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(54) **REFRIGERATING AIR-CONDITIONING DEVICE**

(57) A refrigerating and air-conditioning apparatus is provided, with which a cold-storage/refrigeration load and air-conditioning loads such as a cooling load and a heating load can be simultaneously processed and a stable heat source can be supplied throughout the year.

In the refrigerating and air-conditioning apparatus 100, heating energy or cooling energy stored in the primary-side refrigerant is usable as an air-conditioning load through the indoor heat exchanger 118 while cooling energy stored in the primary-side refrigerant is transferred to the secondary-side refrigerant circulated in the cold-storage/refrigeration refrigeration cycle 2 through the first refrigerant-refrigerant heat exchanger 131 so as to be usable as a cold-storage/refrigeration load.

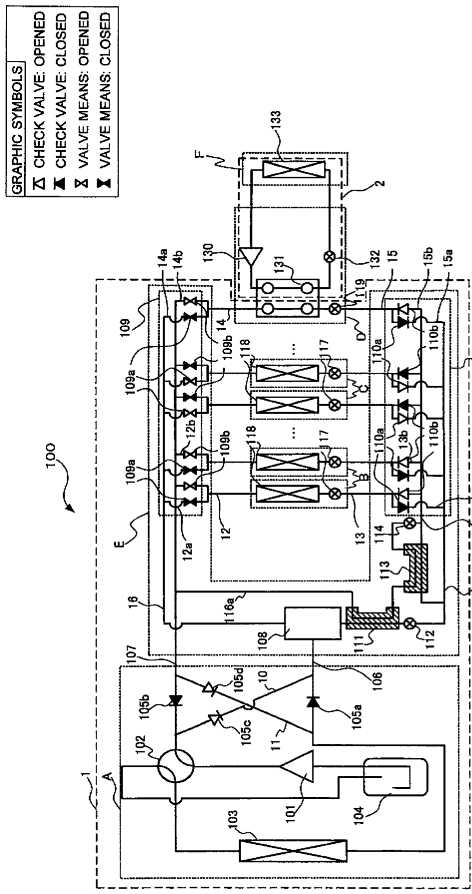


FIG. 1

EP 2 584 285 A1

Description

Technical Field

[0001] The present invention relates to a refrigerating and air-conditioning apparatus integrating an air-conditioning apparatus and a refrigeration apparatus and including a heat pump cycle, and in particular, relates to a refrigerating and air-conditioning apparatus that is devised to achieve stable supply of heat source throughout the year.

Background Art

[0002] To date, there have been proposed refrigerating and air-conditioning apparatuses integrating an air-conditioning apparatus and a refrigeration apparatus together using a cascade heat exchanger, and with which a cooling load, a heating load, and a hot-water load are simultaneously supplied with a binary refrigeration cycle.

[0003] As such an air-conditioning apparatus, the following air-conditioning and refrigeration apparatus has been proposed: "An air-conditioning and refrigeration apparatus comprising an air-conditioning system unit including an air-conditioning compressor, a heat-source side heat exchanger, and a use-side heat exchanger in which the an air-conditioned room is air-conditioned by the use-side heat exchanger; a cooling system unit including a cooling compressor, a condenser, and an evaporator in which a cooling and storing facility located in the air-conditioned room is cooled by the evaporator; and a cascade heat exchanger in which an air-conditioning refrigerant on a low-pressure side of the air-conditioning system unit and a cooling refrigerant on a high-pressure side of the refrigeration system unit is supplied to the cascade heat exchanger so as to cause the air-conditioning refrigerant to supercool the cooling refrigerant. The air-conditioning system unit includes remote control means that issues instructions including start/stop instructions, wherein, the air-conditioning and refrigeration apparatus includes prohibiting means that prohibits, when the cooling compressor of the cooling system unit is operated, at least instructions other than the operating/stopping instructions out of the instructions issued from the remote control means" (see, for example, Patent Literature 1).

[0004] As such an air-conditioning apparatus, the following air-conditioning and refrigeration apparatus has also been proposed. That is, "A refrigeration system comprising an air-conditioning refrigerant circuit formed of a compressor, a heat-source side heat exchanger, a pressure reducing device, and a use-side heat exchanger; a cooling and storing facility refrigerant circuit formed of a compressor, a condenser, a pressure reducing device, and an evaporator; and a cascade heat exchanger and a supercooling heat exchanger that cause heat to be exchanged between a low-pressure side of the air-conditioning refrigerant circuit and a high-pressure side of the cooling and storing facility refrigerant circuit, wherein, when a heating operation of the air-conditioning refrigerant circuit is performed, the high-pressure side refrigerant of the cooling and storing facility refrigerant circuit is caused to flow into the supercooling heat exchanger through the cascade heat exchanger and the condenser (see, for example, Patent Literature 2).

Citation List

Patent Literature

[0005] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2005-249241 (pages 4-5, Fig. 1, etc.)

Patent Literature 2: Japanese Unexamined Patent Application Publication No. 2001-100986 (pages 4-5, Fig. 1, etc.)

Summary of Invention

Technical Problem

[0006] In the refrigerating and air-conditioning apparatuses described in the above-cited Patent Literature 1 and Patent Literature 2, most of the compressors and other components of the air-conditioning circuit and the cold-storage/refrigeration circuit are included in a single heat source unit. Thus, it has not been possible to select a heat source unit in accordance with each varying ratio of an air-conditioning load to a cold-storage/refrigeration load. Furthermore, since the heat source unit needs to be connected to all the load-side units by pipes, the amount of pipes used and the amount of refrigerant are increased, resulting in an increase in the installation cost.

[0007] The present invention has been made for solving the above-described problem. An object of the present invention is to provide a refrigerating and air-conditioning apparatus that is capable of simultaneously processing an air-conditioning load, such as a cooling load and a heating load, and a cold-storage/refrigeration load and that is capable of supplying a stable heat source throughout the year.

Solution to Problem

[0008] A refrigerating and air-conditioning apparatus according to the present invention includes an air-conditioning refrigeration cycle formed by serially connecting an air-conditioning compressor, a heat-source side heat exchanger, first expansion means, and a use-side heat exchanger, and by serially connecting the air-conditioning compressor, the heat-source side heat exchanger, second expansion means, and a primary side of a first refrigerant-refrigerant heat exchanger. The air-conditioning refrigeration cycle causes a primary-side refrigerant to be circulated therein. The refrigerating and air-conditioning apparatus also includes a cold-storage/refrigeration refrigeration cycle formed by serially connecting a refrigeration compressor, a secondary side of the first refrigerant-refrigerant heat exchanger, third expansion means, and a refrigeration heat exchanger. The cold-storage/refrigeration refrigeration cycle causes a secondary-side refrigerant to be circulated therein. In the refrigerating and air-conditioning apparatus, heating energy or cooling energy stored in the primary-side refrigerant is usable as an air-conditioning load through the use-side heat exchanger while cooling energy stored in the primary-side refrigerant is transferred to the secondary-side refrigerant so as to be usable as a cold-storage/refrigeration load.

Advantageous Effects of Invention

[0009] With a refrigerating and air-conditioning apparatus according to the present invention, an air-conditioning load and a cold-storage/refrigeration load can be simultaneously processed, and a stable heat source can be supplied throughout the year.

Brief Description of Drawings

[0010]

[Fig. 1] Fig. 1 is a refrigerant circuit diagram illustrating an example of a refrigerant circuit configuration of a refrigerating and air-conditioning apparatus according to Embodiment 1 of the present invention.
[Fig. 2] Fig. 2 is a refrigerant circuit diagram illustrating flows of refrigerants in a cooling main operation of a refrigerating and air-conditioning apparatus according to Embodiment 1 of the present invention.
[Fig. 3] Fig. 3 is a refrigerant circuit diagram illustrating an example of a refrigerant circuit configuration of a refrigerating and air-conditioning apparatus according to Embodiment 2 of the present invention.
[Fig. 4] Fig. 4 is a refrigerant circuit diagram illustrating an example of a refrigerant circuit configuration of a refrigerating and air-conditioning apparatus according to Embodiment 3 of the present invention.
[Fig. 5] Fig. 5 is a refrigerant circuit diagram illustrating an example of a refrigerant circuit configuration of a refrigerating and air-conditioning apparatus according to Embodiment 4 of the present invention.

Description of Embodiments

[0011] Embodiments of the present invention will be described below with reference to the drawings.

Embodiment 1

[0012] Fig. 1 is a refrigerant circuit diagram illustrating an example of a refrigerant circuit configuration of a refrigerating and air-conditioning apparatus 100 according to Embodiment 1 of the present invention. The refrigerant circuit configuration and operation of the refrigerating and air-conditioning apparatus 100 are described with reference to Fig. 1. The refrigerating and air-conditioning apparatus 100 recovers heat during simultaneous cooling and heating operation. The refrigerating and air-conditioning apparatus 100 is installed in an office building, an apartment, a hotel, or the like. The refrigerating and air-conditioning apparatus 100 uses refrigeration cycles, in which refrigerants are circulated, so as to permit an air conditioning load and a cold-storage/refrigeration load to be simultaneously supplied. In the following drawings including Fig. 1, the relationships among the sizes of components may differ from the actual relationships among the sizes of the components. Also in Fig. 1, flows of refrigerants in a heating main operation performed by the refrigerating and air-conditioning apparatus 100 are illustrated.

[0013] The refrigerating and air-conditioning apparatus 100 according to Embodiment 1 has at least an air-conditioning refrigeration cycle 1 and a cold-storage/refrigeration refrigeration cycle 2. The air-conditioning refrigeration cycle 1 and the cold-storage/refrigeration refrigeration cycle 2 are configured such that, a refrigerant-refrigerant heat exchanger 131 exchanges heat between a refrigerant of the air-conditioning refrigeration cycle 1 and a refrigerant of the cold-storage/refrigeration refrigeration cycle 2 without the refrigerants being mixed together. The refrigerant circulated in the air-conditioning refrigeration cycle 1 is referred to as a primary-side refrigerant, and the refrigerant circulated in the cold-storage/refrigeration refrigeration cycle 2 is referred to as a secondary-side refrigerant. Regarding the term cold-storage/refrigeration, the term means cold storage and/or refrigeration.

[Air-conditioning Refrigeration Cycle 1]

[0014] The air-conditioning refrigeration cycle 1 includes a heat source unit A, indoor units B (referred to as cooling indoor units B hereafter) that bears, for example, a cooling load, indoor units C (referred to as heating indoor units C hereafter) that bears, for example, a heating load, a cold-storage/refrigeration booster unit D (in particular, a primary side of the refrigerant-refrigerant heat exchanger 131) that serves as a heat source for the cold-storage/refrigeration refrigeration cycle 2, and a relay unit E. Although the indoor units B are described as cooling indoor units and the indoor units C are described as heating indoor units, these are only examples of the functions of the indoor units B and the indoor units C. Alternatively, the indoor units B may bear the heating load and the indoor units C may bear the cooling load. Note that when simply referred to as "indoor units", both indoor units B and indoor units C are included

[0015] As illustrated in Fig. 1, the cooling indoor units B, the heating indoor units C, and the air-conditioning refrigeration cycle 1 side of the cold-storage/refrigeration booster unit D are connected in parallel to the heat source unit A through the relay unit E. The relay unit E is disposed between the heat source unit A and the cooling indoor units B, the heating indoor units C, and the air-conditioning refrigeration cycle 1 side of the cold-storage/refrigeration booster unit D. The relay unit E switches the flow of the primary-side refrigerant, thereby allowing the cooling indoor units B, heating indoor units C, and the cold-storage/refrigeration booster unit D to perform their respective functions. The air-conditioning refrigeration cycle 1 side of the cold-storage/refrigeration booster unit D is referred to as a primary side of the cold-storage/refrigeration booster unit D, and the cold-storage/refrigeration refrigeration cycle 2 side of the cold-storage/refrigeration booster unit D is referred to as a secondary side of the cold-storage/refrigeration booster unit D.

{Heat Source Unit A}

[0016] The heat source unit A supplies heating energy or cooling energy to the cooling indoor units B, the heating indoor units C, and the primary side of the cold-storage/refrigeration booster unit D through the relay unit E. An air-conditioning compressor 101, a four-way valve 102 serving as a flow switching means, an outdoor heat exchanger (a heat-source side heat exchanger) 103, and an accumulator 104 are connected in series by pipes and are disposed in the heat source unit A. In the heat source unit A, it is desirable that a fan or other air-sending devices, which supplies air to the outdoor heat exchanger 103, be provided at a position close to the outdoor heat exchanger 103.

[0017] The air-conditioning compressor 101 suctions and compresses the primary-side refrigerant so as to cause the primary-side refrigerant to enter a high-temperature high-pressure state. The four-way valve 102 switches the flow of the primary-side refrigerant. The outdoor heat exchanger 103, which functions as an evaporator or a radiator (condenser), causes heat to be exchanged between air supplied from the air-sending device (not shown) and the primary-side refrigerant, thereby evaporating and gasifying the primary-side refrigerant or condensing and liquefying the primary-side refrigerant. The accumulator 104 is disposed on a suction side of the air-conditioning compressor 101 and stores the excessive primary-side refrigerant. It is sufficient that the accumulator 104 be a container in which the excessive primary-side refrigerant can be stored.

[0018] The heat source unit A includes a check valve 105a that allows the primary-side refrigerant in a high-pressure side connection pipe 106 between the outdoor heat exchanger 103 and the relay unit E to flow only in a fixed direction (a direction from the heat source unit A to the relay unit E) and a check valve 105b that allows the primary-side refrigerant in a low-pressure side connection pipe 107 between the four-way valve 102 and the relay unit E to flow only in a fixed direction (a direction from the relay unit E to the heat source unit A).

[0019] The high-pressure side connection pipe 106 and the low-pressure side connection pipe 107 are connected to each other by a first connection pipe 10, which connects a downstream side of the check valve 105a to a downstream side of the check valve 105b, and a second connection pipe 11, which an upstream side of the check valve 105a to an upstream side of the check valve 105b. The first connection pipe 10 is provided with a check valve 105c, which allows the primary-side refrigerant to flow only in a direction from the low-pressure side connection pipe 107 to the high-pressure side connection pipe 106. Also, the second connection pipe 11 is provided with a check valve 105d, which allows the primary-side refrigerant to flow only in a direction from the low-pressure side connection pipe 107 to the high-pressure side connection pipe 106.

[Indoor Unit]

[0020] The indoor units receive cooling energy or heating energy supplied from the heat source unit A to cover the cooling load or the heating load. An air-conditioning expansion means 117 and an indoor heat exchanger (use-side heat exchanger) 118 are connected in series and disposed in each indoor unit. In Fig. 1, an example is illustrated in which two cooling indoor units B and two heating indoor units C are connected. In the indoor units, it is desirable that fans or other air-sending devices, which supply air to the indoor heat exchangers 118, be provided at positions close to the indoor heat exchangers 118. For convenience of description, pipes that connect the relay unit E to the indoor heat exchangers 118 are referred to as connection pipes 12, and pipes that connect the relay unit E to the air-conditioning expansion means 117 are referred to as connection pipes 13.

[0021] The air-conditioning expansion means 117, which have functions of pressure reducing valves and expansion valves, reduce the pressure of the primary-side refrigerant and expand the primary-side refrigerant. It is desirable that the air-conditioning expansion means 117 include means that can variably control its opening degrees, for example, precision flow rate control means using electronic expansion valves, or inexpensive refrigerant flow rate regulating means such as capillary tubes. The indoor heat exchangers 118 function as radiators (condensers) or evaporators, cause heat to be exchanged between air supplied from the air-sending device (not shown) and the primary-side refrigerant, thereby condensing and liquefying the primary-side refrigerant or evaporating and gasifying the primary-side refrigerant.

{Cold-storage/refrigeration Booster Unit D}

[0022] The cold-storage/refrigeration booster unit D has a function of transferring cooling energy from the heat source unit A to the cold-storage/refrigeration refrigeration cycle 2 through the refrigerant-refrigerant heat exchanger 131. An expansion means 119 and the refrigerant-refrigerant heat exchanger 131 are connected in series on the primary side of the cold-storage/refrigeration booster unit D. The air-conditioning refrigeration cycle 1 and the cold-storage/refrigeration refrigeration cycle 2 are connected to each other in a cascade manner with the refrigerant-refrigerant heat exchanger 131. That is, the refrigerant-refrigerant heat exchanger 131 causes heat to be exchanged between the primary-side refrigerant and the secondary-side refrigerant.

[0023] As is the case with the air-conditioning expansion means 117, the expansion means 119, which has the functions of a pressure reducing valve and an expansion valve, reduces the pressure of the primary-side refrigerant and expands the primary-side refrigerant. It is desirable that the expansion means 119 include means that can variably control its opening degree, for example, a precision flow rate control means using an electronic expansion valve, or an inexpensive refrigerant flow rate regulating means such as a capillary tube. The refrigerant-refrigerant heat exchanger 131, which functions as a radiator (condenser) and an evaporator, causes heat to be exchanged between the secondary-side refrigerant circulated in the cold-storage/refrigeration refrigeration cycle 2 and the primary-side refrigerant circulated in the air-conditioning refrigeration cycle 1. For convenience of description, a pipe that connects the relay unit E to the refrigerant-refrigerant heat exchanger 131 is referred to as a connection pipe 14, and a connection pipe that connects the relay unit E to the expansion means 119 is referred to as a connection pipe 15.

[0024] {Relay Unit E}

The relay unit E connects the heat source unit A to use-side units (indoor units B, indoor units C, and cold-storage/refrigeration booster unit D) and alternatively opens or closes either of a valve means 109a and a valve means 109b of a first distribution section 109, thereby determining whether the indoor heat exchangers 118 are used as radiators or evaporators and whether the refrigerant-refrigerant heat exchanger 131 is used as a water cooling device or a water heating device. The relay unit E includes at least a gas-liquid separator 108, the first distribution section 109, a second distribution section 110, a first internal heat exchanger 111, a first relay unit expansion means 112, a second internal heat exchanger 113, and a second relay unit expansion means 114.

[0025] In the first distribution section 109, connection pipes 12 and connection pipe 14 are each branched into two pipes. One of the branched pipes (each of the connection pipes 12b and the connection pipe 14b) is connected to the low-pressure side connection pipe 107 and the other one of the branched pipes (each of the connection pipes 12a and the connection pipe 14a) is connected to a connection pipe (referred to as a connection pipe 16) that is connected to the gas-liquid separator 108. The valve means 109a, which are controlled to open or close so as to allow or not allow the refrigerant to be directed therethrough, are provided in the connection pipes 12a and the connection pipe 14a. The valve means 109b, which are controlled to open or close so as to allow or not allow the refrigerant to be directed therethrough, are provided in the connection pipes 12b and the connection pipe 14b.

[0026] In the second distribution section 110, connection pipes 13 and the connection pipe 15 are each branched into two pipes. One of the branched pipes (each of the connection pipes 13a and the connection pipes 15a) are connected to one another in a first combining section 115 and the other one of the branched pipes (each of the connection pipes 13b and the connection pipes 15b) are connected to one another in a second combining section 116. Also in the second distribution section 110, check valves 110a, which allow the refrigerant to flow therethrough only in a single direction, are provided in the connection pipes 13a and the connection pipe 15a, and check valves 110b, which allow the refrigerant to flow therethrough only in a single direction, are provided in the connection pipes 13b and the connection pipe 15b. Instead of the check valves 110a and 110b, valve means such as solenoid valves may be used. By doing this, passages in the second distribution section 110 can be reliably switched.

[0027] The first combining section 115 connects the second distribution section 110 to the gas-liquid separator 108 through the first relay unit expansion means 112 and the first internal heat exchanger 111. The second combining section 116 branches at a position between the second distribution section 110 and the second internal heat exchanger 113. One of the branched second combining section 116 is connected to the first combining section 115 at a position between the second distribution section 110 and the first relay unit expansion means 112 through the second internal heat exchanger 113. The other one of the branched second combining section 116 (a second combining section 116a) is connected to the low-pressure side connection pipe 107 through the second relay unit expansion means 114, the second internal heat exchanger 113, and the first internal heat exchanger 111.

[0028] The gas-liquid separator 108 separates the refrigerant into a gas refrigerant and a liquid refrigerant. The gas-liquid separator 108 is provided in the high-pressure side connection pipe 106. One end of the gas-liquid separator 108 is connected to the valve means 109a of the first distribution section 109 and another end of the gas-liquid separator 108 is connected to the second distribution section 110 th rough the first combining section 115. The first distribution section 109 alternatively opens or closes either of the valve means 109a and the valve means 109b, thereby causing the refrigerant to flow into or flow out of the indoor heat exchangers 118 and the refrigerant-refrigerant heat exchanger 131. The second distribution section 110 uses the check valves 110a and the check valves 110b so as to allow the refrigerant to flow through either of the check valves 110a and the check valves 110b.

[0029] The first internal heat exchanger 111 is provided in the first combining section 115 between the gas-liquid separator 108 and the first relay unit expansion means 112. The first internal heat exchanger 111 causes heat to be exchanged between the refrigerant directed through the first combining section 115 and the refrigerant directed through the second combining section 116a, which is branched from the second combining section 116. The first relay unit expansion means 112 is provided in the first combining section 115 between the first internal heat exchanger 111 and the second distribution section 110. The first relay unit expansion means 112 reduces the pressure of the refrigerant and expands the refrigerant. It is desirable that the first relay unit expansion means 112 include a means such as a means that can variably control an opening degree, for example, a precision flow rate control means using an electronic expansion valve, or an inexpensive refrigerant flow rate regulating means such as a capillary tube.

[0030] The second internal heat exchanger 113 is provided in the second combining section 116. The second internal heat exchanger 113 causes heat to be exchanged between the refrigerant directed through the second combining section 116 and the refrigerant directed through the second combining section 116a branched from the second combining section 116. The second relay unit expansion means 114 is provided in the second combining section 116 between the second internal heat exchanger 113 and the second distribution section 110. The second relay unit expansion means 114, which functions as a pressure reducing valve and an expansion valve, reduces the pressure of the refrigerant and expands the refrigerant. As is the case with the first relay unit expansion means 112, it is desirable that the second relay unit expansion means 114 include means that can variably control an opening degree, for example, a precision flow rate control means using an electronic expansion valve, or an inexpensive refrigerant flow rate regulating means such as a capillary tube.

[0031] As described above, the air-conditioning refrigeration cycle 1 is established by serially connecting the air-conditioning compressor 101, the four-way valve 102, the indoor heat exchangers 118, the air-conditioning expansion means 117, the outdoor heat exchanger 103, and the accumulator 104; by serially connecting the air-conditioning compressor 101, the four-way valve 102, the refrigerant-refrigerant heat exchanger 131, the expansion means 119, the outdoor heat exchanger 103, and the accumulator 104; by parallelly connecting the indoor heat exchangers 118 and the refrigerant-refrigerant heat exchanger 131 through the relay unit E; and by circulating the refrigerant through these components.

[0032] The air-conditioning compressor 101 may be any that is capable of compressing the suctioned refrigerant into a high-pressure state, and is not limited to a specific type of compressor. For example, the air-conditioning compressor 101 may use one of a variety of compressors such as reciprocating, rotary, scroll, and screw compressors. The rotation speed of the air-conditioning compressor 101 may be variably controllable by an inverter or may be fixed.

[0033] The type of refrigerant circulated in the air-conditioning refrigeration cycle 1 is not particularly limited. The refrigerant, for example, may be any one of the following: a natural refrigerant such as carbon dioxide (CO_2), hydrocarbon, or helium, an alternative refrigerant without chlorine such as HFC410A, HFC407C, or HFC404A, and a fluorocarbon refrigerant used in existing products such as R22 or R134a.

[0034] Here, with reference to Fig. 1, the flow of the primary-side refrigerant in the air-conditioning refrigeration cycle 1 during the heating main operation performed by the refrigerating and air-conditioning apparatus 100 is described. The refrigerating and air-conditioning apparatus 100 has a cooling only operation mode, in which all the indoor units perform cooling operation; a heating only operation mode, in which all the indoor units perform heating operation; a cooling main operation mode (see Fig. 2), in which heating and cooling are performed and the cooling load is greater; and a heating main operation mode, heating and cooling are performed and the heating load is greater. In Fig. 1, the flow of the refrigerant is indicated by opening and closing states (hollow (open state) and solid (closed state)) of the check valves and the valve means.

[0035] The primary-side refrigerant, the state of which has been turned into a high-temperature high-pressure gas by the air-conditioning compressor 101, is discharged from the air-conditioning compressor 101, flows through the four-way valve 102, is directed through the check valve 105c, is guided to the high-pressure side connection pipe 106, and flows into the gas-liquid separator 108 of the relay unit E in a superheated gas state. The primary-side refrigerant in a superheated gas state having flowed into the gas-liquid separator 108 flows through the connection pipe 16 and is distributed to circuits where the valve means 109a of the first distribution section 109 are open, that is, to the heating indoor units C. The primary-side refrigerant having flowed into the heating indoor units C transfers heat in the indoor heat exchangers 118 (that is, heats the indoor air). Then the pressure of the primary-side refrigerant is reduced by the air-conditioning expansion means 117, and the flows of the primary-side refrigerant are merged with each other in the first combining section 115.

[0036] Meanwhile, part of the primary-side refrigerant in a superheated gas state having flowed into the gas-liquid separator 108 exchanges heat in the first internal heat exchanger 111 with the primary-side refrigerant, which has been expanded by the second relay unit expansion means 114 and has a low temperature and a low pressure, thereby becoming to have a degree of supercooling. Then, the part of the primary-side refrigerant passes through the first relay unit expansion means 112 and, in the first combining section 115, is merged with the primary-side refrigerant having been used for air-conditioning (the primary-side refrigerant that has flowed into the heating indoor units C and that has transferred heat in the indoor heat exchangers 118). The part of the primary-side refrigerant in a superheated gas state passing through the first relay unit expansion means 112 may be completely shut off by completely closing the first relay unit expansion means 112.

[0037] After that, the merged primary-side refrigerant exchanges heat in the second internal heat exchanger 113 with the primary-side refrigerant, which has been expanded by the second relay unit expansion means 114 and has a low temperature and a low pressure, thereby becoming to have a degree of supercooling. This primary-side refrigerant is distributed to the second combining section 116 side and the second relay unit expansion means 114 side.

[0038] The primary-side refrigerant directed through the second combining section 116 is distributed to circuits where the valve means 109b are open, that is, to the cooling indoor units B and the primary side of the cold-storage/refrigeration booster unit D. The primary-side refrigerant having flowed into the cooling indoor units B is expanded by the air-conditioning expansion means 117 so as to have a low temperature and a low pressure, evaporates in the indoor heat exchangers 118, and flows into the low-pressure side connection pipe 147 through the valve means 109b. The primary-side refrigerant having flowed into the primary side of the cold-storage/refrigeration booster unit D is expanded by the expansion means 119 so as to have a low temperature and a low pressure, evaporates in the refrigerant-refrigerant heat exchanger 131, and flows into the low-pressure side connection pipe 107 through the valve means 109b.

[0039] The primary-side refrigerant having been directed through the second relay unit expansion means 114 exchanges heat in the second internal heat exchanger 113 and the first internal heat exchanger 111 to evaporate, and is, in the low-pressure side connection pipe 107, merged with the primary-side refrigerant that has flowed out from the cooling indoor units B and the primary side of the cold-storage/refrigeration booster unit D. The primary-side refrigerant having been merged in the low-pressure side connection pipe 107 passes through the check valve 105d, is guided to the outdoor heat exchanger 103, in which the liquid refrigerant that is made to remain depending on the operation condition is made to evaporate, and returns to the air-conditioning compressor 101 through the four-way valve 102 and the accumulator 104.

[Cold-storage/refrigeration Refrigeration Cycle 2]

[0040] The cold-storage/refrigeration refrigeration cycle 2 includes the cold-storage/refrigeration booster unit D (in particular, the secondary side of the refrigerant-refrigerant heat exchanger 131) and a cold-storage/refrigeration unit F. That is, the cold-storage/refrigeration refrigeration cycle 2 includes a refrigeration compressor 130 disposed in the cold-storage/refrigeration booster unit D, the refrigerant-refrigerant heat exchanger 131, refrigeration expansion means 132, and a refrigeration heat exchanger 133 disposed in the cold-storage/refrigeration unit F connected in series by pipes. The cold-storage/refrigeration refrigeration cycle 2 is connected to the air-conditioning refrigeration cycle 1 through the refrigerant-refrigerant heat exchanger 131 disposed in the cold-storage/refrigeration booster unit D.

{Cold-storage/refrigeration Booster Unit D}

[0041] As described above, the cold-storage/refrigeration booster unit D transfers heating energy or cooling energy from the heat source unit A to the cold-storage/refrigeration refrigeration cycle 2 through the refrigerant-refrigerant heat exchanger 131. The refrigeration compressor 130, the secondary side of the refrigerant-refrigerant heat exchanger 131, and the refrigeration expansion means 132 are connected in series on the secondary side of the cold-storage/refrigeration booster unit D.

[0042] The refrigeration compressor 130 suctions and compresses the secondary-side refrigerant so as to cause the secondary-side refrigerant to enter a high-temperature high-pressure state. The rotation speed of the refrigeration compressor 130 may be variably controllable by an inverter or may be fixed. The refrigeration compressor 130 may be any that is capable of compressing the suctioned secondary-side refrigerant into a high-pressure state, and is not limited to a specific type of compressor. For example, the refrigeration compressor 130 may use one of a variety of compressors such as reciprocating, rotary, scroll, and screw compressors.

[0043] As described above, the refrigerant-refrigerant heat exchanger 131 causes heat to be exchanged between the primary-side refrigerant circulated in the air-conditioning refrigeration cycle 1 and the secondary-side refrigerant circulated in the cold-storage/refrigeration refrigeration cycle 2. The refrigeration expansion means 132, which has the functions of a pressure reducing valve and an expansion valve, reduces the pressure of the secondary-side refrigerant and expand the secondary-side refrigerant. It is desirable that the refrigeration expansion means 132 include means that can variably control an opening degree, for example, a precision flow rate control means using an electronic expansion valve, or an inexpensive refrigerant flow rate regulating means such as a capillary tube.

[0044] The type of the secondary-side refrigerant circulated in the cold-storage/refrigeration refrigeration cycle 2 is not particularly limited. The secondary-side refrigerant may be, for example, any one of a natural refrigerant such as carbon dioxide, hydrocarbon, or helium; an alternative refrigerant without chlorine such as HFC410A, HFC407C, or HFC404A; and a fluorocarbon refrigerant used in existing products such as R22 or R134a.

{Coid-storage/refrigeration Unit F}

[0045] The cold-storage/refrigeration unit F receives cooling energy supplied from the cold-storage/refrigeration booster unit D and covers the cold-storage/refrigeration load. The refrigeration heat exchanger 133 is disposed in the cold-storage/refrigeration unit F. The refrigeration heat exchanger 133 is provided between the refrigeration expansion means 132 and the refrigeration compressor 130 of the cold-storage/refrigeration booster unit D, functions as an evaporator, causes heat to be exchanged between air supplied from the air-sending device (not shown) and the secondary-side refrigerant, and evaporates and gasifies the secondary-side refrigerant. In the cold-storage/refrigeration unit F, it is desirable that a fan or other air-sending devices, which supplies air to the refrigeration heat exchanger 133, be provided at a position close to the refrigeration heat exchanger 133.

[0046] Here, the flow of the primary-side refrigerant in the cold-storage/refrigeration refrigeration cycle 2 is described.

A hot-water supply refrigerant, the temperature and pressure of which have been increased by the refrigeration compressor 130, is discharged from the refrigeration compressor 130 and flows into the refrigerant-refrigerant heat exchanger 131. In the refrigerant-refrigerant heat exchanger 131, the secondary-side refrigerant having flowed into the refrigerant-refrigerant heat exchanger 131 is cooled and condensed by the primary side circulated in the air-conditioning refrigeration cycle 1. This secondary-side refrigerant is expanded by the refrigeration expansion means 132. The expanded secondary-side refrigerant flows out of the cold-storage/refrigeration booster unit D and flows into the cold-storage/refrigeration unit F.

[0047] The secondary-side refrigerant having flowed into the cold-storage/refrigeration unit F receives heat from air supplied from the air-sending device (not shown) and evaporates in the refrigeration heat exchanger 133, and flows out of the cold-storage/refrigeration unit F. The secondary-side refrigerant having flowed out of the cold-storage/refrigeration unit F flows into the secondary side of the cold-storage/refrigeration booster unit D and returns to the refrigeration compressor 130.

[0048] Although it is not illustrated, the refrigerating and air-conditioning apparatus 100 desirably includes sensors or the like that detect a discharge pressure and a suction pressure of the primary-side refrigerant, a discharge temperature and a suction temperature of the primary-side refrigerant, the temperature of the primary-side refrigerant flowing into and out of the outdoor heat exchanger 103, the temperature of outside air taken into the heat source unit A, the temperature of the primary-side refrigerant flowing into and out of the indoor heat exchangers 118, a discharge pressure and a suction pressure of the secondary-side refrigerant, a discharge temperature and a suction temperature of the secondary-side refrigerant, the temperature of the secondary-side refrigerant flowing into and out of the refrigeration heat exchanger 133, the temperature of outside air taken in the cold-storage/refrigeration unit F, and the temperatures of the primary-side refrigerant and the secondary-side refrigerant flowing into and out of the refrigerant-refrigerant heat exchanger 131.

[0049] Information (temperature information, pressure information, and the like) detected by these various sensors is transmitted to controlling means (not shown) that controls the operation of the refrigerating and air-conditioning apparatus 100 and used for control of the drive frequency of the air-conditioning compressor 101, switching of the four-way valve 102, opening and closing of the valve means 109a and the valve means 109b, the drive frequency of the refrigeration compressor 130, the opening degrees of various expansion devices, and the like.

[0050] As described above, the air-conditioning refrigeration cycle 1 and the cold-storage/refrigeration refrigeration cycle 2 have respective independent refrigerant circuit configurations (the air-conditioning refrigeration cycle 1 and the cold-storage/refrigeration refrigeration cycle 2). Thus, the refrigerants circulated in the respective refrigerant circuits may be of the same type or of different types. That is, the refrigerants of the respective refrigerant circuits flow such that, in the refrigerant-refrigerant heat exchanger 131, heat is exchanged between the refrigerants while the refrigerants are not mixed with each other.

[0051] Although a case in which the excess refrigerant is stored in a liquid receiving unit (accumulator 104) in the air-conditioning refrigeration cycle 1 has been described, not limited to this is, the accumulator 104 may be omitted in the case where the excess refrigerant is stored in the heat exchanger that functions as a radiator in the refrigeration cycle. Furthermore, in Fig. 1, an example in which two cooling indoor units B and two heating indoor units C are connected is illustrated. Alternatively, one or more cooling indoor units B and zero or one or more heating indoor units C may be connected.

[0052] Furthermore, although the example illustrated in Fig. 1, one cold-storage/refrigeration booster unit D and one cold-storage/refrigeration unit F are connected, this does not limit the numbers of the cold-storage/refrigeration booster units D and the cold-storage/refrigeration units F to be connected. For example, two or more cold-storage/refrigeration booster units D may be connected, or two or more cold-storage/refrigeration units F may be connected. Capacities of the disposed indoor units and the disposed cold-storage/refrigeration booster unit D may all be uniform, or may be varied from large to small capacities.

[0053] As described above, in the refrigerating and air-conditioning apparatus 100 according to Embodiment 1, a cold storage or refrigeration load system is configured as a binary cycle. In order to meet a demand for refrigeration at a low temperature (for example, -20°C), it is only required to set the temperature of the evaporator (refrigeration heat exchange unit 133) of the cold-storage/refrigeration refrigeration cycle 2 to a low temperature (for example, evaporating temperature of -25°C). Thus, even when there is a different cooling air-conditioning load, the evaporating temperature of the cooling indoor units B (for example, 0°C) does not need to be reduced, and accordingly, energy saving can be achieved while comfort of the indoor space on the air-conditioning load side can be maintained. Furthermore, when there is, for example, a demand for hot water at a low temperature during air-conditioning cooling operation in winter, the refrigerating and air-conditioning apparatus 100 performs heating air-conditioning by reusing exhaust heat recovered in the cold-storage/refrigeration refrigeration cycle 2. Thus, the system COP is significantly improved and energy is saved.

[0054] Fig. 2 is a refrigerant circuit diagram illustrating flows of the refrigerants in a cooling main operation of the refrigerating and air-conditioning apparatus 100 according to Embodiment 1 of the present invention. The cooling main operation of the air-conditioning refrigeration cycle 1 performed by the refrigerating and air-conditioning apparatus 100 is described with reference to Fig. 2. In Fig. 2, the flow of the refrigerant is indicated by opening and closing states (hollow (open state) and solid (closed state)) of the check valves and valve means.

[0055] The primary-side refrigerant in a gaseous state, the temperature and pressure of which has been increased by the air-conditioning compressor 101, is discharged from the air-conditioning compressor 101 and flows into the outdoor heat exchanger 103 through the four-way valve 102. The primary-side refrigerant having flowed into the outdoor heat exchanger 103 transfers heat to air supplied to the outdoor heat exchanger 103 so as to be cooled down to about the ambient temperature. This primary-side refrigerant flows out of the outdoor heat exchanger 103, is directed through the check valves 105a, is guided to the high-pressure side connection pipe 106, and flows into the gas-liquid separator 108 of the relay unit E.

[0056] The primary-side refrigerant having flowed into the gas-liquid separator 108 flows out of the gas-liquid separator 108 and flows into the first internal heat exchanger 111. The primary-side refrigerant having flowed into the first internal heat exchanger 111 exchanges heat with the primary-side refrigerant, which has been expanded by the second relay unit expansion means 114 and has a low temperature and a low pressure, thereby becoming to have a degree of supercooling. Then the primary-side refrigerant passes through the first relay unit expansion means 112 and is merged with the primary-side refrigerant having been used for air-conditioning at the first combining section 115. After that, the merged primary-side refrigerant exchanges heat in the second internal heat exchanger 113 with the primary-side refrigerant, which has been expanded by the second relay unit expansion means 114 and has a low temperature and a low pressure, thereby further becoming to have a degree of supercooling. Then, the merged primary-side refrigerant is divided into the primary-side refrigerant that flows through the second combining section 116 and the primary-side refrigerant that flows through the second relay unit expansion means 114.

[0057] The primary-side refrigerant passing through the second combining section 116 is distributed to the circuits where the valve means 109b are open, that is, to the cooling indoor units B and the primary side of the cold-storage/refrigeration booster unit D. The primary-side refrigerant having flowed into the cooling indoor units B is expanded by the air-conditioning expansion means 117 so as to have a low temperature and a low pressure, evaporates in the indoor heat exchangers 118, and flows into the low-pressure side connection pipe 107 through the valve means 109b. The primary-side refrigerant having flowed into the primary side of the cold-storage/refrigeration booster unit D is expanded by the expansion means 119 so as to have a low temperature and a low pressure, evaporates in the refrigerant-refrigerant heat exchanger 131, and flows into the low-pressure side connection pipe 107 through the valve means 109b.

[0058] The primary-side refrigerant having been directed through the second relay unit expansion means 114 exchanges heat in the second internal heat exchanger 113 and the first internal heat exchanger 111 to evaporate, and is, in the low-pressure side connection pipe 107, merged with the primary-side refrigerant having flowed out from the cooling indoor units B and the primary side of the cold-storage/refrigeration booster unit D.

[0059] Meanwhile, the primary-side refrigerant, which has been separated by the gas-liquid separator 108 and is in a gaseous state, is distributed to the heating indoor unit C side through the valve means 109a. The primary-side refrigerant having flowed into the heating indoor units C transfers heat in the indoor heat exchangers 118. Then, the pressure of the primary-side refrigerant is reduced by the air-conditioning expansion means 117, and flows of the primary-side refrigerant are merged with each other in the first combining section 115.
Finally, the primary-side refrigerant having been merged in the low-pressure side connection pipe 107 returns to the air-conditioning compressor 101 through the check valve 105b, the four-way valve 102, and the accumulator 104. The flow of the secondary-side refrigerant circulated in the cold-storage/refrigeration refrigeration cycle 2 is similar to that in the heating main operation.

[0060] Thus, with the refrigerating and air-conditioning apparatus 100, an optimum load-side unit can be selected in accordance with the air-conditioning load, the cold storage load, and the refrigeration load. With the refrigerating and air-conditioning apparatus 100, there is no need of separate new pipes provided from the heat source unit A to each of the load-side units and only the load-side units needs to be connected by pipes to the relay unit E. This can reduce the amount of used pipes. Furthermore, with the refrigerating and air-conditioning apparatus 100, by using an integrated air-conditioning system that can simultaneously provide a cooling load and a heating load, an air-conditioning load and a cold-storage/refrigeration load can be simultaneously supplied using a binary refrigeration cycle. Thus, with the refrigerating and air-conditioning apparatus 100, a stable heat source can be supplied throughout the year. Furthermore, with the refrigerating and air-conditioning apparatus 100, heat recovery in the load-side units can be performed throughout the year, thereby energy saving operations are allowed.

Embodiment 2

[0061] Fig. 3 is a refrigerant circuit diagram illustrating an example of a refrigerant circuit configuration of a refrigerating and air-conditioning apparatus 100a according to Embodiment 2 of the present invention. The configuration of the refrigerant circuit of the refrigerating and air-conditioning apparatus 100a that I one that recovers heat during simultaneous cooling and heating operation is described with reference to Fig. 3. As is the case with the refrigerating and air-conditioning apparatus 100 according to Embodiment 1, the refrigerating and air-conditioning apparatus 100a is installed in an office building, an apartment, a hotel, or the like. The refrigerating and air-conditioning apparatus 100a uses refrigeration cycles, in which refrigerants are circulated, so as to permit the air conditioning load and the cold-storage/refrigeration load to be simultaneously supplied. In Embodiment 2, points that are different from Embodiment 1 is mainly described, and the same components as those of Embodiment 1 are denoted by the same reference signs and description thereof is omitted.

[0062] In the exemplary configuration described in Embodiment 1, the cold-storage/refrigeration booster unit D and the cold-storage/refrigeration unit F are separate housings and are connected to each other by pipes; however, in an exemplary configuration described in Embodiment 2, the cold-storage/refrigeration booster unit and the cold-storage/refrigeration unit are a single housing (a unit G illustrated in Fig. 3). By configuring the cold-storage/refrigeration booster unit and the cold-storage/refrigeration unit as a single unit G, contribution can be made to reduction in total unit installation area and production costs in addition to further reduction of pipes.

Embodiment 3

[0063] Fig. 4 is a refrigerant circuit diagram illustrating an example of a refrigerant circuit configuration of a refrigerating and air-conditioning apparatus 100b according to Embodiment 3 of the present invention. The configuration of the refrigerant circuit and operation of the refrigerating and air-conditioning apparatus 100b that recovers heat by simultaneous cooling and heating operation is described with reference to Fig. 4. As is the case with the refrigerating and air-conditioning apparatus 100 according to Embodiment 1, the refrigerating and air-conditioning apparatus 100b is installed in an office building, an apartment, a hotel, or the like. The refrigerating and air-conditioning apparatus 100b uses refrigeration cycles, in which refrigerants are circulated, so as to permit the air conditioning load, a hot-water load, and the cold-storage/refrigeration load to be simultaneously supplied. In Embodiment 3, points that are different from Embodiment 1 and Embodiment 2 are mainly described, and the same components as those of Embodiment 1 or Embodiment 2 are denoted by the same reference signs and description thereof is omitted.

[0064] The refrigerating and air-conditioning apparatus 100b according to Embodiment 3 has a configuration in which a hot-water supply system is added to the refrigerating and air-conditioning apparatus according to Embodiment 1 and 2. That is, the refrigerating and air-conditioning apparatus 100b not only has the air-conditioning refrigeration cycle 1 and the cold-storage/refrigeration refrigeration cycle 2 but also has a hot-water supply refrigeration cycle 3 and a hot-water load-side cycle 4. The air-conditioning refrigeration cycle 1 and the hot-water supply refrigeration cycle 3 are formed such that, in a refrigerant-refrigerant heat exchanger 141, heat is exchanged between the refrigerant of the air-conditioning refrigeration cycle 1 and a refrigerant of the hot-water supply refrigeration cycle 3 while the refrigerant of the air-conditioning refrigeration cycle 1 and the refrigerant of the hot-water supply refrigeration cycle 3 are not mixed with each other. The hot-water supply refrigeration cycle 3 and the hot-water load-side cycle 4 are formed such that, in a heat medium-refrigerant heat exchanger 143, heat is exchanged between the refrigerant of the hot-water supply refrigeration cycle 3 and a heat medium (for example, water, an anti-freeze solution, or the like) of the hot-water load-side cycle 4 while the refrigerant of the hot-water supply refrigeration cycle 3 and the heat medium of the hot-water load-side cycle 4 are not mixed with each other. The refrigerant circulated in the hot-water supply refrigeration cycle 3 is referred to as a hot-water supply refrigerant.

[Hot-Water Supply Refrigeration Cycle 3]

[0065] The hot-water supply refrigeration cycle 3 includes a hot-water supply compressor 140 disposed in a hot-water supply booster unit H, the hot-water supply refrigerant side of the heat medium-refrigerant heat exchanger 143, a hot-water supply expansion means 142, and the hot-water supply refrigerant side of the refrigerant-refrigerant heat exchanger 141 that are connected in series by pipes. The hot-water supply refrigeration cycle 3 supplies heating energy from the heat source unit A to a hot-water supply unit I through the refrigerant-refrigerant heat exchanger 141. The hot-water supply booster unit H is disposed such that, as is the case with the indoor units or the cold-storage/refrigeration booster unit D, the hot-water supply booster unit H is connected in parallel to the heat source unit A. Thus, the hot-water supply booster unit H performs its function when the flow of the primary-side refrigerant is switched by the relay unit E.

[Hot-Water Supply Load-side Cycle 4]

[0066] The hot-water load-side cycle 4 includes a water circulation pump 144 disposed in the hot-water supply unit I, the heat medium side of the heat medium-refrigerant heat exchanger 143, and a hot-water storage tank 145 that are connected in series by pipes. The hot-water load-side cycle 4 boils water stored in the hot-water storage tank 145 using heating energy transferred through the heat medium-refrigerant heat exchanger 143 of the hot-water supply booster unit H.

{Hot-Water Supply Booster Unit H}

[0067] The hot-water supply booster unit H transfers heating energy from the heat source unit A to the hot-water supply refrigeration cycle 3 through the refrigerant-refrigerant heat exchanger 141. An expansion means 120 and the refrigerant-refrigerant heat exchanger 141 are connected in series on the primary side of the hot-water supply booster unit H. On the secondary side (hot-water supply side) of the hot-water supply booster unit H, the hot-water supply compressor 140, the hot-water supply refrigerant side of the heat medium-refrigerant heat exchanger 143, the hot-water supply expansion means 142, and the hot-water supply refrigerant side of the refrigerant-refrigerant heat exchanger 141 are connected in series. The air-conditioning refrigeration cycle 1 and the hot-water supply refrigeration cycle 3 are connected to each other in a cascade manner with the refrigerant-refrigerant heat exchanger 141. That is, the refrigerant-refrigerant heat exchanger 141 causes heat to be exchanged between the primary-side refrigerant and the hot-water supply refrigerant.

[0068] As is the case with the air-conditioning expansion means 117, the expansion means 120, which has functions of a pressure reducing valve and expansion valve, reduces the pressure of the primary-side refrigerant and expands the primary-side refrigerant. It is desirable that the expansion means 120 include a means such as a means that can variably control an opening degree, for example, a precision flow rate control means using an electronic expansion valve, or an inexpensive refrigerant flow rate regulating means such as a capillary tube. The refrigerant-refrigerant heat exchanger 141, which functions as a radiator (condenser) or an evaporator, causes heat to be exchanged between the hot-water supply refrigerant circulated in the hot-water supply refrigeration cycle 3 and the primary-side refrigerant circulated in the air-conditioning refrigeration cycle 1. For convenience of description, a pipe that connects the relay unit E to the refrigerant-refrigerant heat exchanger 141 is referred to as the connection pipe 14a, and a connection pipe that connects the relay unit E to the expansion means 120 is referred to as the connection pipe 15a.

[0069] The hot-water supply compressor 140 suctions and compresses the hot-water supply refrigerant so as to cause the hot-water supply refrigerant to enter a high-temperature high-pressure state. The rotation speed of the hot-water supply compressor 140 may be variably controllable by an inverter or may be fixed. The hot-water supply compressor 140 may be any that is capable of compressing the suctioned refrigerant into a high-pressure state, and is not limited to a specific type of compressor. For example, the hot-water supply compressor 140 may use one of a variety of compressors such as reciprocating, rotary, scroll, and screw compressors.

[0070] The heat medium-refrigerant heat exchanger 143 causes heat to be exchanged between the hot-water supply refrigerant circulated in the hot-water supply refrigeration cycle 3 and the heat medium circulated in the hot-water load-side cycle. That is, the hot-water supply refrigeration cycle 3 and the hot-water load-side cycle are connected to each other in a cascade manner through the heat medium-refrigerant heat exchanger 143. The hot-water supply expansion means 142, which has the functions of a pressure reducing valve and an expansion valve, reduces the pressure of the hot-water supply refrigerant and expands the hot-water supply refrigerant. It is desirable that the hot-water supply expansion means 142 include a means such as a means that can variably control an opening degree, for example, a precision flow rate control means using an electronic expansion valve, or an inexpensive refrigerant flow rate regulating means such as a capillary tube.

[0071] The type of the refrigerant circulated in the hot-water supply refrigeration cycle 3 is not particularly limited. The refrigerant may be, for example, any one of a natural refrigerant such as carbon dioxide, hydrocarbon, or helium, an alternative refrigerant without chlorine such as HFC410A, HFC407C, or HFC404A, and a fluorocarbon refrigerant used in existing products such as R22 or R134a.

{Hot-Water Supply Unit I}

[0072] The hot-water supply unit I boils water using heating energy supplied from the hot-water supply booster unit H. The water circulation pump 144, the heat medium side of the heat medium-refrigerant heat exchanger 143, and the hot-water storage tank 145 are connected in series in the hot-water supply unit I. That is, the hot-water supply unit I is established by the water circulation pump 144, the heat medium-refrigerant heat exchanger 143, and the hot-water storage tank 145 that are connected so as to form the hot-water load-side cycle 4, in which the heat medium is circulated. The pipes of the hot-water load-side cycle 4 includes, for example, copper pipes, stainless pipes, steel pipes, polyvinyl chloride-based pipes, or the like.

[0073] The water circulation pump 144 suctions the water stored in the hot-water storage tank 145 and apply pressure to the water so as to circulate the water in the hot-water load-side cycle 4. It is desirable that the rotation speed of the water circulation pump 144 be controlled by, for example, an inverter. As described above, the heat medium-refrigerant heat exchanger 143 causes heat to be exchanged between the heat medium circulated in the hot-water load-side cycle 4 and the hot-water supply refrigerant circulated in the hot-water supply refrigeration cycle 3. Water heated by the heat medium-refrigerant heat exchanger 143 is stored in the hot-water storage tank 145.

[0074] In general, there are demands for the hot-water load even in summer, and demands for the cold-storage/refrigeration load in winter. Thus, in the refrigerating and air-conditioning apparatus 100b, the hot-water supply booster unit H and the cold-storage/refrigeration booster unit D are incorporated into a single system. This is expected to increase opportunities of loads for cooling (the cooling load and cold-storage/refrigeration load) and loads for heating (the heating load and hot-water load) being simultaneously used throughout the year, and accordingly, to increase energy saving effects due to heat recovery.

[0075] Here, the flow of the hot-water supply refrigerant in the hot-water supply refrigeration cycle 3 is described. The heat source unit A, the indoor units, the cold-storage/refrigeration unit F, operation of the relay unit E, and the flow of the primary-side refrigerant of the refrigerating and air-conditioning apparatus 100b are similar to those in Embodiment 1 and Embodiment 2. The flow of the primary-side refrigerant flowing from the relay unit E to the hot-water supply booster unit H is similar to the flow of the primary-side refrigerant flowing from the relay unit E to the heating indoor units C. High-temperature refrigerant gas is directed through the valve means 109a, transfers heat in the refrigerant-refrigerant heat exchanger 141, passes through the expansion means 119, and is merged in the first combining section 115.

[0076] In the hot-water supply booster unit H, the hot-water supply refrigerant, the temperature and pressure of which have been increased by the hot-water supply compressor 140, is discharged from the hot-water supply compressor 140 and flows into the heat medium-refrigerant heat exchanger 143. In the heat medium-refrigerant heat exchanger 143, the hot-water supply refrigerant having flowed in transfers heat by heating the heat medium circulated in the hot-water load-side cycle 4. This hot-water supply refrigerant is expanded by the hot-water supply expansion means 142. The expanded hot-water supply refrigerant receives heat from the primary-side refrigerant of the air-conditioning refrigeration cycle 1 and evaporates in the refrigerant-refrigerant heat exchanger 141, and returns to the hot-water supply compressor 140.

[0077] The type of the secondary-side refrigerant circulated in the hot-water supply refrigeration cycle 3 is not particularly limited. The secondary-side refrigerant may be, for example, any one of a natural refrigerant such as carbon dioxide, hydrocarbon, or helium, an alternative refrigerant without chlorine such as HFC410A, HFC407C, or HFC404A, and a fluorocarbon refrigerant used in existing products such as R22 or R134a. The air-conditioning refrigeration cycle 1 and the hot-water supply refrigeration cycle 3 have respective independent refrigerant circuit configurations. Thus, the refrigerants circulated in the respective refrigerant circuits may be of the same type or of different types. That is, the refrigerants of the respective refrigerant circuits flow such that, in the refrigerant-refrigerant heat exchanger 141, heat is exchanged between the refrigerants of the respective refrigerant circuits while the refrigerants are not mixed with each other.

[0078] As described above, in the refrigerating and air-conditioning apparatus 100b, a hot-water load system is configured as a binary cycle. Thus, in order to meet a demand for hot water at a high temperature (for example, 80°C), it is only required to set the temperature of the radiator of the hot-water supply refrigeration cycle 3 to a high temperature (for example, condensing temperature of 85°C). As a result, even when there is a different heating load, the condensing temperature (for example, 50°C) of the heating indoor units C does not need to be increased, and accordingly, energy saving can be achieved. Furthermore, hitherto, when there is, for example, a demand for hot-water at a high temperature during air-conditioning cooling operation in summer, the hot water needs to be supplied using a boiler or the like. With the refrigerating and air-conditioning apparatus 100b, heating energy that has been conventionally emitted to the atmosphere is recovered and reused for supplying hot water. Thus, the system COP is significantly improved and energy is saved.

[0079] Next, the flow of the heat medium (here, water) flowing in the hot-water load-side cycle 4 is described.

The water circulation pump 144 draws water, which is stored in the hot-water storage tank 145 and has a comparatively low temperature, from a bottom of the hot-water storage tank 145 and applies pressure to the water. The water, to which pressure is applied by the water circulation pump 144, flows into the heat medium-refrigerant heat exchanger 143 and receives heat in the heat medium-refrigerant heat exchanger 143 from the hot-water supply refrigerant circulated in the hot-water supply refrigeration cycle 3. That is, the water having flowed into the heat medium-refrigerant heat exchanger 143 is boiled by the hot-water supply refrigerant circulated in the hot-water supply refrigeration cycle 3, and the temperature of the water is increased. The boiled water returns to an upper portion of the hot-water storage tank 145, in which the temperature is comparatively high, and is stored in the hot-water storage tank 145.

[0080] Although a case in which the excess refrigerant is stored in the liquid receiving unit (accumulator 104) in the air-conditioning refrigeration cycle 1 has been described, not limited to this, the accumulator 104 may be omitted in the case where the excess refrigerant is stored in the heat exchanger that functions as a radiator in the refrigeration cycle. Furthermore, in Fig. 4 an example in which two cooling indoor units B and two heating indoor units C are connected is illustrated. Alternatively, zero or three or more cooling indoor units B and zero or one or three or more heating indoor units C may be connected.

[0081] Furthermore, although in the example illustrated in Fig. 4, one hot-water supply booster unit H and one hot-water supply unit I are connected, this does not limit the numbers of the hot-water supply booster units H and the hot-water supply units I to be connected. For example, two or more hot-water supply booster units H may be connected, or two or more hot-water supply units I may be connected. Furthermore, in the illustrated example, one cold-storage/refrigeration booster unit D and one cold-storage/refrigeration unit F are connected, this does not limit the numbers of the cold-storage/refrigeration booster units D and the cold-storage/refrigeration units F to be connected. For example, two or more cold-storage/refrigeration booster units D may be connected, or two or more cold-storage/refrigeration units F may be connected. Capacities of the disposed indoor units and the booster units may all be uniform, or may be varied from large to small capacities.

Embodiment 4

[0082] Fig. 5 is a refrigerant circuit diagram illustrating an example of a refrigerant circuit configuration of a refrigerating and air-conditioning apparatus 100c according to Embodiment 4 of the present invention. The refrigerant circuit configuration and operation of the refrigerating and air-conditioning apparatus 100c are described with reference to Fig. 5. As is the case with the refrigerating and air-conditioning apparatus 100 according to Embodiment 1, the refrigerating and air-conditioning apparatus 100c is installed in an office building, an apartment, a hotel, or the like.
The refrigerating and air-conditioning apparatus 100c uses refrigeration cycles, in which refrigerants are circulated, so as to permit the cooling load and the cold-storage/refrigeration load to be simultaneously supplied. In Embodiment 4, points that are different from Embodiments 1 to 3 are mainly described, and the same components as those of Embodiments 1 to 3 are denoted by the same reference signs and description thereof is omitted.

[0083] Regarding the refrigerating and air-conditioning apparatuses according to Embodiments 1 to 3, the systems in which the relay units E are provided between the heat source units A and load-side units so as to permit the simultaneous cooling and heating operation to be performed have been described. Regarding the refrigerating and air-conditioning apparatus 100c according to Embodiment 4, a system dedicated to cooling as illustrated in Fig. 5 is described.

[0084] The refrigerating and air-conditioning apparatus 100c according to Embodiment 4 has at least an air-conditioning refrigeration cycle 1c and a cold-storage/refrigeration refrigeration cycle 2c. The air-conditioning refrigeration cycle 1 c and the cold-storage/refrigeration refrigeration cycle 2c are formed such that, in a refrigerant-refrigerant heat exchanger 131 c, heat is exchanged between a refrigerant of the air-conditioning refrigeration cycle 1 c and a refrigerant of the cold-storage/refrigeration refrigeration cycle 2c while both the refrigerants are not mixed with each other. The refrigerant circulated in the air-conditioning refrigeration cycle 1 c is referred to as a primary-side refrigerant, and the refrigerant circulated in the cold-storage/refrigeration refrigeration cycle 2c is referred to as a secondary-side refrigerant.

[Air-conditioning Refrigeration Cycle 1c]

[0085] The air-conditioning refrigeration cycle 1 is formed of a heat source unit Ac, indoor units Bc (referred to as cooling indoor units Bc hereafter) that covers, for example, a cooling load, and a cold-storage/refrigeration booster unit Dc (in particular, a primary side of the refrigerant-refrigerant heat exchanger 131 c) that serves as a heat source for the cold-storage/refrigeration refrigeration cycle 2c.

[0086] As illustrated in Fig. 5, the cooling indoor units Bc and the air-conditioning refrigeration cycle 1 side of the cold-storage/refrigeration booster unit Dc are connected in parallel to the heat source unit Ac. The air-conditioning refrigeration cycle 1 c side of the cold-storage/refrigeration booster unit Dc is referred to as a primary side of the cold-storage/refrigeration booster unit Dc, and the cold-storage/refrigeration refrigeration cycle 2c side of the cold-storage/refrigeration booster unit Dc is referred to as a secondary side of the cold-storage/refrigeration booster unit it Dc.

{Heat Source UnitAc}

[0087] The heat source unit Ac supplies cooling energy to the cooling indoor units B and the primary side of the cold-storage/refrigeration booster unit Dc. An air-conditioning compressor 101c, an outdoor heat exchanger (a heat-source side heat exchanger) 103c, and an accumulator 104c are connected in series by pipes and disposed in the heat source unit Ac. In the heat source unit Ac, it is desirable that a fan or another air-sending device, which supplies air to the outdoor heat exchanger 103, be provided at a position close to the outdoor heat exchanger 103.

[0088] The air-conditioning compressor 101c suctions and compresses the primary-side refrigerant so as to cause the primary-side refrigerant to enter a high-temperature high-pressure state. The outdoor heat exchanger 103c functions as a radiator (condenser) and causes heat to be exchanged between air supplied from the air-sending device (not shown) and the primary-side refrigerant, thereby condensing and liquefying the primary-side refrigerant. The accumulator 104c is disposed on a suction side of the air-conditioning compressor 101c and stores the excessive primary-side refrigerant. The accumulator 104c may be any container capable of storing the excessive primary-side refrigerant.

[Cooling Indoor Unit Bc]

[0089] The cooling indoor units Bc receive cooling energy or heating energy supplied from the heat source unit Ac and cover the cooling load. An air-conditioning expansion means 117c and an indoor heat exchanger (use-side heat exchangers) 118c are connected in series and disposed in each cooling indoor unit Bc. In the example illustrated in Fig. 5, two cooling indoor units B are connected. In the cooling indoor units Bc, it is desirable that fans or other air-sending devices, which supply air to the indoor heat exchangers 118c, be provided at positions close to the indoor heat exchangers 118c.

[0090] The air-conditioning expansion means 117c, which have functions of pressure reducing valves and expansion valves, reduce the pressure of the primary-side refrigerant and expand the primary-side refrigerant. It is desirable that the air-conditioning expansion means 117c include means such as means that can variably control opening degrees, for example, precision flow rate control means using electronic expansion valves, or inexpensive refrigerant flow rate regulating means such as capillary tubes. The indoor heat exchangers 118c function as evaporators and cause heat to be exchanged between air supplied from the air-sending devices (not shown) and the primary-side refrigerant, thereby evaporating and gasifying the primary-side refrigerant.

{Cold-storage/refrigeration Booster Unit Dc}

[0091] The cold-storage/refrigeration booster unit Dc transfers cooling energy from the heat source unitAc to the cold-storage/refrigeration refrigeration cycle 2c through the refrigerant-refrigerant heat exchanger 131c. An expansion means 119c and the refrigerant-refrigerant heat exchanger 131c are connected in series on the primary side of the cold-storage/refrigeration booster unit Dc. The air-conditioning refrigeration cycle 1 c and the cold-storage/refrigeration refrigeration cycle 2c are connected to each other in a cascade manner with the refrigerant-refrigerant heat exchanger 131 c. That is, the refrigerant-refrigerant heat exchanger 131 c causes heat to be exchanged between the primary-side refrigerant and the secondary-side refrigerant.

[0092] As is the case with the air-conditioning expansion means 117c, the expansion means 119c, which has the functions of a pressure reducing valve and an expansion valve, reduces the pressure of the primary-side refrigerant and expands the primary-side refrigerant. It is desirable that the expansion means 119c include a means such as a means that can variably control an opening degree, for example, a precision flow rate control means using an electronic expansion valve, or an inexpensive refrigerant flow rate regulating means such as a capillary tube. The refrigerant-refrigerant heat exchanger 131c, which functions as an evaporator, causes heat to be exchanged between the secondary-side refrigerant circulated in the cold-storage/refrigeration refrigeration cycle 2c and the primary-side refrigerant circulated in the air-conditioning refrigeration cycle 1 c.

[0093] As described above, the air-conditioning refrigeration cycle 1 c is established by the air-conditioning compressor 101 c, the outdoor heat exchanger 103c, the air-conditioning expansion means 117c, the indoor heat exchangers 118c, and the accumulator 104c that are connected in series; the air-conditioning compressor 101c, the outdoor heat exchanger 103c, the expansion means 119c, the refrigerant-refrigerant heat exchanger 131 c, and the accumulator 1 04c that are connected in series; and by the refrigerant circulating through these components.

[0094] The air-conditioning compressor 101 c may be any that is capable of compressing the suctioned refrigerant into a high-pressure state, and is not limited to a specific type of compressor. For example, the air-conditioning compressor 101 c may use one of a variety of compressors such as reciprocating, rotary, scroll, and screw compressors. The rotation speed of the air-conditioning compressor 101 c may be variably controllable by an inverter or may be fixed.

[0095] The type of the refrigerant circulated in the air-conditioning refrigeration cycle 1c is not particularly limited. The refrigerant may be, for example, any one of a natural refrigerant such as carbon dioxide (CO_2), hydrocarbon, or helium, an alternative refrigerant without chlorine such as HFC410A, HFC407C, or HFC404A, and a fluorocarbon refrigerant used in existing products such as R22 or R134a.

[0096] Here, with reference to Fig. 5, the flow of the primary-side refrigerant in the air-conditioning refrigeration cycle 1 c during operation performed by the refrigerating and air-conditioning apparatus 100c is described. The primary-side refrigerant in a gaseous state, the temperature and pressure of which has been increased by the air-conditioning compressor 101 c, is discharged from the air-conditioning compressor 101c and flows into the outdoor heat exchanger 103c. The primary-side refrigerant in a superheated gas state having flowed into the outdoor heat exchanger 103c is cooled by air supplied to the outdoor heat exchanger 103c and liquefied. This primary-side refrigerant flows out of the outdoor heat exchanger 103c, flows through a high-pressure side connection pipe 106c, and is distributed to the cooling indoor units Bc and the primary side of the cold-storage/refrigeration booster unit Dc.

[0097] The primary-side refrigerant having flowed into the cooling indoor units Bc is expanded by the air-conditioning expansion means 117c so as to have a low temperature and a low pressure, evaporates in the indoor heat exchangers 118c, and flows into a low-pressure side connection pipe 107c. The primary-side refrigerant having flowed into the primary side of the cold-storage/refrigeration booster unit Dc is expanded by the expansion means 119c so as to have a low temperature and a low pressure, evaporates in the refrigerant-refrigerant heat exchanger 131 c, and flows into the low-pressure side connection pipe 107c. The primary-side refrigerant flowing in the low-pressure side connection pipe 107c then flows into the heat source unit A and returns to the air-conditioning compressor 101 c through the accumulator 104c.

[Cold-storage/refrigeration Refrigeration Cycle 2c]

[0098] The cold-storage/refrigeration refrigeration cycle 2c is formed of the cold-storage/refrigeration booster unit Dc (in particular, the secondary side of the refrigerant-refrigerant heat exchanger 131) and a cold-storage/refrigeration unit Fc. That is, the cold-storage/refrigeration refrigeration cycle 2c includes a refrigeration compressor 130c disposed in the cold-storage/refrigeration booster unit Dc, the refrigerant-refrigerant heat exchanger 131c, refrigeration expansion means 132c, and a refrigeration heat exchanger 133c disposed in the cold-storage/refrigeration unit Fc that are connected in series by pipes. The cold-storage/refrigeration refrigeration cycle 2c is connected to the air-conditioning refrigeration cycle 1 c through the refrigerant-refrigerant heat exchanger 131c disposed in the cold-storage/refrigeration booster unit Dc.

{Cold-storage/refrigeration Booster Unit Dc}

[0099] As described above, the cold-storage/refrigeration booster unit Dc transfers cooling energy from the heat source unit Ac to the cold-storage/refrigeration refrigeration cycle 2c through the refrigerant-refrigerant heat exchanger 131 c. The refrigeration compressor 130c, the secondary side of the refrigerant-refrigerant heat exchanger 131c, and the refrigeration expansion means 132c are connected in series on the secondary side of the cold-storage/refrigeration booster unit Dc.

[0100] The refrigeration compressor 130c suctions and compresses the secondary-side refrigerant so as to cause the secondary-side refrigerant to enter a high-temperature high-pressure state. The rotation speed of the refrigeration compressor 130c may be variably controllable by an inverter or may be fixed. The refrigeration compressor 130c may be any that is capable of compressing the suctioned secondary-side refrigerant into a high-pressure state, and is not limited to a specific type of compressor. For example, the refrigeration compressor 130c may use one of a variety of compressors such as reciprocating, rotary, scroll, and screw compressors.

[0101] As described above, the refrigerant-refrigerant heat exchanger 131c causes heat to be exchanged between the primary-side refrigerant circulated in the air-conditioning refrigeration cycle 1 c and the secondary-side refrigerant circulated in the cold-storage/refrigeration refrigeration cycle 2c. The refrigeration expansion means 132c, which has the functions of a pressure reducing valve and an expansion valve, reduces the pressure of the secondary-side refrigerant and expand the secondary-side refrigerant. It is desirable that the refrigeration expansion means 132c include a means such as a means that can variably control an opening degree, for example, a precision flow rate control means using an electronic expansion valve, or an inexpensive refrigerant flow rate regulating means such as a capillary tube.

[0102] The type of the secondary-side refrigerant circulated in the cold-storage/refrigeration refrigeration cycle 2c is not particularly limited. The secondary-side refrigerant may be, for example, any one of a natural refrigerant such as carbon dioxide, hydrocarbon, or helium, an alternative refrigerant without chlorine such as HFC410A, HFC407C, or HFC404A, and a fluorocarbon refrigerant used in existing products such as R22 or R134a.

{Cold-storage/refrigeration Unit Fc}

[0103] The cold-storage/refrigeration unit Fc receives cooling energy supplied from the cold-storage/refrigeration booster unit Dc and covers the cold-storage/refrigeration load. The refrigeration heat exchanger 133c is disposed in the cold-storage/refrigeration unit Fc. The refrigeration heat exchanger 133c is provided between the refrigeration expansion means 132c of the cold-storage/refrigeration booster unit Dc and the refrigeration compressor 130c, functions as an evaporator, causes heat to be exchanged between air supplied from the air-sending device (not shown) and the secondary-side refrigerant, and evaporates and gasifies the secondary-side refrigerant. In the cold-storage/refrigeration unit Fc, it is desirable that a fan or another air-sending device, which supplies air to the refrigeration heat exchanger 133c, be provided at a position close to the refrigeration heat exchanger 133c.

[0104] The flows of the secondary-side refrigerant of the cold-storage/refrigeration booster unit Dc and the cold-storage/refrigeration unit Fc, that is, the flow of the secondary-side refrigerant in the cold-storage/refrigeration refrigeration cycle 2c is similar to that of the secondary-side refrigerant in the cold-storage/refrigeration booster unit D and the cold-storage/refrigeration unit F described in Embodiments 1 to 3, that is, the flow of the secondary-side refrigerant in the cold-storage/refrigeration refrigeration cycle 2.

[0105] The refrigerating and air-conditioning apparatus 100c having such a configuration is intended for use, for example, in southern areas where weather is comparatively warm throughout the year, and is advantageous in cases where there are cooling loads and no heating load throughout the year. Thus, with refrigerating and air-conditioning apparatus 100c, an optimum load-side unit can be selected in accordance with the air-conditioning load (cooling load) and the cold-storage/refrigeration load, Furthermore, since the heat sources of the air-conditioning load and the cold-storage/refrigeration load are housed in a single unit (heat source unit A), the installation space can be decreased.

[0106] Although the refrigerating and air-conditioning apparatus according to the present invention has been described in separate Embodiments, the refrigerating and air-conditioning apparatus may be configured by adequately combining features of each Embodiment. By adequately combining Embodiments, effects of the features of each Embodiment can be obtained in combination with one another.

Reference Signs List

[0107] 1 air-conditioning refrigeration cycle, 1 c air-conditioning refrigeration cycle, 2 cold-storage/refrigeration refrigeration cycle, 2c cold-storage/refrigeration refrigeration cycle, 3 hot-water supply refrigeration cycle, 4 hot-water load-side cycle, 10 first connection pipe, 11 second connection pipe, 12 connection pipe, 12a connection pipe, 12b connection pipe, 13 connection pipe, 13a connection pipe, 13b connection pipe, 14 connection pipe, 14a connection pipe, 14b connection pipe, 15 connection pipe, 15a connection pipe, 15b connection pipe, 16 connection pipe, 100 refrigerating and air-conditioning apparatus, 100a refrigerating and air-conditioning apparatus, 100b refrigerating and air-conditioning apparatus, 100c refrigerating and air-conditioning apparatus, 101 air-conditioning compressor, 101c air-conditioning compressor, 102 four-way valve, 103 outdoor heat exchanger, 103c outdoor heat exchanger, 104 accumulator, 104c accumulator, 105a check valve, 105b check valve, 105c check valve, 105d check valve, 106 high-pressure side connection pipe, 106c high-pressure side connection pipe, 107 low-pressure side connection pipe, 107c low-pressure side connection pipe, 108 gas-liquid separator, 109 first distribution section, 109a valve means, 109b valve means, 110 second distribution section, 110a check valve, 110b check valve, 111 first internal heat exchanger, 112 first relay unit expansion means, 113 second internal heat exchanger, 114 second relay unit expansion means, 115 first combining section, 116 second combining section, 116a second combining section, 117 air-conditioning expansion means (first expansion means), 117c air-conditioning expansion means (first expansion means), 118 indoor heat exchanger, 118c indoor heat exchanger, 119 expansion means (second expansion means), 119c expansion means (second expansion means), 120 expansion means, 130 refrigeration compressor, 130c refrigeration compressor, 131 refrigerant-refrigerant heat exchanger (first refrigerant-refrigerant heat exchanger), 131c refrigerant-refrigerant heat exchanger (first refrigerant-refrigerant heat exchanger), 132 refrigeration expansion means (third expansion means), 132c refrigeration expansion means (third expansion means), 133 refrigeration heat exchanger, 133c refrigeration heat exchanger, 140 hot-water supply compressor, 141 refrigerant-refrigerant heat exchanger (second refrigerant-refrigerant heat exchanger), 142 hot-water supply expansion means (fourth expansion means), 143 heat medium-refrigerant heat exchanger, 144 water circulation pump, 145 hot-water storage tank, A heat source unit, Ac heat source unit, B indoor unit, Bc indoor unit, C indoor unit, D refrigeration booster unit, E relay unit, F refrigeration unit, Fc refrigeration unit, G unit, H hot-water supply booster unit, and I hot-water supply unit.

Claims

1. A refrigerating and air-conditioning apparatus comprising:

an air-conditioning refrigeration cycle formed by serially connecting an air-conditioning compressor, a heat-source side heat exchanger, first expansion means, and a use-side heat exchanger, and by serially connecting the air-conditioning compressor, the heat-source side heat exchanger, second expansion means, and a primary side of a first refrigerant-refrigerant heat exchanger, the air-conditioning refrigeration cycle causing a primary-side refrigerant to be circulated therein; and

a cold-storage/refrigeration refrigeration cycle formed by serially connecting a refrigeration compressor, a secondary side of the first refrigerant-refrigerant heat exchanger, third expansion means, and a refrigeration heat exchanger, the cold-storage/refrigeration refrigeration cycle causing a secondary-side refrigerant to be circulated therein,

wherein heating energy or cooling energy stored in the primary-side refrigerant is usable as an air-conditioning load through the use-side heat exchanger

and cooling energy stored in the primary-side refrigerant is transferred to the secondary-side refrigerant through the first refrigerant-refrigerant heat exchanger so as to be usable as a cold-storage/refrigeration load.

2. The refrigerating and air-conditioning apparatus of Claim 1,

wherein the air-conditioning compressor and the heat-source side heat exchanger are disposed in a heat source unit,

wherein the first expansion means and the use-side heat exchanger are disposed in an indoor unit, and

wherein the second expansion means, the first refrigerant-refrigerant heat exchanger, the refrigeration compressor, the third expansion means, and the refrigeration heat exchanger are disposed in a unit separate from the heat source unit and the indoor unit.

3. The refrigerating and air-conditioning apparatus of Claim 1,
wherein the air-conditioning compressor and the heat-source side heat exchanger are disposed in a heat source unit,
wherein the first expansion means and the use-side heat exchanger are disposed in an indoor unit,
wherein the second expansion means, the first refrigerant-refrigerant heat exchanger, the refrigeration compressor, and the third expansion means are disposed in a cold-storage/refrigeration booster unit, and
wherein the refrigeration heat exchanger is disposed in a refrigeration unit.

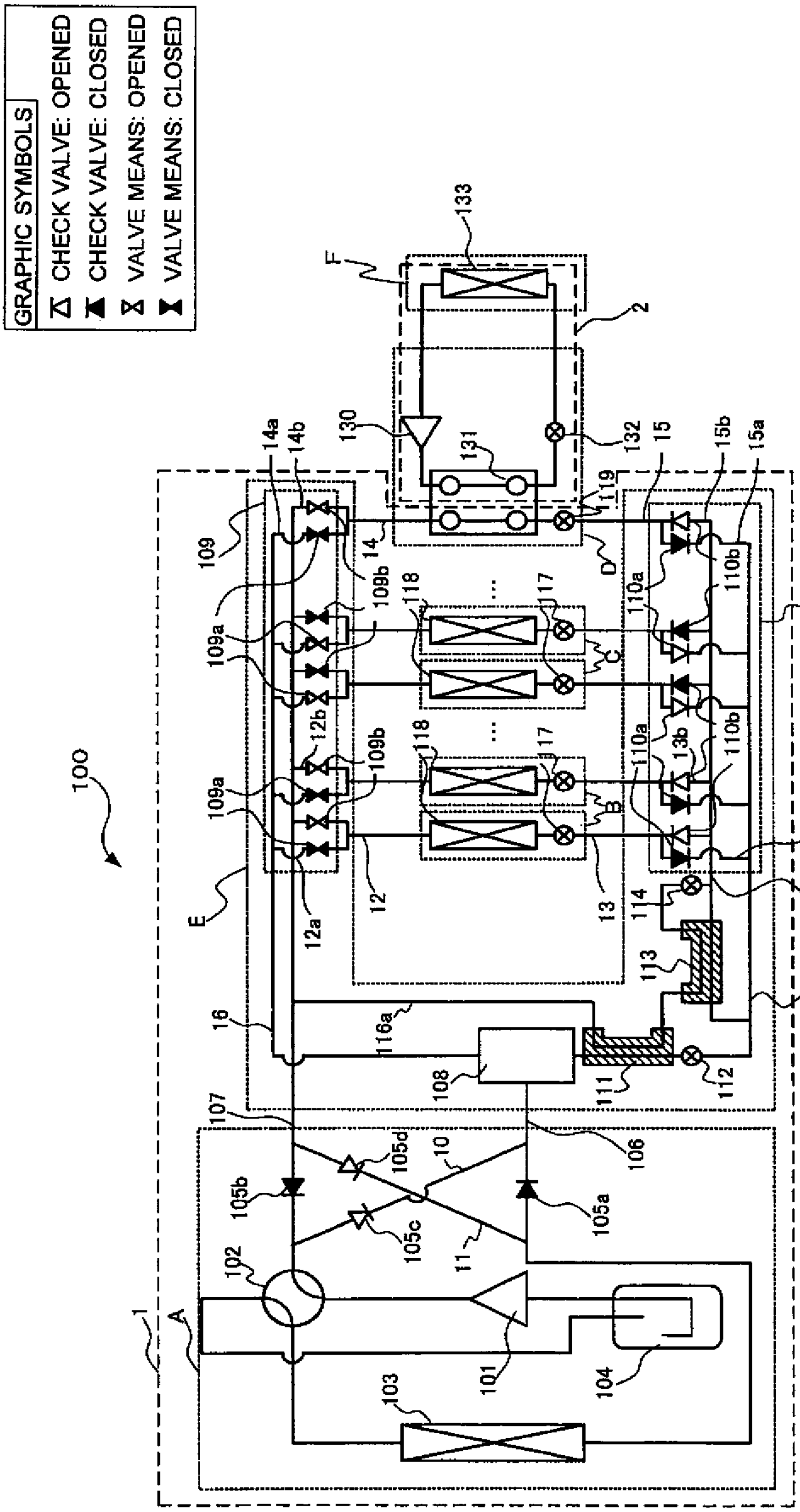
4. The refrigerating and air-conditioning apparatus of Claim 2 or 3, further comprising:

at least one relay unit that is operable between the heat source unit and the indoor unit and between the heat source unit and the cold-storage/refrigeration booster unit, the relay unit transferring heating energy or cooling energy produced by the heat source unit to the indoor unit, the relay unit transferring the cooling energy produced by the heat source unit to the cold-storage/refrigeration booster unit.

5. The refrigerating and air-conditioning apparatus of any one of Claims 1 to 4, further comprising:

a hot-water supply refrigeration cycle formed by serially connecting a hot-water supply compressor, a hot-water supply refrigerant side of a heat medium-refrigerant heat exchanger, fourth expansion means, and a hot-water supply refrigerant side of a second refrigerant-refrigerant heat exchanger, the hot-water supply refrigeration cycle causing a hot-water supply refrigerant to be circulated therein,
wherein heating energy stored in the primary-side refrigerant is transferred to the hot-water supply refrigerant through the second refrigerant-refrigerant heat exchanger so as to be usable as a hot-water load.

6. The refrigerating and air-conditioning apparatus of Claim 5,
wherein the hot-water supply compressor, the hot-water supply refrigerant side of the heat medium-refrigerant heat exchanger, the fourth expansion means, and the second refrigerant-refrigerant heat exchanger are disposed in a hot-water supply booster unit.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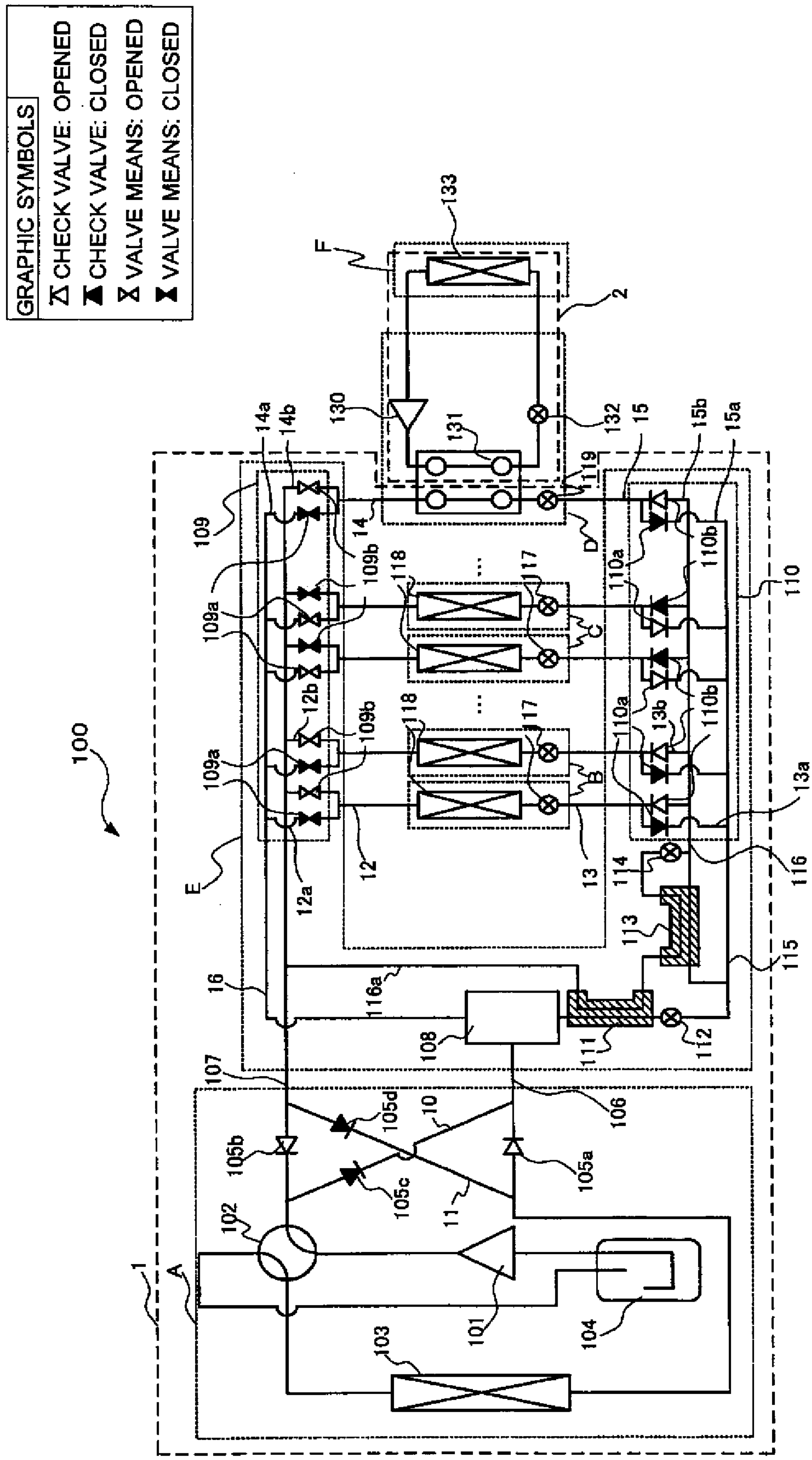
F I G. 1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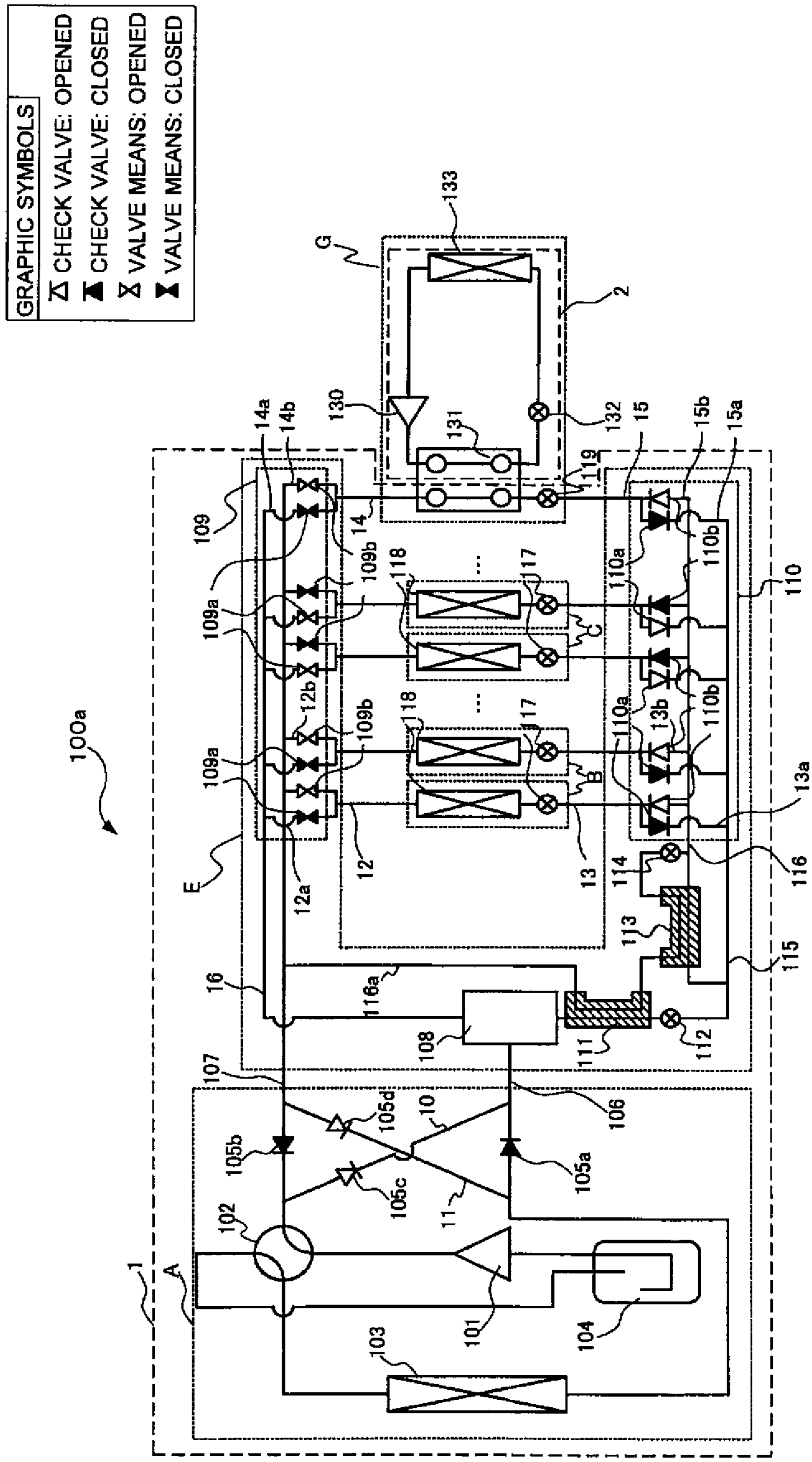
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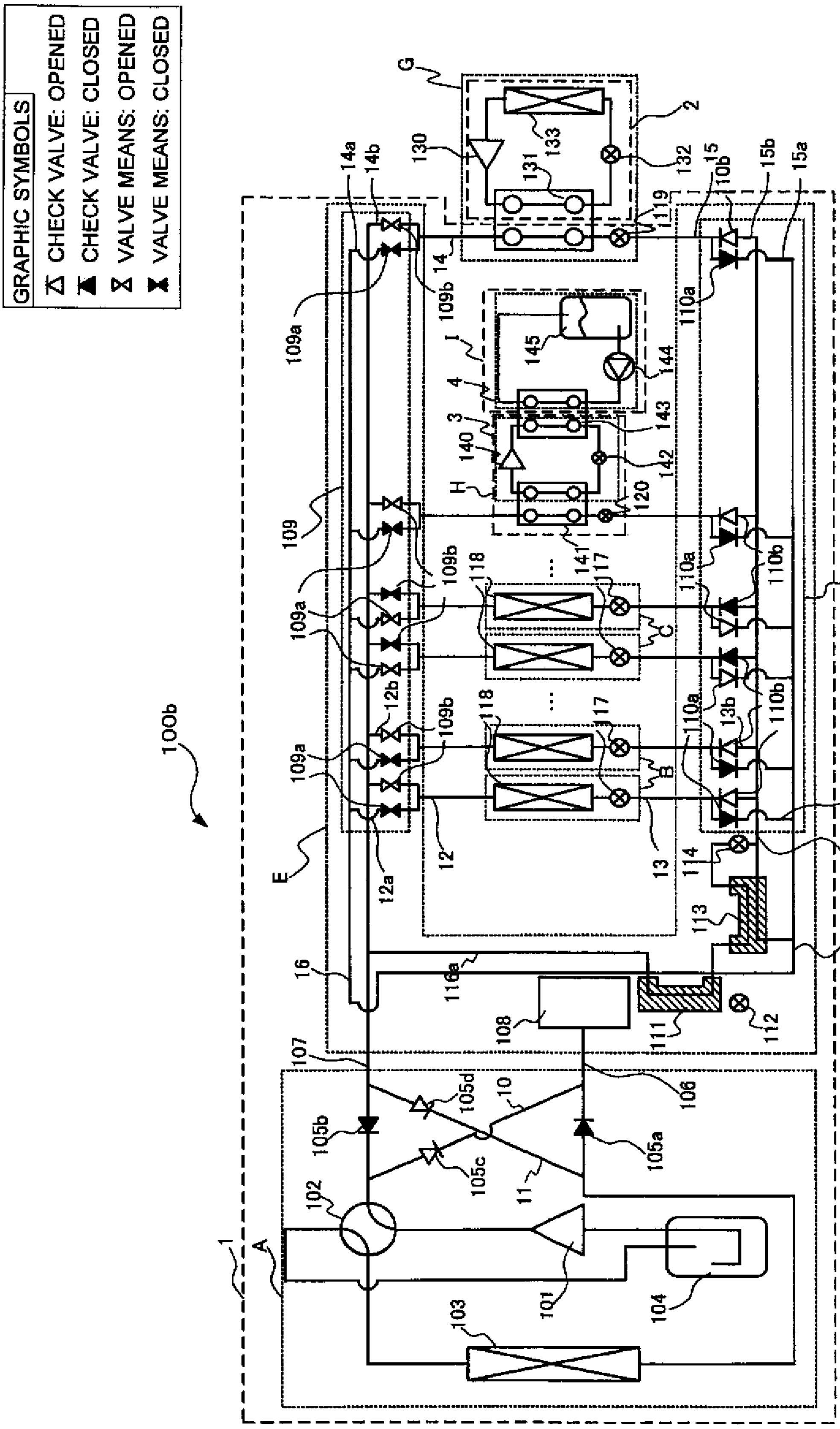
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F I G. 4

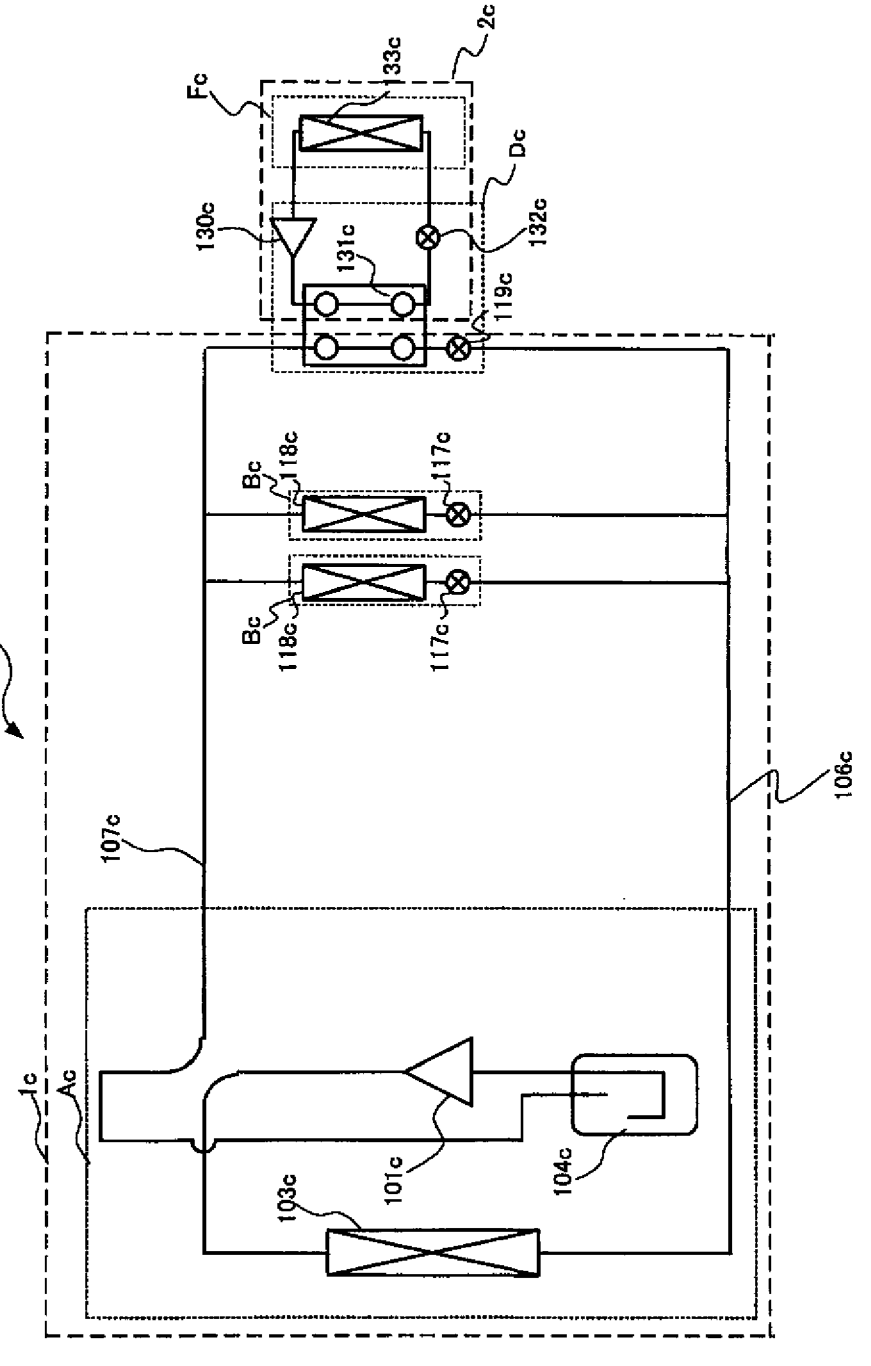
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FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/004088

A. CLASSIFICATION OF SUBJECT MATTER
F25B7/00(2006.01)i, *F25B1/00*(2006.01)i, *F25B29/00*(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)
F25B7/00, F25B1/00, F25B29/00

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

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.
X Y	WO 2000/05542 A1 (Daikin Industries, Ltd.), 03 February 2000 (03.02.2000), fig. 1; description, page 11, line 8 to page 15, line 16	1,2 4-6
X Y	WO 1998/45651 A1 (Daikin Industries, Ltd.), 15 October 1998 (15.10.1998), fig. 1; description, page 7, line 14 to page 10, line 18	1,2 4-6
X Y	JP 2002-277098 A (Daikin Industries, Ltd.), 25 September 2002 (25.09.2002), fig. 1, 2; paragraphs [0054] to [0083]	1,3 4-6
Y	WO 2009/098751 A1 (Mitsubishi Electric Corp.), 13 August 2009 (13.08.2009), fig. 1 to 4; paragraphs [0014] to [0060]	4-6

☐ 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	Date of mailing of the international search report
31 August, 2010 (31.08.10)	14 September, 2010 (14.09.10)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2010/004088

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JP 2002-277098 A	2002.09.25	(Family: none)
WO 2009/098751 A1	2009.08.13	EP 2184563 A

Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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- JP 2005249241 A **[0005]**
- JP 2001100986 A **[0005]**