through the first suction pipe 21d into the first compressor 21 and is compressed again.

[0062] The liquid refrigerant at the high pressure that has been sent to the second liquid refrigerant communication pipe 10 is reduced in pressure to the second low pressure in the refrigeration cycle by the second utilization-side expansion valve 71 and thereafter is sent to the second utilization-side heat exchanger 72. In the second utilization-side heat exchanger 72, the refrigerant at the second low pressure exchanges heat with the room air and evaporates. The gas refrigerant at the second low pressure that has evaporated in the second utilization-side heat exchanger 72 is sent through the second gas refrigerant communication pipe 11 and the first and second switching mechanisms 25, 26 to the second low-pressure pipe 32. The gas refrigerant at the second low pressure flowing through the second low-pressure pipe 32 is sucked through the second suction pipe 22d into the second compressor 22 and is compressed again.

[0063] Here, in a case where the cooling load (i.e., the flow rate of the refrigerant at the second low pressure corresponding to this cooling load) in the second utilization unit 7 (the second utilization-side heat exchanger 72) can be processed by just the second compressor 22, the control valve 34 in the interconnecting low-pressure pipe 33 is set to a completely closed state, whereby the refrigerant at the first low pressure flowing through the first low-pressure pipe 31 is processed by the first compressor 21 and the refrigerant at the second low pressure flowing through the second low-pressure pipe 32 is processed by the second compressor 22 as described above.

[0064] However, in a case where the cooling load (i.e., the flow rate of the refrigerant at the second low pressure corresponding to this cooling load) in the second utilization unit 7 (the second utilization-side heat exchanger 72) cannot be processed by just the second compressor 22, the control valve 34 is set to an open state, whereby the first low-pressure pipe 31 becomes communicated with the second low-pressure pipe 32 and the refrigerant at the second low pressure flowing through the second low-pressure pipe 32 is sucked into the second compressor 22 and is also sucked into the first compressor 21 (see the dashed-line arrow showing the flow of the refrigerant shown near the low-pressure pipe 33 in FIG. 2). That is, some of the air-conditioning load in the second utilization unit 7 (the second utilization-side heat exchanger 72) becomes processed also by the first compressor 21. At this time, the control valve 34 has its opening degree controlled so as to reduce, from the second low pressure to the first low pressure, the pressure of some of the refrigerant at the second low pressure flowing through the second low-pressure pipe 32 (the flow rate of the refrigerant at the second low pressure that cannot be processed by the second compressor 22).

-Refrigerating and Heating Operation-

[0065] The refrigerating and heating operation is an operation where the refrigerator is refrigerated by the first utilization unit 6 and heating of the room is performed by the second utilization unit 7. For this reason, in the refrigerating and heating operation, the heat source-side heat exchanger 24 functions as an evaporator of the refrigerant, the first utilization-side heat exchanger 62 functions as an evaporator of the refrigerant, and the second utilization-side heat exchanger 72 functions as a radiator of the refrigerant.

[0066] First, in the refrigerating and heating operation, the first switching mechanism 25 is set to the second state (the state indicated by the dashed lines in FIG. 3), the second switching mechanism 26 is set to the first state (the state indicated by the solid lines in FIG. 3), the first utilization-side on-off valve 63 is set to an open state, the heat source-side expansion valve 50b is set to a completely open state, the first on-off valve 45b is set to a closed state, and the control valve 34, the inflow-side injection expansion valve 29c, the outflow-side injection expansion valves 30a, 30b, the first utilization-side expansion valve 61, and the second utilization-side expansion valve 71 are controlled to predetermined opening degrees. Furthermore, in the refrigerating and heating operation, the first compressor 21, the second compressor 22, the heat source-side fan 46, the first utilization-side fan 64, and the second utilization-side fan 73 are driven.

[0067] Then, as shown in FIG. 3, the refrigerant at the high pressure in the refrigeration cycle that has been compressed in the first compressor 21 and the second compressor 22 is sent through the first switching mechanism 25 to the second gas refrigerant communication pipe 11.

[0068] The gas refrigerant at the high pressure that has been sent to the second gas refrigerant communication pipe 11 is sent to the second utilization-side heat exchanger 72. In the second utilization-side heat exchanger 72, the gas refrigerant at the high pressure exchanges heat with the room air and radiates heat (condenses). The liquid refrigerant at the high pressure that has radiated heat in the second utilization-side heat exchanger 72 is sent through the second utilization-side expansion valve 71 to the second liquid refrigerant communication pipe 10.

[0069] The liquid refrigerant at the high pressure that has been sent to the second liquid refrigerant communication pipe 10 flows in the order of the third liquid refrigerant pipe 47, the fourth liquid refrigerant pipe 48, the first liquid refrigerant pipe 45, the receiver 27, and the second liquid refrigerant pipe 46. The liquid refrigerant at the high pressure flowing through the second liquid refrigerant pipe 46 flows through the high-pressure-side heat exchange flow passage 28a of the subcooling heat exchanger 28. In the subcooling heat exchanger 28, the liquid refrigerant at the high pressure flowing through the high-pressure-side heat exchange flow passage 28a exchanges heat with the refrigerant at the intermediate pressure in the refrigeration cycle flowing through the intermediate-pressure-side heat exchange flow passage 28b and is refrigerated. The liquid refrigerant at the high pressure that has been refrigerated in the high-pressure-side heat exchange flow passage 28a flows through the fifth liquid refrigerant pipe 49. Some of the liquid refrigerant at the high pressure flowing through the fifth liquid refrigerant flow pipe 49 is branched to the inflow-side injection pipe 29a of the injection pipe 29 and the sixth liquid refrigerant pipe 50, while the rest is sent to the first liquid refrigerant communication pipe 8. The liquid refrigerant at the high pressure that has been branched to the inflow-side injection pipe 29a is reduced in pressure to the intermediate pressure by the inflow-side injection expansion valve 29c and thereafter flows through the intermediate-pressure-side heat exchange flow passage 28b of the subcooling heat exchanger 28. The refrigerant at the intermediate pressure flowing through the intermediate pressure-side heat exchange flow passage 28b exchanges heat with the liquid refrigerant at the high pressure flowing through the high-pressure-side heat exchange flow passage 28a and evaporates. The refrigerant at the intermediate pressure that has evaporated in the intermediate-pressure-side heat exchange flow passage 28b flows through the outflow-side injection pipe 29b of the injection pipe 29. The refrigerant at the intermediate pressure flowing through the outflow-side injection pipe 29b is branched in two and is injected through the outflow-side injection expansion valves 30a, 30b into the intermediate ports 21b, 22b of the first compressor 21 and the second compressor 22. The liquid refrigerant at the high pressure that has been branched to the sixth liquid refrigerant pipe 50 is reduced in pressure to the second low pressure in the refrigeration cycle by the heat source-side expansion valve 50b and thereafter is sent to the heat source-side heat exchanger 24. In the heat source-side heat exchanger 24, the refrigerant at the second low pressure exchanges heat with the outdoor air and evaporates. The gas refrigerant at the second low pressure that has evaporated in the heat source-side heat exchanger 24 is sent through the first and second switching mechanisms 25, 26 to the second low-pressure pipe 32. The gas refrigerant at the second low pressure flowing through the second low-pressure pipe 32 is sucked through the second suction pipe 22d into the second compressor 22 and is compressed again.

[0070] The liquid refrigerant at the high pressure that has been sent to the first liquid refrigerant communication pipe 8 is reduced in pressure to the first low pressure in the refrigeration cycle by the first utilization-side expansion valve 61 and thereafter is sent to the first utilization-side heat exchanger 62. In the first utilization-side heat exchanger 62, the refrigerant at the first low pressure exchanges heat with the refrigerator air and evaporates. The gas refrigerant at the first low pressure that has evaporated in the first utilization-side heat exchanger 62 is sent through the first gas refrigerant communication pipe 9 to the first low-pressure pipe 31. The gas refrigerant at the first low pressure flowing through the first low-pressure pipe 31 is sucked through the first suction pipe 21d into the first compressor 21 and is compressed again.

[0071] Here, in a case where the heating load (i.e., the flow rate of the refrigerant at the second low pressure corresponding to this heating load) in the second utilization unit 7 (the second utilization-side heat exchanger 72) can be processed by just the second compressor 22, the control valve 34 in the interconnecting low-pressure pipe 33 is set to a completely closed state, whereby the refrigerant at the first low pressure flowing through the first low-pressure pipe 31 is processed by the first compressor 21, and the refrigerant at the second low pressure flowing through the second low-pressure pipe 32 is processed by the second compressor 22 as described above.

[0072] However, in a case where the heating load (i.e., the flow rate of the refrigerant at the second low pressure corresponding to this heating load) in the second utilization unit 7 (the second utilization-side heat exchanger 72) cannot be processed by just the second compressor 22, the control valve 34 is set to an open state, whereby the first low-pressure pipe 31 becomes communicated with the second low-pressure pipe 32 and the refrigerant at the second low pressure flowing through the second low-pressure pipe 32 is sucked into the second compressor 22 and is also sucked into the first compressor 21 (see the dashed-line arrow showing the flow of the refrigerant shown near the low-pressure pipe 33 in FIG. 3). That is, part of the heating load in the second utilization unit 7 (the second utilization-side heat exchanger 72) becomes processed also by the first compressor 21. At this time, the control valve 34 has its opening degree controlled so as to reduce, from the second low pressure to the first low pressure, the pressure of some of the refrigerant at the second low pressure flowing through the second low-pressure pipe 32 (the flow rate of the refrigerant at the second low pressure that cannot be processed by the second compressor 22).

<Connection Configuration between Low-pressure Pipes and Suction Pipes>

[0073] When performing the operation of switching the control valve 34 in the interconnecting low-pressure pipe 33 to an open state in the refrigerating and cooling operation and the refrigerating and heating operation described above (see FIG. 2 and FIG. 3), it is desired to reduce as much as possible flow resistance when the refrigerant returns through the low-pressure pipes 31 to 33 to the first compressor 21 and the second compressor 22. Furthermore, in the refrigeration apparatus 1, refrigerating machine oil is filled together with the refrigerant to lubricate the first compressor 21 and the second compressor 22, so when performing this operation of switching the control valve 34 in the interconnecting low-pressure pipe 33 to an open state, it is desired to reduce as much as possible imbalance in the refrigerating machine oil when the refrigerant returns through the low-pressure pipes 31 to 33 to the first compressor 21 and the second compressor 22.

[0074] Therefore, here, as shown in FIG. 4, the connection configuration between the second low-pressure pipe 32, the second compressor 22 (the second suction pipe 22d), and the interconnecting low-pressure pipe 33 is characterized in that a second branch pipe 36 is interposed. Here, as shown in FIG. 5, the second branch pipe 36 has a junction-side open portion 36a that opens in a predetermined direction (the left direction of the page in FIG. 5) and two branch-side open portions 36b, 36c that open in substantially the opposite direction (the right direction of the page in FIG. 5) to that of the junction-side open portion 36a, so that overall the second branch pipe 36 is substantially Y-shaped. In this second branch pipe 36, the branch-side open portions 36b, 36c open in substantially the opposite direction to that of the junction-side open portion 36a, so fluid (the refrigerant and the refrigerating machine oil) inflowing from the junction-side open portion 36a side can be smoothly flowed to the branch-side open portions 36b, 36c side. Additionally, here, the connection configuration is characterized in that the second low-pressure pipe 32 is connected to the junction-side open portion 36a of the second branch pipe 36, and the interconnecting low-pressure pipe 33 and the second suction pipe 22d are connected to the two branch-side open portions 36b, 36c.

[0075] In this connection configuration between the second low-pressure pipe 32, the second compressor 22 (the second suction pipe 22d), and the interconnecting low-pressure pipe 33 using the second branch pipe 36, when performing the operation of switching the control valve 34 in the interconnecting low-pressure pipe 33 to an open state, the refrigerant flowing through the second low-pressure pipe 32 and the refrigerating machine oil flowing together with the refrigerant can be smoothly distributed via the second branch pipe 36 to the second suction pipe 22d (the second compressor 22 side) and the interconnecting low-pressure pipe 33 (the first compressor 21 side).

[0076] Because of this, here, flow resistance and imbalance in the refrigerating machine oil when the refrigerant returns through the second low-pressure pipe 32 and the interconnecting low-pressure pipe 33 to the first compressor 21 and the second compressor 22 can be reduced as much as possible.

[0077] Moreover, here, as shown in FIG. 4, the second branch pipe 36 is disposed in such a way that the refrigerant inflowing from the junction-side open portion 36a is distributed in a horizontal direction and flows out from the two branch-side open portions 36b, 36c. That is, the junction-side open portion 36a of the second branch pipe 36 faces a lateral direction, the branch-side open portions 36b, 36c face a lateral direction on substantially the opposite side to that of the junction-side open portion 36a, and the branch-side open portions 36b, 36c are disposed in such a way as to open at the same height positions (hereinafter, this disposition is called a "horizontal disposition").

[0078] Here, the distribution of the refrigerant and the refrigerating machine oil in the second branch pipe 36 can be made excellent because of this horizontal disposition of the second branch pipe 36.

[0079] Furthermore, as shown in FIG. 4, the connection configuration between the first low-pressure pipe 31, the first compressor 21 (the first suction pipe 21d), and the interconnecting low-pressure pipe 33 is characterized in that a first branch pipe 35 is interposed. Here, as shown in FIG. 5, the first branch pipe 35 has a junction-side open portion 35a that opens in a predetermined direction (the left direction of the page in FIG. 5) and two branch-side open portions 35b, 35c that open in substantially the opposite direction (the right direction of the page in FIG. 5) to that of the junction-side open portion 35a, so that overall the first branch pipe 35 is substantially Y-shaped. In this first branch pipe 35, the branch-side open portions 35b, 35c open in substantially the opposite direction to that of the junction-side open portion 35a, so fluid (the refrigerant and the refrigerating machine oil) inflowing from the junction-side open portion 35a side can be smoothly flowed to the branch-side open portions 35b, 35c side. Additionally, here, the connection configuration is characterized in that the first low-pressure pipe 31 is connected to the junction-side open portion 35a of the first branch pipe 35, and the interconnecting low-pressure pipe 33 and the first suction pipe 21d are connected to the two branch-side open portions 35b, 35c. Furthermore, the first branch pipe 35 is also horizontally disposed like the second branch pipe 36. That is, the junction-side open portion 35a of the first branch pipe 35 faces a lateral direction, the branch-side open portions 35b, 35c face a lateral direction on substantially the opposite side to that of the junction-side open portion 35a, and the branch-side open portions 35b, 35c are disposed in such a way as to open at the same height positions.

[0080] In this connection configuration between the first low-pressure pipe 31, the first compressor 21 (the first suction pipe 21d), and the interconnecting low-pressure pipe 33 using the first branch pipe 35, when causing the refrigerant flowing through the first low-pressure pipe 31 to be sucked into the first compressor 21, the refrigerant flowing through the first low-pressure pipe 31 and the refrigerating machine oil flowing together with the refrigerant can be smoothly flowed via the first branch pipe 35 to the first suction pipe 21d.

[0081] Because of this, here, flow resistance and imbalance in the refrigerating machine oil when the refrigerant returns through the first low-pressure pipe 31 to the first compressor 21 can be reduced as much as possible.

(2) Second Embodiment

<Configuration of Refrigeration Apparatus>

[0082] The first embodiment (see FIG. 1 to FIG. 3) employs a configuration that has the first compressor 21 that compresses the refrigerant at the first low pressure and the second compressor 22 that compresses the refrigerant at the second low pressure and where the first low-pressure pipe 31 through which flows the refrigerant at the first low pressure and the second low-pressure pipe 32 through which flows the refrigerant at the second low pressure communicate with each other via the interconnecting low-pressure pipe 33 that has the control valve 34 capable of opening degree control. Additionally, in a case where the air-conditioning load in the second utilization-side heat exchanger 72 cannot be processed by just the second compressor 22, the control valve 34 is set to an open state, whereby the first low-pressure pipe 31 becomes communicated with the second low-pressure pipe 32 and the refrigerant at the second low pressure flowing through the second low-pressure pipe 32 is sucked into the second compressor 22 and is also sucked into the first compressor 21.

[0083] However, this configuration is not limited to a configuration resulting from two compressors-the first and second compressors 21, 22-and may also be a configuration having the addition of a third compressor 23.

[0084] FIG. 6 is a general configuration diagram of the refrigeration apparatus 1 pertaining to a second embodiment of the invention. Here, the configuration of the first embodiment is further provided with the third compressor 23 and a third suction pipe 23d that is connected to the third compressor 23.

[0085] The third compressor 23 is a compressor that compresses the refrigerant to the high pressure in the refrigeration cycle. Here, as the third compressor 23, like the first compressor 21 and the second compressor 22, a compressor with a closed structure in which a rotary-type or scroll-type positive-displacement compression element (not shown in the drawings) is driven by a compressor motor 23a is used. Furthermore, like the first compressor 21 and the second compressor 22, the compression element of the third compressor 23 is provided with an intermediate port 23b that opens to a position at the intermediate pressure in the refrigeration cycle. Furthermore, in contrast to the first compressor 21 and the second compressor 22, a compressor motor with a fixed rotational speed is used for the compressor motor 23a. Additionally, a third discharge pipe 23c is connected to the discharge side of the third compressor 23. The third discharge pipe 23c is, like those of the first compressor 21 and the second compressor 22, connected to the first port 25a of the first switching mechanism 25. The third suction pipe 23d communicates with the first low-pressure pipe 31 through the first branch pipe 35 and the interconnecting low-pressure pipe 33. A branch portion of the outflow-side injection pipe 29b configuring the injection pipe 29 is connected to the intermediate port 23b, as with the first compressor 21 and the second compressor 22. That is, the other end of the outflow-side injection pipe 29b branches in three and is connected to the intermediate ports 21b, 22b, 23b of the first compressor 21, the second compressor 22, and the third compressor 23. Additionally, an outflow-side injection expansion valve 30c for controlling the flow rate of the refrigerant that becomes injected into the intermediate port 23b is, in addition to the outflow-side injection expansion valves 30a, 30b, also provided in the outflow-side injection pipe 29b. The outflow-side injection expansion valve 30c includes an electrically powered expansion valve capable of opening degree control like the outflow-side injection expansion valves 30a, 30b.

[0086] It will be noted that the configuration of the refrigeration apparatus 1 of the present embodiment is the same as that of the first embodiment except for the third compressor 23 and its peripheral configuration (including the connection configuration between low-pressure pipes and suction pipes described later), so description will be omitted here.

<Actions of Refrigeration Apparatus>

[0087] Next, the actions of the refrigeration apparatus 1 of the present embodiment will be described using FIG. 7 and FIG. 8.

[0088] As in the first embodiment, the refrigeration apparatus 1 is configured to be able to perform the refrigerating and cooling operation and the refrigerating and heating operation in which the refrigerating operation and an air-conditioning operation (the cooling operation or the heating operation) are combined. Here, regarding the refrigerating and cooling operation and the refrigerating and heating operation, mainly that which differs from the first embodiment will be described. It will be noted that these operations are, as in the first embodiment, performed by the control unit 12 that controls the constituent devices of the refrigeration apparatus 1.

[0089] In the refrigerating and cooling operation and the refrigerating and heating operation of the present embodiment, device actions and settings that are the same as those in the refrigerating and cooling operation and the refrigerating and heating operation of the first embodiment are performed, and also the outflow-side injection expansion valve 30c is controlled to a predetermined opening degree and the third compressor 23 is driven.

[0090] Additionally, in the refrigerating and cooling operation and the refrigerating and heating operation of the present embodiment, the flows of the refrigerant shown in FIG. 7 and

[0091] FIG. 8 are obtained. The flows of the refrigerant shown in FIG. 7 and FIG. 8 are the same as those in the refrigerating and cooling operation of the first embodiment except that the third compressor 23 sucks in and compresses the refrigerant at the low pressure in the refrigeration cycle while injection is performed into the intermediate port 23b of the third compressor 23 through the injection pipe 29, so description will be omitted here.

[0092] Here, in a case where the air-conditioning load (i.e., the flow rate of the refrigerant at the second low pressure corresponding to this air-conditioning load) in the second utilization unit 7 (the second utilization-side heat exchanger 72) can be processed by just the second compressor 22, the control valve 34 in the interconnecting low-pressure pipe 33 is set to a completely closed state, whereby the refrigerant at the first low pressure flowing through the first low-pressure pipe 31 is processed by the first compressor 21 and the third compressor 23 and the refrigerant at the second low pressure flowing through the second low-pressure pipe 32 is processed by the second compressor 22 as described above.

[0093] However, in a case where the air-conditioning load (i.e., the flow rate of the refrigerant at the second low pressure corresponding to this air-conditioning load) in the second utilization unit 7 (the second utilization-side heat exchanger 72) cannot be processed by just the second compressor 22, the control valve 34 is set to an open state, whereby the first low-pressure pipe 31 becomes communicated with the second low-pressure pipe 32 and the refrigerant at the second low pressure flowing through the second low-pressure pipe 32 is sucked into the second compressor 22 and is also sucked into the third compressor 23 (see the dashed-line arrow showing the flow of the refrigerant shown near the low-pressure pipe 33 in FIG. 7 and FIG. 8). That is, part of the air-conditioning load in the second utilization unit 7 (the second utilization-side heat exchanger 72) becomes processed also by the third compressor 23. At this time, the control valve 34 has its opening degree controlled so as to reduce, from the second low pressure to the first low pressure, the pressure of some of the refrigerant at the second low pressure flowing through the second low-pressure pipe 32 (the flow rate of the refrigerant at the second low pressure that cannot be processed by the second compressor 22).

<Connection Configuration between Low-pressure Pipes and Suction Pipes>

[0094] When performing the operation of switching the control valve 34 in the interconnecting low-pressure pipe 33 to an open state also in the refrigerating and cooling operation and the refrigerating and heating operation described above (see FIG. 7 and FIG. 8), it is desired to reduce as much as possible flow resistance when the refrigerant returns through the low-pressure pipes 31 to 33 to the first compressor 21, the second compressor 22, and the third compressor 23. Furthermore, in the refrigeration apparatus 1, refrigerating machine oil is filled together with the refrigerant to lubricate the first compressor 21, the second compressor 22, and the third compressor 23, so when performing this operation of switching the control valve 34 in the interconnecting low-pressure pipe 33 to an open state, it is desired to reduce as much as possible imbalance in the refrigerating machine oil when the refrigerant returns through the low-pressure pipes 31 to 33 to the first compressor 21, the second compressor 22, and the third compressor 23.

[0095] Therefore, here, as shown in FIG. 9, the connection configuration between the second low-pressure pipe 32, the second compressor 22 (the second suction pipe 22d), and the interconnecting low-pressure pipe 33 is characterized in that, as in the first embodiment, the second branch pipe 36 is interposed, the second low-pressure pipe 32 is connected to the junction-side open portion 36a of the second branch pipe 36, and the interconnecting low-pressure pipe 33 and the second suction pipe 22d are connected to the two branch-side open portions 36b, 36c.

[0096] In this connection configuration between the second low-pressure pipe 32, the second compressor 22 (the second suction pipe 22d), and the interconnecting low-pressure pipe 33 using the second branch pipe 36, when performing the operation of switching the control valve 34 in the interconnecting low-pressure pipe 33 to an open state, the refrigerant flowing through the second low-pressure pipe 32 and the refrigerating machine oil flowing together with the refrigerant can be smoothly distributed via the second branch pipe 36 to the second suction pipe 22d (the second compressor 22 side) and the interconnecting low-pressure pipe 33 (the third compressor 23 side).

[0097] Because of this, here, flow resistance and imbalance in the refrigerating machine oil when the refrigerant returns through the second low-pressure pipe 32 and the interconnecting low-pressure pipe 33 to the second compressor 22 and the third compressor 23 can be reduced as much as possible. Furthermore, here, as in the first embodiment, the distribution of the refrigerant and the refrigerating machine oil in the second branch pipe 36 can be made excellent because of the horizontal disposition of the second branch pipe 36.

[0098] Furthermore, here, as shown in FIG. 9, the connection configuration between the first low-pressure pipe 31, the first compressor 21 (the first suction pipe 21d), and the interconnecting low-pressure pipe 33 is characterized in that, as in the first embodiment, the first branch pipe 35 is interposed, the first low-pressure pipe 31 is connected to the junction-side open portion 35a of the first branch pipe 35, and the interconnecting low-pressure pipe 33 and the first suction pipe 21d are connected to the two branch-side open portions 35b, 35c. Furthermore, the first branch pipe 35 is also horizontally disposed as in the first embodiment. Furthermore, here, the connection configuration is characterized in that the third suction pipe 23d of the third compressor 23 is connected to a portion of the interconnecting low-pressure pipe 33 on the first branch pipe 35 side of the control valve 34.

[0099] In this configuration where the third compressor 23 is further connected to the portion of the interconnecting low-pressure pipe 33 on the first branch pipe 35 side of the control valve 34, the refrigerant flowing through the first low-pressure pipe 31 can be sucked into the first compressor 21 and also the third compressor 23, and at this time the refrigerant flowing through the first low-pressure pipe 31 and the refrigerating machine oil flowing together with the refrigerant can be smoothly distributed via the first branch pipe 35 to the first suction pipe 21d (the first compressor 21 side) and the interconnecting low-pressure pipe 33 (the third compressor 23 side). Moreover, by horizontally disposing the first branch pipe 35, the distribution of the refrigerant and the refrigerating machine oil in the first branch pipe 35 can be made excellent. Furthermore, in this configuration, by switching the control valve 34 in the interconnecting low-pressure pipe 33 to an open state, the refrigerant flowing through the second low-pressure pipe 32 can be sucked into the second compressor 22 and also the third compressor 23, and at this time the refrigerant flowing through the second low-pressure pipe 32 and the refrigerating machine oil flowing together with the refrigerant can be smoothly distributed via the second branch pipe 36 to the second suction pipe 22d (the second compressor 22 side) and the interconnecting low-pressure pipe 33 (the third compressor 23 side).

[0100] Because of this, here, it can be made possible for the refrigerant flowing through the first low-pressure pipe 31 to be sucked into the first compressor 21 and also the third compressor 23 and for the refrigerant flowing through the second low-pressure pipe 32 to be sucked into the second compressor 22 and also the third compressor 23, and flow resistance and imbalance in the refrigerating machine oil when the refrigerant returns through the first low-pressure pipe 31, the second low-pressure pipe 32, and the interconnecting low-pressure pipe 33 to the first compressor 21, the second compressor 22, and the third compressor 23 can be reduced as much as possible.

[0101] Furthermore, here, as shown in FIG. 9, the connection configuration between the third compressor 23 (the third suction pipe 23d) and the interconnecting low-pressure pipe 33 (first and third interconnecting low-pressure pipes 33a, 33c) is characterized in that a third branch pipe 37 is interposed. Here, as shown in FIG. 5, the third branch pipe 37 has a junction-side open portion 37a that opens in a predetermined direction (the left direction of the page in FIG. 5) and two branch-side open portions 37b, 37c that open in substantially the opposite direction (the right direction of the page in FIG. 5) to that of the junction-side open portion 37a, so that overall the third branch pipe 37 is substantially Y-shaped. In this third branch pipe 37, the branch-side open portions 37b, 37c open in substantially the opposite direction to that of the junction-side open portion 37a, so fluid (the refrigerant and the refrigerating machine oil) inflowing from both the branch-side open portion 37b, 37c sides can also be smoothly flowed to the junction-side open portion 37a side. Additionally, here, the connection configuration is characterized in that the third suction pipe 23d is connected to the junction-side open portion 37a of the third branch pipe 37, and a first interconnecting low-pressure pipe 33a and a third interconnecting low-pressure pipe 33c are connected to the two branch-side open portions 37b, 37c. Here, the first interconnecting low-pressure pipe 33a is the portion of the interconnecting low-pressure pipe 33 that interconnects the branch-side open portion 35b of the first branch pipe 35 and one of the two branch-side open portions 37b, 37c (here, the branch-side open portion 37b) of the third branch pipe 37. A second interconnecting low-pressure pipe 33b is the portion of the interconnecting low-pressure pipe 33 that interconnects the branch-side open portion 36b of the second branch pipe 36 and the control valve 34. The third interconnecting low-pressure pipe 33c is the portion that interconnects the control valve 34 and the other of the two branch-side open portions 37b, 37c (here, the branch-side open portion 37c) of the third branch pipe 37. Furthermore, the third branch pipe 37 is also horizontally disposed like the first and second branch pipes 35, 36.

[0102] In this connection configuration between the third suction pipe 23d and the first and third interconnecting low-pressure pipes 33a, 33c using the third branch pipe 37, both when causing the refrigerant flowing through the first low-pressure pipe 31 to be sucked into the third compressor 23 and when causing the refrigerant flowing through the second low-pressure pipe 32 to be sucked into the third compressor 23, the refrigerant flowing through the first and second low-pressure pipes 31, 32 and the refrigerating machine oil flowing together with the refrigerant can be smoothly flowed via the third branch pipe 37 to the third suction pipe 23d.

[0103] Because of this, here, flow resistance and imbalance in the refrigerating machine oil when the refrigerant returns through the interconnecting low-pressure pipe 33 to the third compressor 23 can be reduced as much as possible.

<Example Modifications>

[0104] The connection configuration between the low-pressure pipes and the suction pipes applied to the configuration having the first compressor 21, the second compressor 22, and the third compressor 23 (see FIG. 6 to FIG. 8) is not limited to the configuration shown in

FIG. 9 and may also be a configuration such as shown in FIG. 10.

[0105] First, here, as shown in FIG. 10, the connection configuration between the second low-pressure pipe 32, the second compressor 22 (the second suction pipe 22d), and the interconnecting low-pressure pipe 33 is characterized in that, as in the configuration of FIG. 9, the second branch pipe 36 is interposed, the second low-pressure pipe 32 is connected to the junction-side open portion 36a of the second branch pipe 36, and the interconnecting low-pressure pipe 33 and the second suction pipe 22d are connected to the two branch-side open portions 36b, 36c.

[0106] In this connection configuration between the second low-pressure pipe 32, the second compressor 22 (the second suction pipe 22d), and the interconnecting low-pressure pipe 33 using the second branch pipe 36, when performing the operation of switching the control valve 34 in the interconnecting low-pressure pipe 33 to an open state, the refrigerant flowing through the second low-pressure pipe 32 and the refrigerating machine oil flowing together with the refrigerant can be smoothly distributed via the second branch pipe 36 to the second suction pipe 22d (the second compressor 22 side) and the interconnecting low-pressure pipe 33 (the third compressor 23 side).

[0107] Because of this, here, flow resistance and imbalance in the refrigerating machine oil when the refrigerant returns through the second low-pressure pipe 32 and the interconnecting low-pressure pipe 33 to the second compressor 22 and the third compressor 23 can be reduced as much as possible. Furthermore, here, as in the configuration of FIG. 9, the distribution of the refrigerant and the refrigerating machine oil in the second branch pipe 36 can be made excellent because of the horizontal disposition of the second branch pipe 36.

[0108] Furthermore, here, as shown in FIG. 10, the connection configuration between the first low-pressure pipe 31, the first compressor 21 (the first suction pipe 21d), the third compressor 23 (the third suction pipe 23d), and the interconnecting low-pressure pipe 33 is characterized in that a junction low-pressure pipe 40 is connected to the first low-pressure pipe 31 and the interconnecting low-pressure pipe 33, and the first suction pipe 21d of the first compressor 21 and the third suction pipe 23d of the third compressor 23 are connected to the junction low-pressure pipe 40 connected to the first low-pressure pipe 31 and the interconnecting low-pressure pipe 33.

[0109] In this configuration where the first and third compressors 21, 23 are connected to the junction low-pressure pipe 40, the refrigerant flowing through the first low-pressure pipe 31 can be sucked through the junction low-pressure pipe 40 into the first compressor 21 and also the third compressor 23. Furthermore, in this configuration, by switching the control valve 34 in the interconnecting low-pressure pipe 33 to an open state, the refrigerant flowing through the second low-pressure pipe 32 can be sucked into the second compressor 22 and can also be sucked through the interconnecting low-pressure pipe 33 and the junction low-pressure pipe 40 into the third compressor 23, and at this time the refrigerant flowing through the second low-pressure pipe 32 and the refrigerating machine oil flowing together with the refrigerant can be smoothly distributed via the second branch pipe 36 to the second suction pipe 22d (the second compressor 22 side) and the interconnecting low-pressure pipe 33 and the junction low-pressure pipe 40 (the third compressor 23 side).

[0110] Moreover, here, as shown in FIG. 10, the connection configuration between the junction low-pressure pipe 40, the first compressor 21 (the first suction pipe 21d), and the third compressor 23 (the third suction pipe 23d) is characterized in that a fourth branch pipe 38 is interposed. Here, as shown in FIG. 5, the fourth branch pipe 38 has a junction-side open portion 38a that opens in a predetermined direction (the left direction of the page in FIG. 5) and two branch-side open portions 38b, 38c that open in substantially the opposite direction (the right direction of the page in FIG. 5) to that of the junction-side open portion 38a, so that overall the fourth branch pipe 38 is substantially Y-shaped. In this fourth branch pipe 38, the branch-side open portions 38b, 38c open in substantially the opposite direction to that of the junction-side open portion 38a, so fluid (the refrigerant and the refrigerating machine oil) inflowing from the junction-side open portion 38a side can be smoothly flowed to the branch-side open portions 38b, 38c side. Additionally, here, the connection configuration is characterized in that the junction low-pressure pipe 40 is connected to the junction-side open portion 38a of the fourth branch pipe 38, and the first suction pipe 21d and the third suction pipe 23d are connected to the two branch-side open portions 38b, 38c.

[0111] In this connection configuration between the junction low-pressure pipe 40, the first suction pipe 21d, and the third suction pipe 23d using the fourth branch pipe 38, the refrigerant flowing through the first low-pressure pipe 31 and the second low-pressure pipe 32 and the refrigerating machine oil flowing together with the refrigerant can be smoothly distributed via the junction low-pressure pipe 40 and the fourth branch pipe 38 to the first suction pipe 21d (the first compressor 21 side) and the third suction pipe 23d (the third compressor 23 side).

[0112] Because of this, here, it can be made possible for the refrigerant flowing through the first low-pressure pipe 31 to be sucked into the first compressor 21 and also the third compressor 23 and for the refrigerant flowing through the second low-pressure pipe 32 to be sucked into the second compressor 22 and also the third compressor 23, and flow resistance and imbalance in the refrigerating machine oil when the refrigerant returns through the first low-pressure pipe 31, the second low-pressure pipe 32, the interconnecting low-pressure pipe 33, the junction low-pressure pipe 40, and the fourth branch pipe 38 to the first compressor 21, the second compressor 22, and the third compressor 23 can be reduced as much as possible.

[0113] Moreover, here, as shown in FIG. 10, the fourth branch pipe 38 is horizontally disposed, so the distribution of the refrigerant and the refrigerating machine oil in the fourth branch pipe 38 can be made excellent.

[0114] Furthermore, here, as shown in FIG. 10, the connection configuration between the first low-pressure pipe 31, the first and third compressors 21, 23 (the junction low-pressure pipe 40), and the interconnecting low-pressure pipe 33 is characterized in that a fifth branch pipe 39 is interposed. Here, as shown in FIG. 5, the fifth branch pipe 39 has a junction-side open portion 39a that opens in a predetermined direction (the left direction of the page in FIG. 5) and two branch-side open portions 39b, 39c that open in substantially the opposite direction (the right direction of the page in FIG. 5) to that of the junction-side open portion 39a, so that overall the fifth branch pipe 39 is substantially Y-shaped. In this fifth branch pipe 39, the branch-side open portions 39b, 39c open in substantially the opposite direction to that of the junction-side open portion 39a, so fluid (the refrigerant and the refrigerating machine oil) inflowing from both the branch-side open portion 39b, 39c sides can also be smoothly flowed to the junction-side open portion 39a side. Additionally, here, the connection configuration is characterized in that the junction low-pressure pipe 40 is connected to the junction-side open portion 39a of the fifth branch pipe 39, and the first low-pressure pipe 31 and the interconnecting low-pressure pipe 33 are connected to the two branch-side open portions 39b, 39c. Furthermore, the fifth branch pipe 39 is also horizontally disposed like the second branch pipe 36 and the fourth branch pipe 38.

[0115] In this connection configuration between the first low-pressure pipe 31, the junction low-pressure pipe 40, and the interconnecting low-pressure pipe 33 using the fifth branch pipe 39, both when causing the refrigerant flowing through the first low-pressure pipe 31 to be sucked into the third compressor 23 and when causing the refrigerant flowing through the interconnecting low-pressure pipe 33 to be sucked into the third compressor 23, the refrigerant flowing through the first low-pressure pipe 31 and the interconnecting low-pressure pipe 33 and the refrigerating machine oil flowing together with the refrigerant can be smoothly flowed via the fifth branch pipe 39 to the junction low-pressure pipe 40.

[0116] Because of this, here, flow resistance and imbalance in the refrigerating machine oil when the refrigerant returns through the junction low-pressure pipe 40 to the first compressor 21 and the third compressor 23 can be reduced as much as possible.

(3) Other Embodiments

[0117] In the refrigeration apparatus 1 of the first embodiment (see FIG. 1, etc.), the two compressors 21, 22 are both provided with respect to the one heat source unit 2, and in the refrigeration apparatus 1 of the second embodiment (see FIG. 6, etc.), the three compressors 21, 22, 23 are all provided with respect to the one heat source unit 2, and the connection configurations between the low-pressure pipes and the suction pipes (see FIG. 4, FIG. 9, and FIG. 10) are provided in the heat source unit 2.

[0118] However, the refrigeration apparatus 1 of the first and second embodiments is not limited to an apparatus where the connection configurations between the low-pressure pipes and the suction pipes are provided in the heat source unit 2 having plural compressors and may also be an apparatus that uses plural heat source units each having one compressor and where the connection configurations between the low-pressure pipes and the suction pipes are provided so as to interconnect these heat source units.

[0119] For example, as shown in FIG. 11, the refrigeration apparatus 1 may be configured in such a way that the heat source unit 2 having the three compressors 21, 22, 23 of the second embodiment is divided into a first heat source unit 2a having the first compressor 21, a second heat source unit 2b having the second compressor 22, a third heat source unit 2c having the third compressor 23, and connection configurations between the low-pressure pipes 31, 32, 33 and the suction pipes 21d, 22d, 23d and the like. Here, the heat source units 2a, 2b, 2c differ from the heat source unit 2 of the second embodiment mainly in that they do not have the switching mechanisms 25, 26 and in that the suction pipes 21d, 22d, 23d extend outside the units via first gas-side stop valves 41a, 41b, 41c. It will be noted that, like the heat source unit 2 of the second embodiment, the heat source units 2a, 2b, 2c each have constituent elements such as a heat source-side heat exchanger, a receiver, and a subcooling heat exchanger. In FIG. 11 illustration of constituent elements is omitted except for the compressors 21, 22, 23, the suction pipes 21d, 22d, 23d (including the first gas-side stop valves 41a, 41b, 41c), heat source-side heat exchangers 24a, 24b, 24c, and liquid refrigerant pipes 47a, 47b, 47c, 49a, 49b, 49c (including liquid-side stop valves 42a, 42b, 42c, 44a, 44b, 44c).

[0120] Additionally, in the refrigeration apparatus 1 having this unit configuration, as described above, the same connection configurations between the low-pressure pipes 31, 32, 33 and the suction pipes 21d, 22d, 23d and the like as in the refrigeration apparatus 1 of the second embodiment can be applied outside the heat source units 2a, 2b, 2c, that is, between the heat source units 2a, 2b, 2c. That is, the same connection configurations between the low-pressure pipes 31, 32, 33 and the suction pipes 21d, 22d, 23d and the like as in the refrigeration apparatus 1 of the second embodiment can also be applied to the refrigeration apparatus 1 shown in FIG. 11 because the refrigeration apparatus 1 shown in FIG. 11 is the same as the refrigeration apparatus 1 of the second embodiment in that it has the first compressor 21, the second compressor 22, and the third compressor 23 except that the connection configurations are outside the heat source units 2a, 2b, 2c. It will be noted that here a configuration (see FIG. 9 and FIG. 10) is applied where, although the first gas refrigerant communication pipe 9 functions as the first low-pressure pipe 31 and the second gas refrigerant communication pipe 11 functions as the second low-pressure pipe 32, both the low-pressure pipes 31, 32 are interconnected by the interconnecting low-pressure pipe 33 (including the control valve 34) and the suction pipes 21d, 22d, 23d are connected to these low-pressure pipes 31, 32, 33.

[0121] In this case also, as in the refrigeration apparatus 1 of the second embodiment, when performing the operation of switching the control valve 34 in the interconnecting low-pressure pipe 33 to an open state, imbalance in the refrigerating machine oil when the refrigerant returns through the low-pressure pipes 31 to 33 to the first compressor 21, the second compressor 22, and the third compressor 23 can be reduced as much as possible.

[0122] Furthermore, although it is not shown in the drawings here, the refrigeration apparatus 1 may also be configured in such a way that the heat source unit 2 having the two compressors 21, 22 as in the first embodiment is divided into a first heat source unit 2a having the first compressor 21, a second heat source unit 2b having the second compressor 22, and the connection configurations between the low-pressure pipes 31, 32, 33 and the suction pipes 21d, 22d and the like, with the connection configurations between the low-pressure pipes 31, 32, 33 and the suction pipes 21d, 22d and the like shown in FIG. 4 being applied.

INDUSTRIAL APPLICABILITY

[0123] The present invention is widely applicable to refrigeration apparatuses having first and second compressors, a heat-source side heat exchanger, first and second utilization-side heat exchangers, a first low-pressure pipe for communicating the first compressor to the first utilization-side heat exchanger, a second low-pressure pipe for communicating the second compressor to the second utilization-side heat exchanger or the heat source-side heat exchanger, and an interconnecting low-pressure pipe that has a control valve capable of opening degree control and is for intercommunicating the first low-pressure pipe and the second low-pressure pipe.

REFERENCE SIGNS LIST

[0124]

1	Refrigeration Apparatus
21	First Compressor
21d	First Suction Pipe
22	Second Compressor
22d	Second Suction Pipe
23	Third Compressor
23d	Third Suction Pipe
24	Heat Source-side Heat Exchanger
31	First Low-pressure Pipe
32	Second Low-pressure Pipe
33	Interconnecting Low-pressure Pipe
33a to 33c	First to Third Interconnecting Low-pressure Pipes
34	Control Valve
35 to 39	First to Fifth Branch Pipes
35a to 39a	Junction-side Open Portions
35b to 39b	Branch-side Open Portions
35c to 39c	Branch-side Open Portions
40	Junction Low-pressure Pipe
62	First Utilization-side Heat Exchanger
72	Second Utilization-side Heat Exchanger

CITATION LIST

PATENT LITERATURE

[0125] Patent Document 1: JP-ANo. 2014-70822

Claims

1. A refrigeration apparatus (1) comprising:

a first compressor (21) and a second compressor (22);
a heat source-side heat exchanger (24);
a first utilization-side heat exchanger (62) and a second utilization-side heat exchanger(72);
a first low-pressure pipe (31) for communicating the first compressor to the first utilization-side heat exchanger;
a second low-pressure pipe (32) for communicating the second compressor to the second utilization-side heat exchanger or the heat source-side heat exchanger; and
an interconnecting low-pressure pipe (33) that has a control valve (34) capable of opening degree control and is for intercommunicating the first low-pressure pipe and the second low-pressure pipe,
wherein the refrigeration apparatus further comprises
a second suction pipe (22d) connected to the second compressor and
a second branch pipe (36) having a junction-side open portion (36a) that opens in a predetermined direction and two branch-side open portions (36b, 36c) that open in substantially the opposite direction to that of the junction-side open portion, with the second low-pressure pipe being connected to the junction-side open portion and with the interconnecting low-pressure pipe and the second suction pipe being connected to the two branch-side open portions.

2. The refrigeration apparatus according to claim 1, wherein the second branch pipe is disposed in such a way that refrigerant inflowing from the junction-side open portion is distributed in a horizontal direction and flows out from the two branch-side open portions.

3. The refrigeration apparatus according to claim 1 or 2, further comprising
a first suction pipe (21d) connected to the first compressor and
a first branch pipe (35) having a junction-side open portion (35a) that opens in a predetermined direction and two branch-side open portions (35b, 35c) that open in substantially the opposite direction to that of the junction-side open portion, with the first low-pressure pipe being connected to the junction-side open portion and with the interconnecting low-pressure pipe and the first suction pipe being connected to the two branch-side open portions.

4. The refrigeration apparatus according to claim 3, wherein the first branch pipe is disposed in such a way that refrigerant inflowing from the junction-side open portion is distributed in a horizontal direction and flows out from the two branch-side open portions.

5. The refrigeration apparatus according to claim 3 or 4, further comprising
a third compressor (23) and
a third suction pipe (23d) connected to the third compressor,
wherein the third suction pipe is connected to a portion of the interconnecting low-pressure pipe on the first branch pipe side of the control valve.

6. The refrigeration apparatus according to claim 5, further comprising a third branch pipe (37) having a junction-side open portion (37a) that opens in a predetermined direction and two branch-side open portions (37b, 37c) that open in substantially the opposite direction to that of the junction-side open portion, with the third suction pipe being connected to the junction-side open portion,
wherein the interconnecting low-pressure pipe has a first interconnecting low-pressure pipe (33a) that interconnects the branch-side open portion of the first branch pipe and one of the two branch-side open portions of the third branch pipe, a second interconnecting low-pressure pipe (33b) that interconnects the branch-side open portion of the second branch pipe and the control valve, and a third interconnecting low-pressure pipe (33c) that interconnects the control valve and the other of the two branch-side open portions of the third branch pipe.

7. The refrigeration apparatus according to claim 1 or 2, further comprising
a junction low-pressure pipe (40) connected to the first low-pressure pipe and the interconnecting low-pressure pipe,
a first suction pipe (21d) connected to the first compressor,
a third compressor (23),
a third suction pipe (23d) connected to the third compressor, and
a fourth branch pipe (38) having a junction-side open portion (38a) that opens in a predetermined direction and two branch-side open portions (38b, 38c) that open in substantially the opposite direction to that of the junction-side open portion, with the junction low-pressure pipe being connected to the junction-side open portion and with the first suction pipe and the third suction pipe being connected to the two branch-side open portions.

8. The refrigeration apparatus according to claim 7, wherein the fourth branch pipe is disposed in such a way that refrigerant inflowing from the junction-side open portion is distributed in a horizontal direction and flows out from the two branch-side open portions.

9. The refrigeration apparatus according to claim 7 or 8, further comprising a fifth branch pipe (39) having a junction-side open portion (39a) that opens in a predetermined direction and two branch-side open portions (39b, 39c) that open in substantially the opposite direction to that of the junction-side open portion, with the junction low-pressure pipe being connected to the junction-side open portion and with the first low-pressure pipe and the interconnecting low-pressure pipe being connected to the two branch-side open portions.

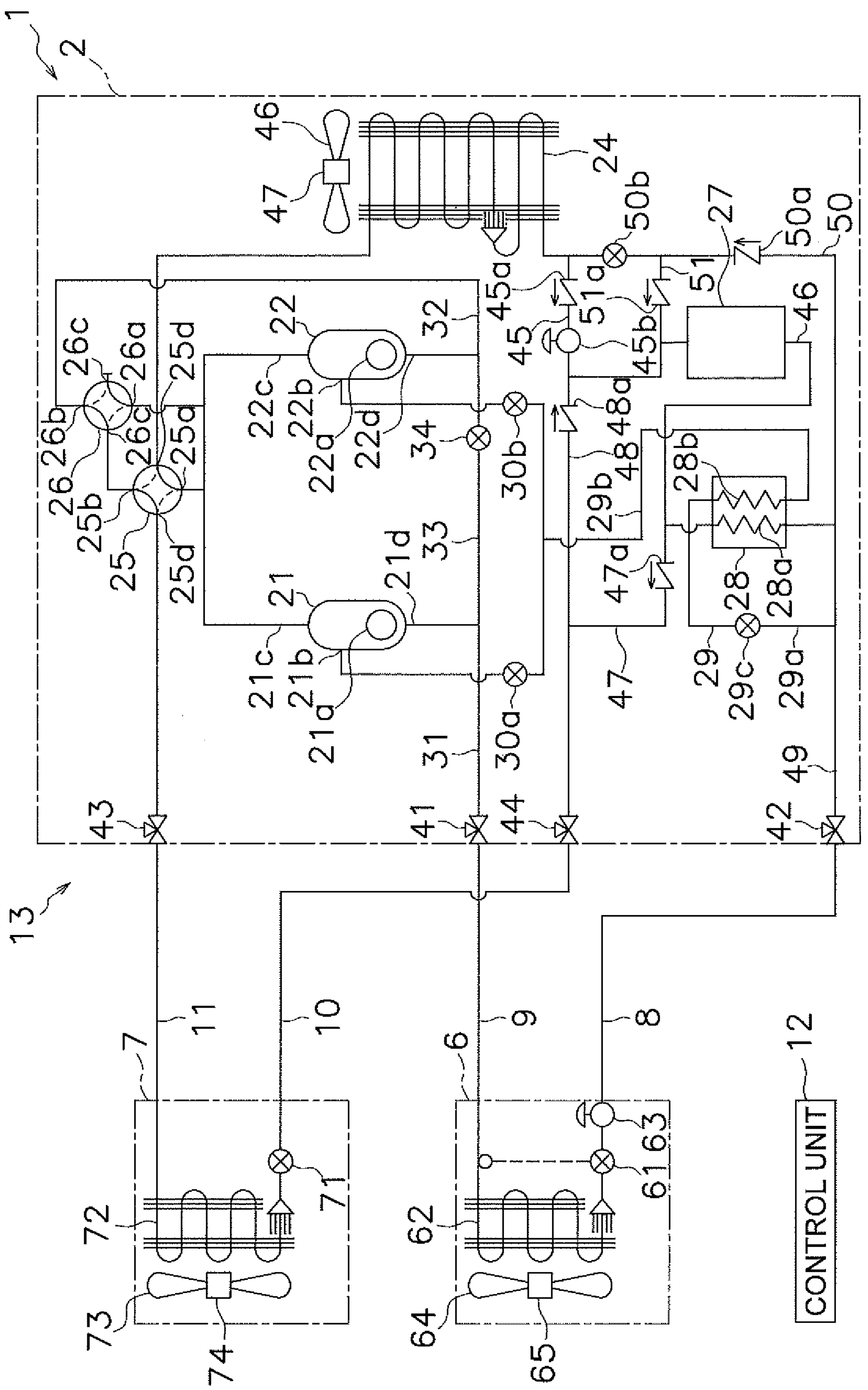
CONTROL UNIT
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FIG. 1

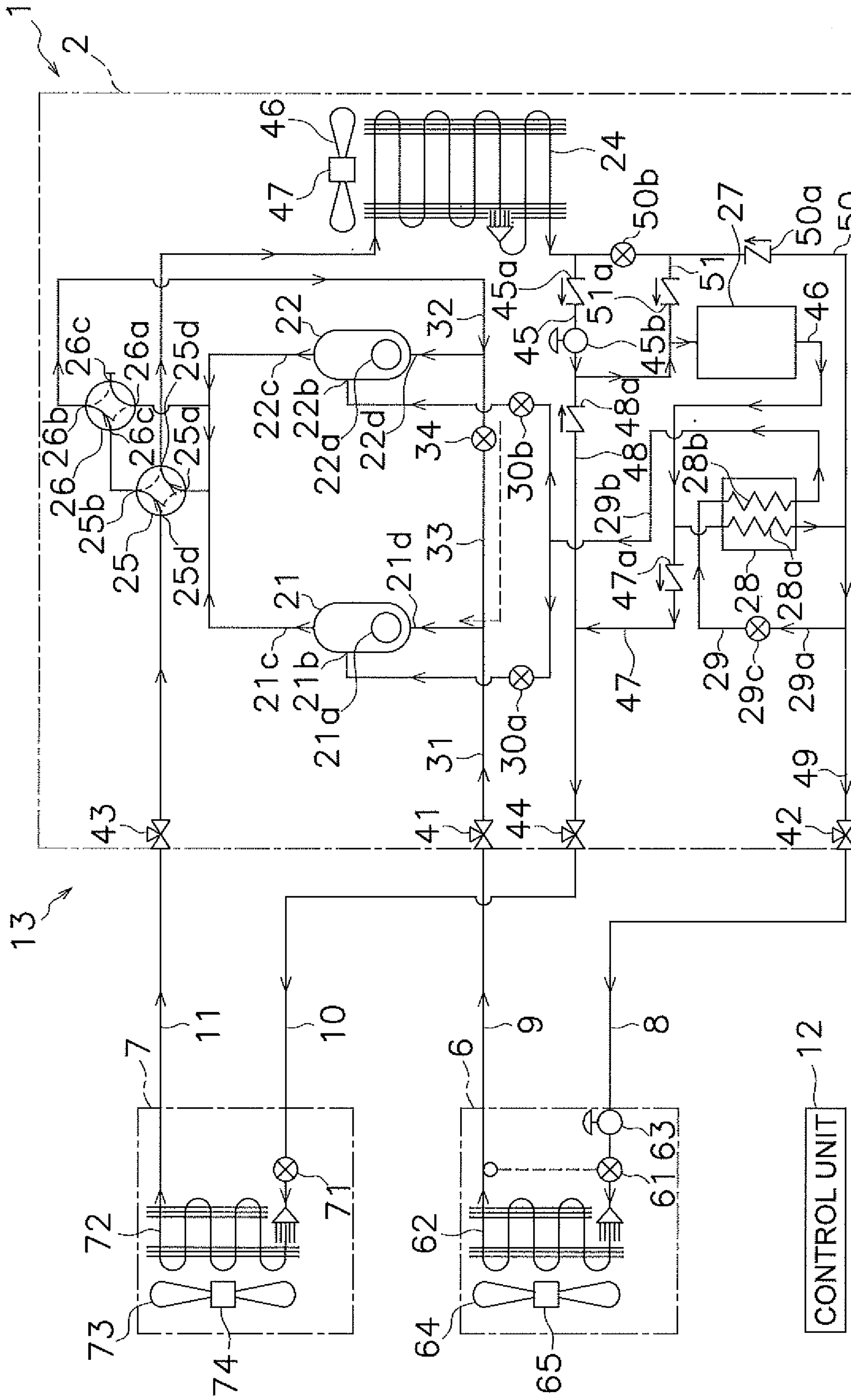


FIG. 2

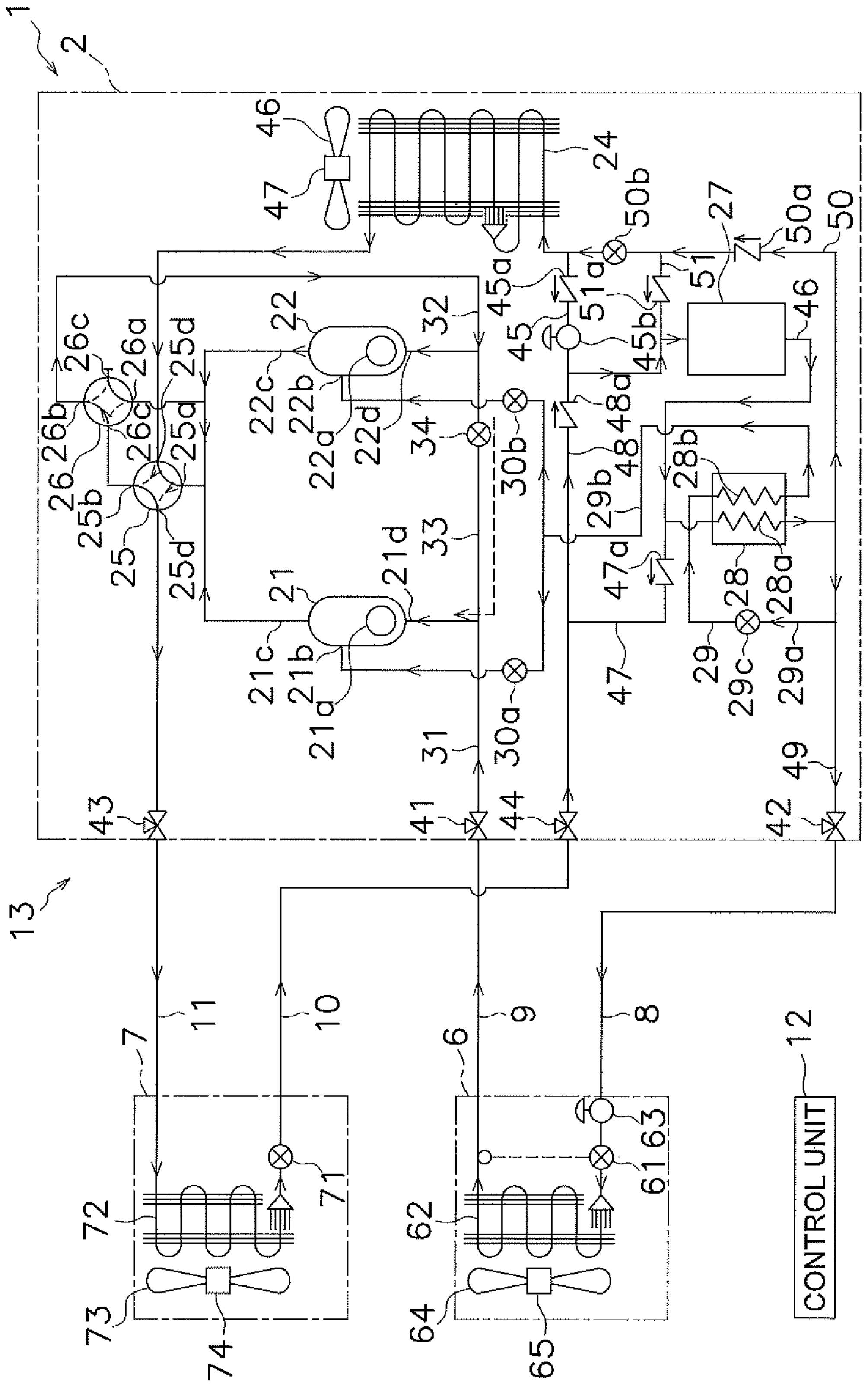


FIG. 3

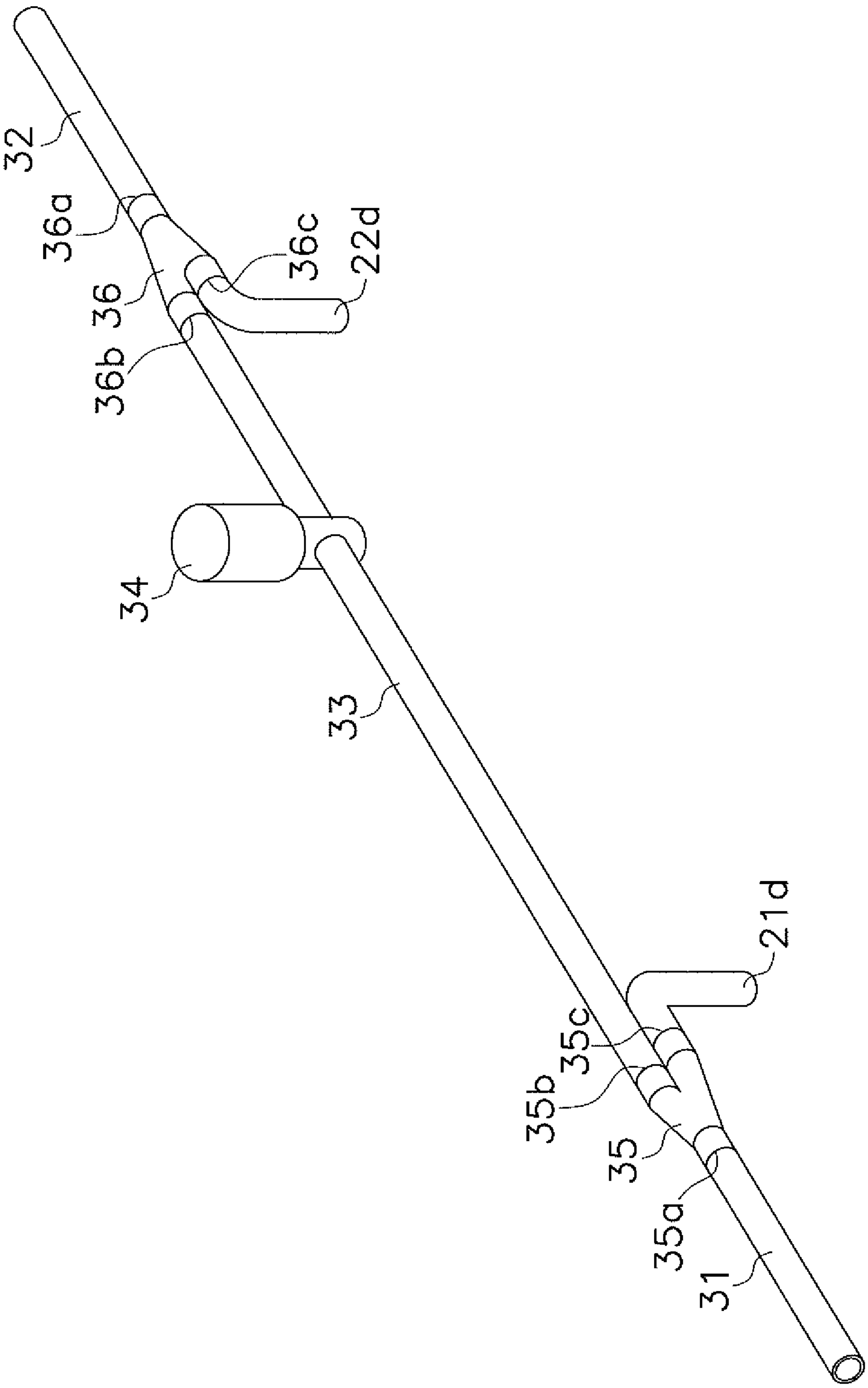
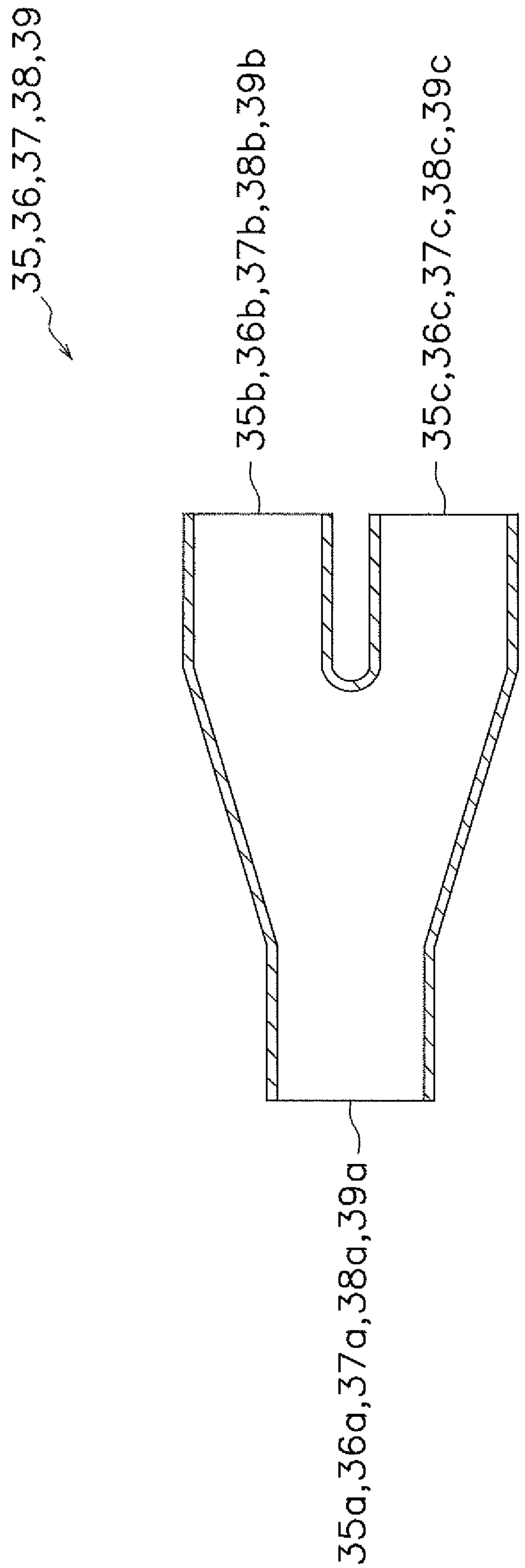


FIG. 4


35,36,37,38,39
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35c,36c,37c,38c,39c
35a,36a,37a,38a,39a

FIG. 5

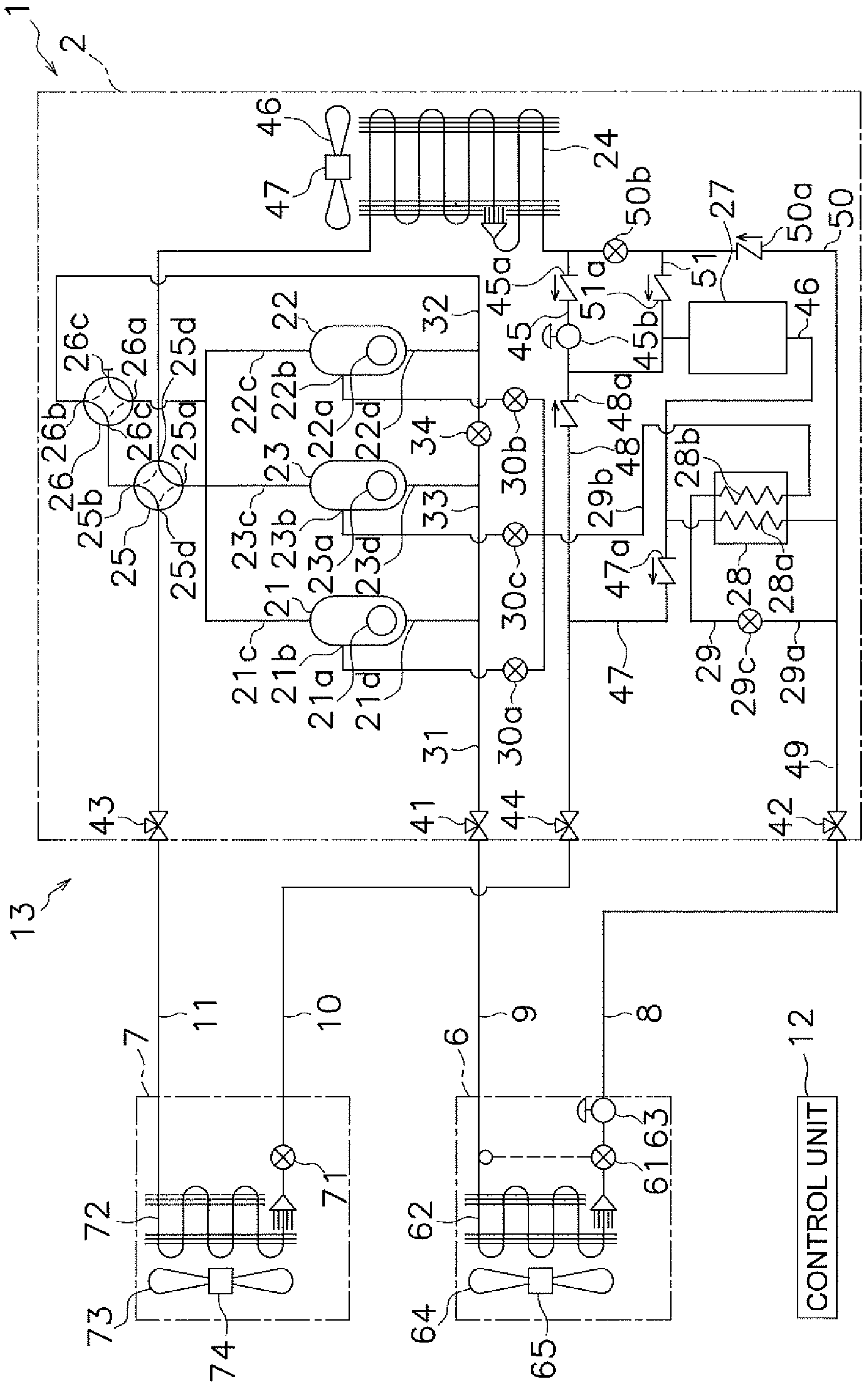


FIG. 6

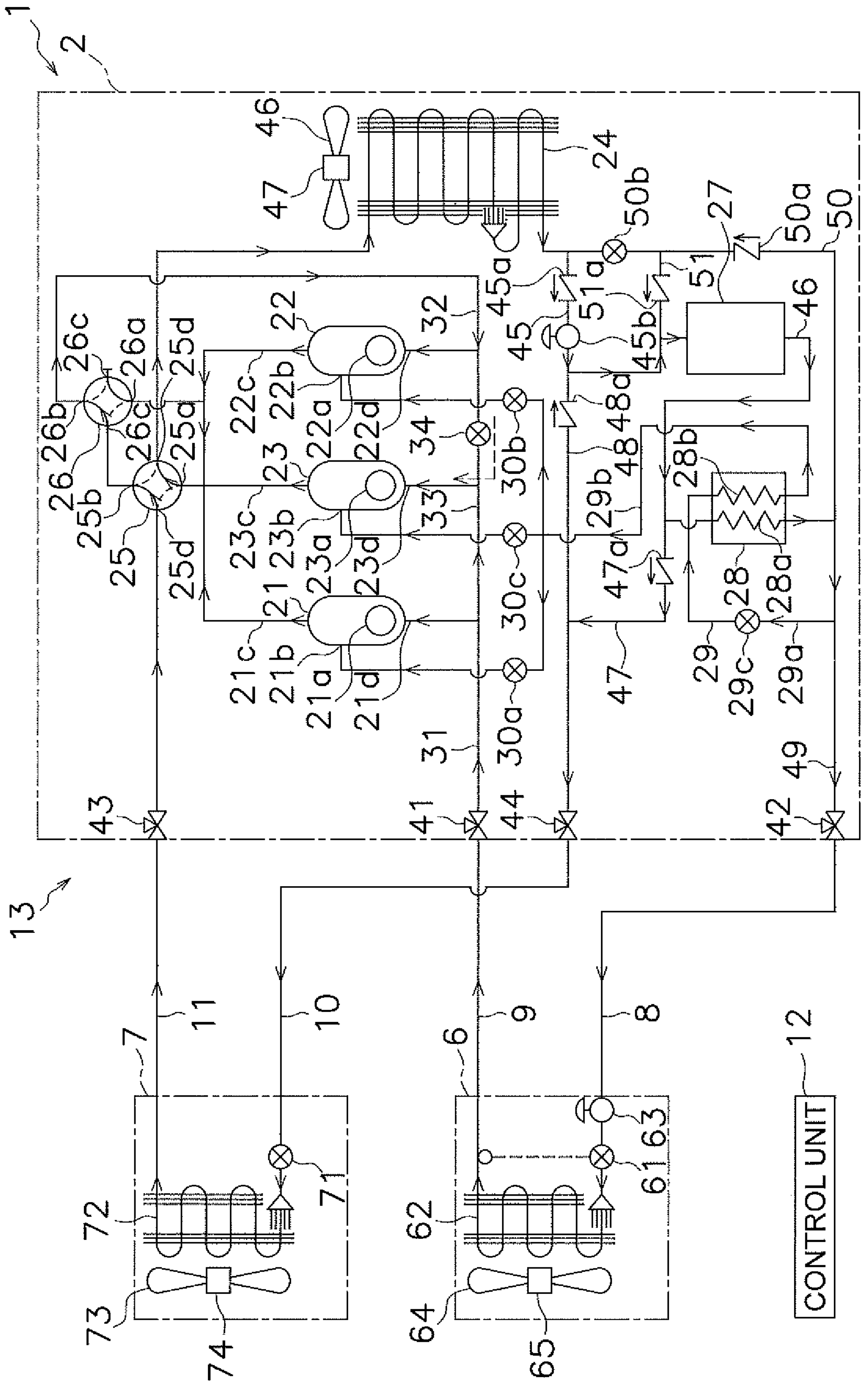


FIG. 7

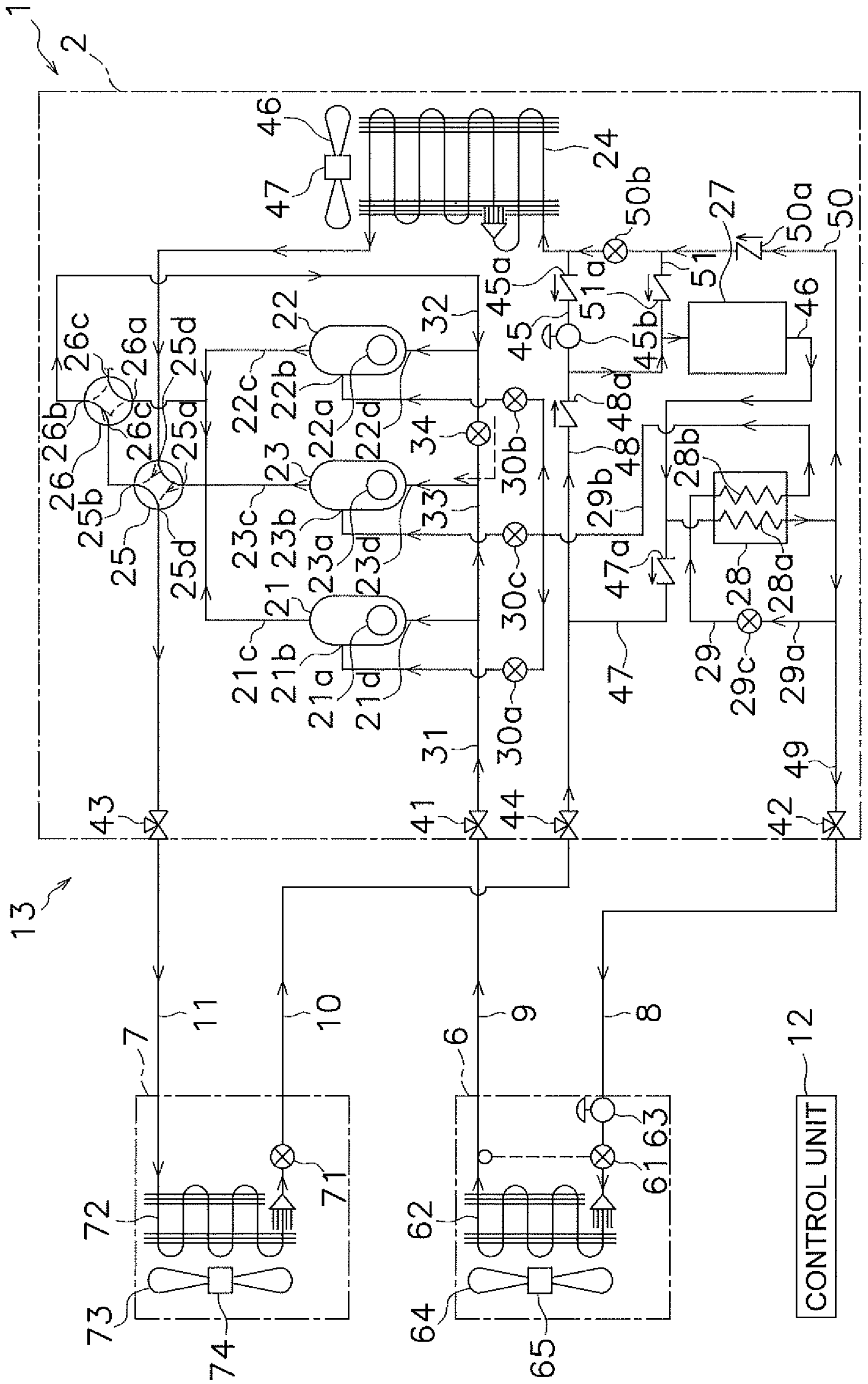
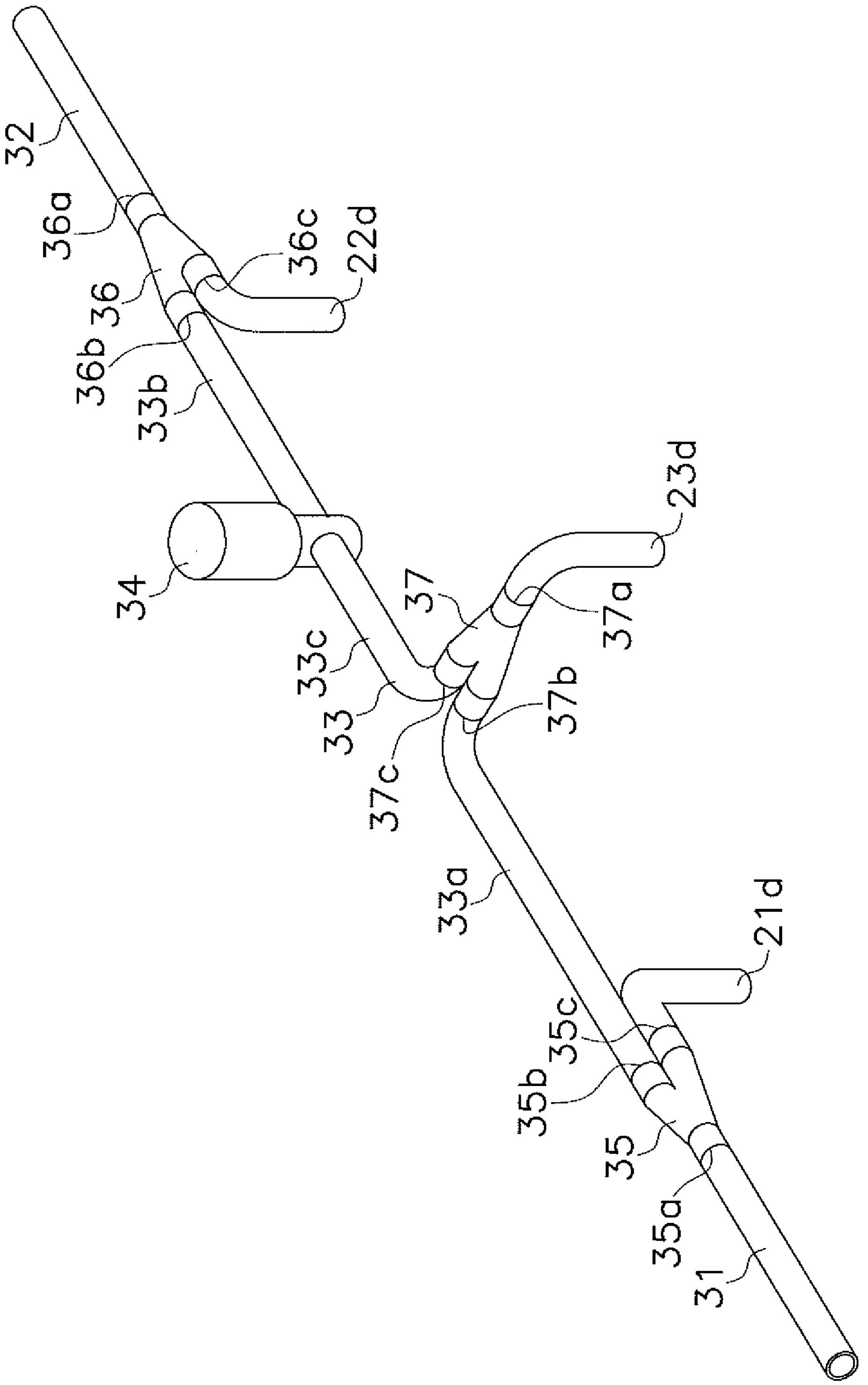


FIG. 8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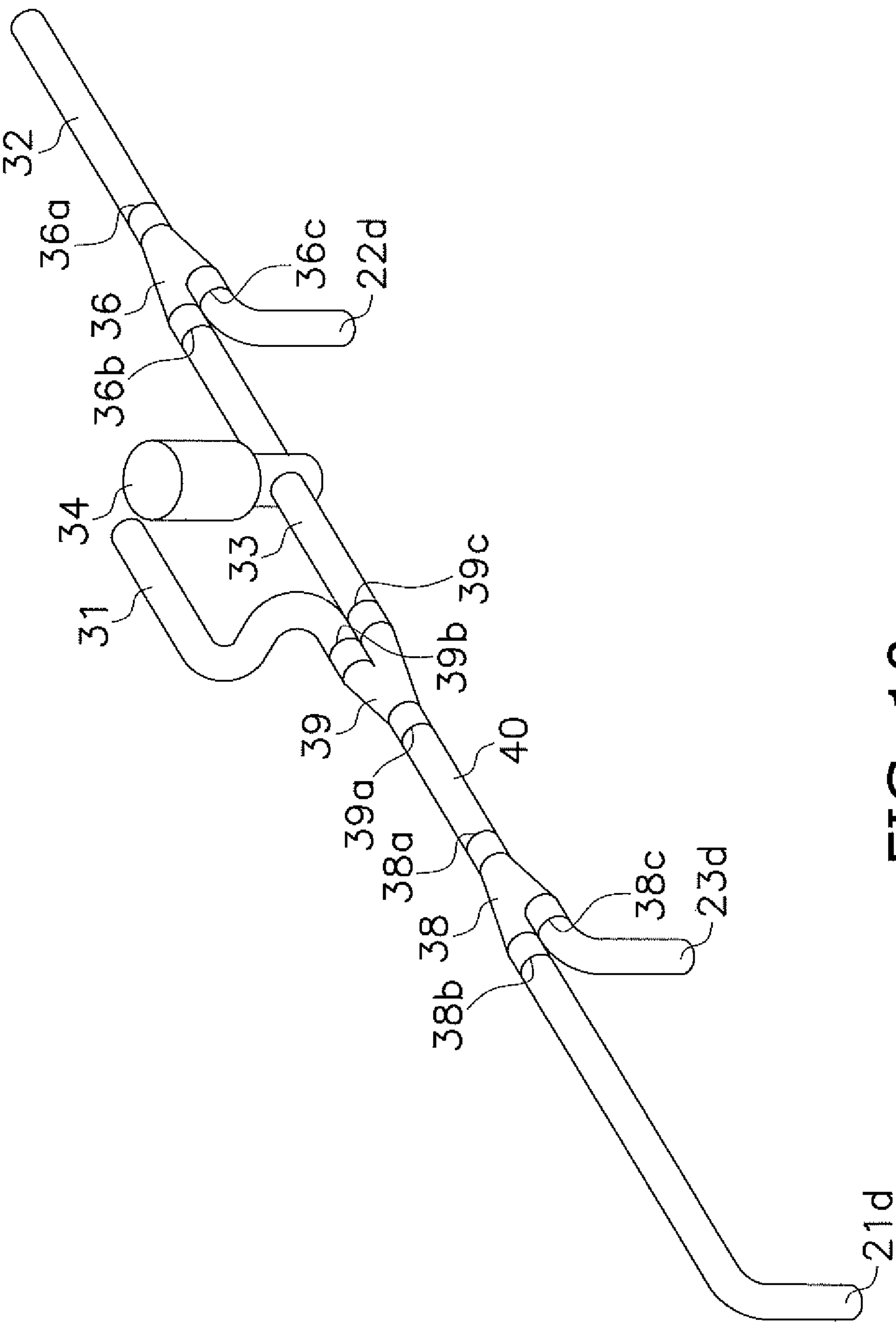
36a
36
36c
22d
36b
33b
34
23d
37
37a
33c
33
37b
37c
33a
21d
35c
35b
35
35a
31

FIG. 9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36a
36
36c
22d
36b
34
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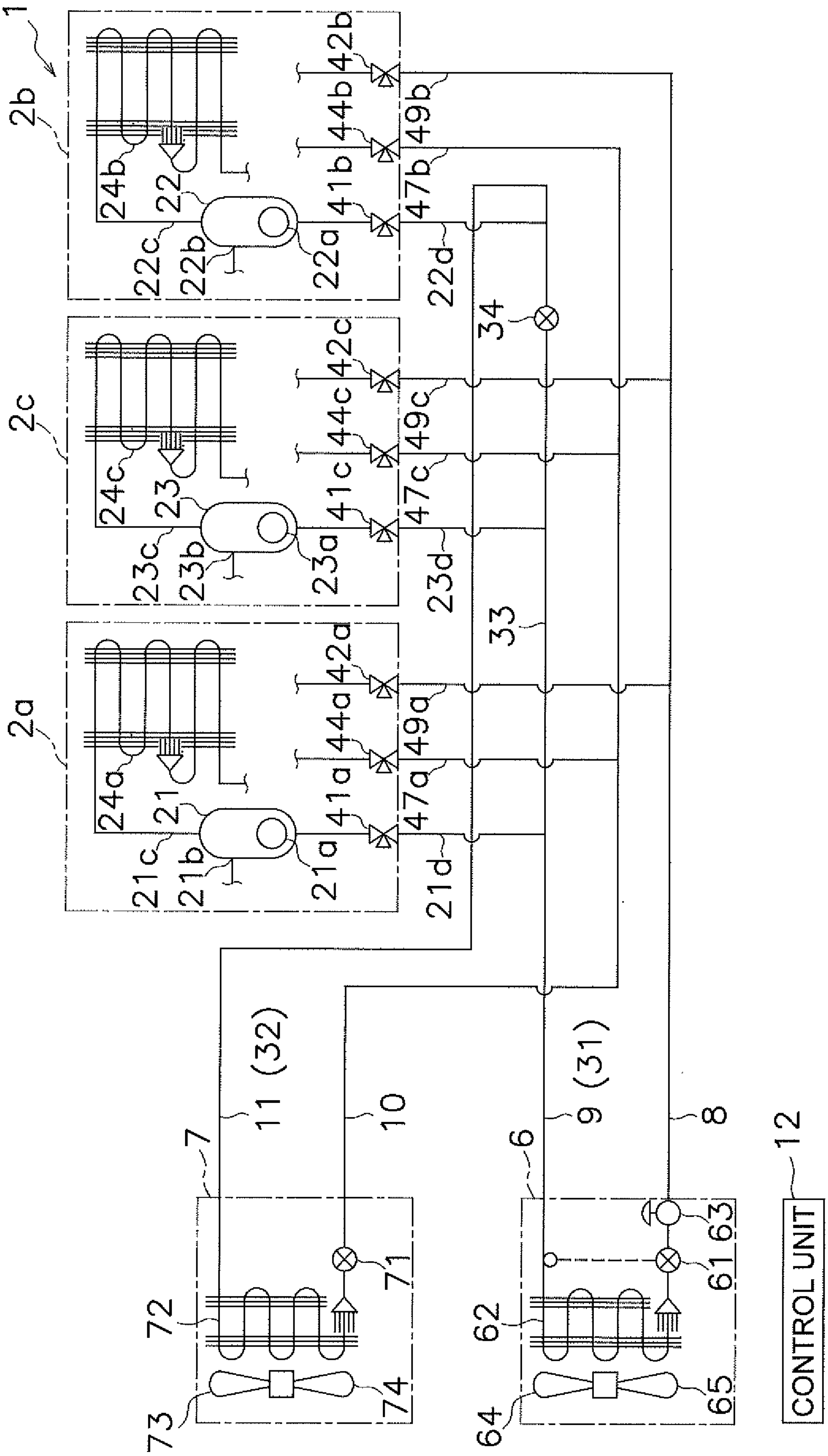
39c
31
39b
39
40
39a
38a
38c
23d
38
38b
21d

FIG. 10


1
2a
2b
2c
21
21a
21b
21c
21d
22
22a
22b
22c
22d
23
23a
23b
23c
23d
24a
24b
24c
33
34
41a
41b
41c
42a
42b
42c
44a
44b
44c
47a
47b
47c
49a
49b
49c
6
7
8
9 (31)
10
11 (32)
12
CONTROL UNIT
61
62
63
64
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71
72
73
74

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/031833

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F25B1/00 (2006. 01)i, F25B5/02 (2006. 01)i, F25B41/00 (2006. 01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. F25B1/00, F25B5/02, F25B41/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Japanese Published Examined Utility Model Applications	1922-1996
Japanese Published Unexamined Utility Model Applications	1971-2017
Japanese Examined Utility Model Registrations	1996-2017
Japanese Registered Utility Model Specifications	1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2014/050099 A1 (DAIKIN INDUSTRIES, LTD.) 03 April 2014, paragraphs [0074]-[0118], [0279]-[0287], fig. 1, 22 & JP 2014-70822 A	1-9
Y	WO 2005/114067 A1 (DAIKIN INDUSTRIES, LTD.) 01 December 2005, paragraphs [0018]-[0024], fig. 4-5 & JP 2005-337524 A & US 2007/0113582 A1, paragraphs [0062]-[0077], fig. 4-5 & EP 1750072 A1 & AU 2005246151 A & KR 10-2006-0122885 A & CN 1910413 A	1-9

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

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"&" document member of the same patent family

Date of the actual completion of the international search
16 November 2017 (16.11.2017)

Date of mailing of the international search report
28 November 2017 (28.11.2017)

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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Patent documents cited in the description

- JP 2014070822 A **[0002] [0125]**