



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
03.09.2008 Bulletin 2008/36

(51) Int Cl.:
F25B 1/00 (2006.01)

(21) Application number: **06834561.0**

(86) International application number:
PCT/JP2006/324806

(22) Date of filing: **13.12.2006**

(87) International publication number:
WO 2007/069624 (21.06.2007 Gazette 2007/25)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR

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(30) Priority: **16.12.2005 JP 2005363739**

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(54) **AIR CONDITIONER**

(57) An object of the present invention is to eliminate stagnation of refrigerant in refrigerating machine oil in a compression mechanism, and to use the difference in the solubility of the refrigerant in the oil to minimize error in predicting the quantity of refrigerant. An air conditioner (1) is provided with a refrigerant circuit (7), refrigerant stagnation judgment means (8a to 8c), and an operation controller (6a to 6c). The refrigerant circuit is a circuit that includes a heat source unit (2a to 2c), a refrigerant communication pipe (4, 5), an expansion mechanism (31a, 31 b, ...), and a utilization unit (29a to 29c, 3a, 3b, ...). A heat source unit and a utilization unit are connected to

the refrigerant fluid communication pipes. The heat source unit has a compression mechanism (21a to 21c) and a heat source side heat exchanger (24a to 24c). The refrigerant stagnation judging means can judge whether the refrigerant has stagnated inside the compression mechanism. The operation controller performs a refrigerant de-stagnation operation for eliminating stagnation of the refrigerant in the case that the refrigerant stagnation judging means has judged in advance that the refrigerant inside the compression mechanism has stagnated when a refrigerant quantity judging operation is carried out for judging the refrigerant quantity inside the refrigerant circuit.

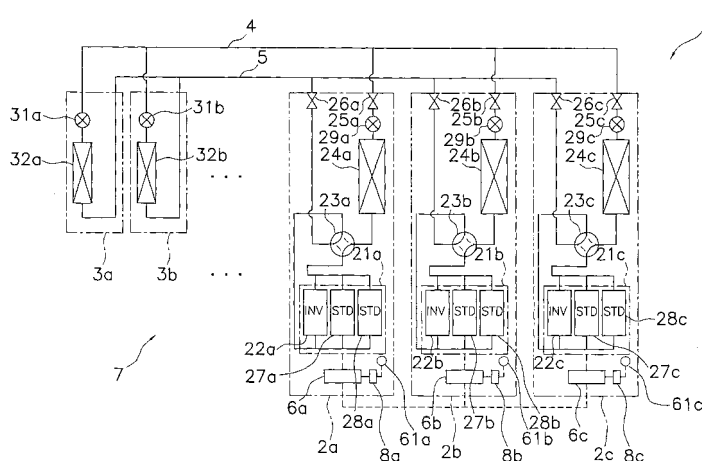


FIG. 1

Description**TECHNICAL FIELD**

[0001] The present invention relates to a refrigerant circuit of an air conditioner and an air conditioner provided therewith.

BACKGROUND ART

[0002] An example of a conventional refrigerant leak detector of a refrigeration apparatus is disclosed in Patent Document 1. In this refrigerant leak detector, a condensation refrigerant temperature and an evaporative refrigerant temperature are kept at a fixed value by using condensation refrigerant temperature adjustment means and evaporative refrigerant temperature adjustment means, and a refrigerant leak detection operation for detecting refrigerant leaks in a refrigerating cycle is carried out using temperature difference calculation means for comparing output signals of a discharge refrigerant temperature detector and set values and calculating a temperature difference. Therefore, the temperature of the condensation refrigerant that flows through a condenser and the temperature of the evaporative refrigerant that flow through an evaporator are kept at a fixed value, whereby the discharge refrigerant temperature under a suitable refrigerant quantity is set to the set value. The set value and the output signal of the discharge refrigerant temperature detector are compared, a judgment is made that a refrigerant leak has not occurred when the value is less than the set value, and a judgment is made that a refrigerant leak has occurred when the value is higher than the set value.

<Patent Document 1>

Japanese Patent Application Publication No. H11-211292

DISCLOSURE OF THE INVENTION**PROBLEMS THAT THE INVENTION IS TO SOLVE**

[0003] However, with the technique of Patent Document 1, a risk is presented that the predicted error of the refrigerant quantity will increase because the refrigerant quantity that dissolves into the refrigerating machine oil inside the compression mechanism increases when the outside temperature is low. The refrigerant leak detection error increases when the internal oil temperature is low immediately after the compressor has started up and when only a portion of the compressors are driven during a refrigerant leak detection operation when a plurality of compressors are present.

[0004] An object of the present invention is to solve the stagnation of refrigerant in refrigeration machine oil inside a compressor, and to minimize the prediction error of the refrigerant quantity produced by the difference of solubility of the refrigerant into the oil.

MEANS OF SOLVING THE PROBLEMS

[0005] The air conditioner according to a first aspect is provided with a refrigerant circuit, a refrigerant stagnation judging means, and an operation controller. The refrigerant circuit is a circuit that includes a heat source unit, refrigerant communication pipes, expansion mechanisms, and a utilization unit. The heat source unit has a compression mechanism and a heat source side heat exchanger. A heat source unit is connected to the refrigerant communication pipes. The utilization unit has a utilization side heat source exchanger and is connected to the refrigerant communication pipe. The refrigerant stagnation judging means can judge whether the refrigerant is stagnant inside the compression mechanism. The operation controller performs a refrigerant de-stagnation operation for eliminating stagnation of the refrigerant in the case that the refrigerant stagnation judging means has judged in advance that the refrigerant is stagnant inside the compression mechanism when a refrigerant quantity judging operation is carried out for judging the refrigerant quantity inside the refrigerant circuit.

[0006] In the air conditioner, the refrigerant stagnation judging means makes a judgment in advance whether refrigerant is stagnant in the refrigeration machine oil inside the compression mechanism when the refrigerant quantity judgment operation is carried out. The operation controller performs the refrigerant de-stagnation operation when the refrigerant stagnation judging means judges that refrigerant has stagnated in the refrigeration machine oil inside the compression mechanism.

[0007] Therefore, in the air conditioner, the refrigerant quantity judgment operation can be performed after refrigerant stagnation has been eliminated in refrigeration machine oil inside the compression mechanism. For this reason, the quantity of refrigerant that dissolves into the refrigeration machine oil inside the compression mechanism can be dramatically reduced and error in predicting the refrigerant quantity can be reduced during the refrigerant quantity judgment operation. A more precise refrigerant quantity judgment operation is made possible because the refrigerant stagnation

can be eliminated in the refrigeration machine oil inside the compression mechanism during the refrigerant quantity judgment operation.

[0008] The air conditioner according to a second aspect is the air conditioner according to the first aspect, wherein the refrigerant stagnation judging means makes a judgment on the basis of the temperature inside the compression mechanism.

[0009] In the air conditioner, the judgment of the refrigerant stagnation judgment means is performed based on the temperature inside the compression mechanism. Refrigerant more readily stagnates in the refrigeration machine oil when the temperature inside the compression mechanism is low. Therefore, it is possible to determine that refrigerant has stagnated in the refrigeration machine oil inside the compression mechanism when the temperature inside the compression mechanism is low. For this reason, it is possible to judge whether refrigerant has stagnated in the refrigeration machine oil inside the compression mechanism on the basis of the temperature inside the compression mechanism.

[0010] The air conditioner according to a third aspect is the air conditioner according to the first aspect, wherein the refrigerant stagnation judging means makes a judgment on the basis of the outside air temperature.

[0011] In the air conditioner, the refrigerant stagnation judging means judges based on the temperature of the outside air. The refrigerant readily becomes stagnant in the refrigeration machine oil when the temperature inside the compression mechanism is low. Therefore, the temperature inside the compression mechanism can be predicted because the temperature of the outside air can be measured. For this reason, the judgment that refrigerant has stagnated in the refrigeration machine oil inside the compression mechanism is made possible when the temperature inside the compression mechanism can be predicted to be low. Judgment as to whether the refrigerant has stagnated in the refrigeration machine oil inside the compression mechanism is thereby made possible.

[0012] The air conditioner according to a fourth aspect is the air conditioner according to the first aspect, wherein the refrigerant stagnation judging means makes a judgment on the basis of weather information.

[0013] In the air conditioner, the refrigerant stagnation judging means makes a judgment based on weather information obtained via a network connected to the refrigerant stagnation judgment means. Therefore, the outside temperature can be acquired from the weather information, and the temperature inside the compression mechanism can be predicted. It is accordingly possible to determine that the refrigerant has stagnated in the refrigeration machine oil inside the compression mechanism when the temperature inside the compression mechanism can be predicted to be low. Judgment as to whether refrigerant has stagnated in the refrigeration machine oil inside the compression mechanism is thereby made possible.

[0014] The air conditioner according to a fifth aspect is the air conditioner according to the first aspect, wherein the refrigerant stagnation judgment means makes judgment on the basis of a refrigerant stagnation interval in which the refrigerant is predicted to readily stagnate inside the compression mechanism.

[0015] In the air conditioner, the refrigerant stagnation judging means makes a judgment based on a time interval that has been set in advance. The refrigerant readily stagnates in the refrigeration machine oil when the temperature inside the compression mechanism is low. The judgment is made by establishing a time interval in which the temperature inside the compression mechanism is predicted to be low. Therefore, the user sets the time interval in which the temperature inside the compression mechanism is predicted to be low, whereby the refrigerant stagnation can be predicted without measuring the temperature inside the compression mechanism. It is thereby possible to judge whether the refrigerant has stagnated in the refrigeration machine oil inside the compression mechanism. Also, production costs can be reduced because a temperature sensor or the like no longer needs to be installed.

[0016] The air conditioner according to a sixth aspect is the air conditioner according to any of the first to fifth aspects, wherein the operation controller performs a control for driving the compression mechanism for a first prescribed time as the refrigerant de-stagnation operation.

[0017] In the air conditioner, the refrigerant de-stagnation operation is a warm-up operation that is performed by driving a compressor for a first prescribed length of time. Therefore, in the refrigerant de-stagnation operation, a compressor is operated for a first prescribed length of time, whereby the interior of the compression mechanism can be warmed up. For this reason, refrigerant stagnation in the refrigeration machine oil inside the compression mechanism can be eliminated.

[0018] The air conditioner according to a seventh aspect is the air conditioner according to any of the first to sixth aspects, wherein a plurality of the heat source units is present.

[0019] In the air conditioner, a plurality of heat source units is present. Therefore, the service life of the entire system can be extended without placing the load exclusively on a single unit even during low-load operation, because the heat source units in the system can be placed in a rotation and driven at fixed intervals of time one unit at a time.

[0020] The air conditioner according to an eighth aspect is the air conditioner according to any of the first to seventh aspects, wherein the compression mechanism has a plurality of compressors.

[0021] In the air conditioner, the compression mechanism has a plurality of compressors. Therefore, all of the heat source units can be continuously operated and the pooling of refrigerant and oil in the refrigerant circuit can be prevented to the extent possible even when the operating load of the utilization unit has been reduced because the capacity of the

compression mechanism can be varied by controlling the number of compressors. The remaining compressors can handle the load even if one of the compressors malfunctions. For this reason, a complete stoppage of the air conditioner can be avoided.

[0022] The air conditioner according to a ninth aspect is the air conditioner according to the eighth aspect, wherein the refrigerant de-stagnation operation is an operation for driving at least a compressor that is not driven during the refrigerant quantity judgment operation.

[0023] In the air conditioner, in relation to the compressors that are used during pre-operation, at least a compressor that is not driven when the refrigerant quantity judging is driven because the compressors that are driven to judge the refrigerant quantity can be sufficiently warmed at the time of the refrigerant quantity judging operation when a plurality of compressor is present.

[0024] Therefore, the energy that is used can be reduced because all of the compressors are not required to operate. Also, the time required for the refrigerant de-stagnation operation can be reduced.

[0025] The air conditioner according to a tenth aspect is the air conditioner according to the eighth aspect, wherein the refrigerant de-stagnation operation is an operation in which the operation controller operates all of the compressors one at a time in sequence for a second prescribed time interval.

[0026] In the air conditioner, all of the compressors are driven for a second prescribed time period in a single-unit rotation when a plurality of compressors is present. It is difficult to cause all of the compressors to operate at the same time at the time of the refrigerant de-stagnation operation due to a low load because the refrigeration operation is carried out when the outside temperature is low. For this reason, the units are operated one at a time for a second prescribed time interval, whereby all of the compressors can be operated in advance.

[0027] The air conditioner according to an eleventh aspect is the air conditioner according to the first aspect, further comprising a heater for warming the compression mechanism. The refrigerant de-stagnation operation is an operation for warming the compression mechanism using the heater.

[0028] In the air conditioner, the refrigerant de-stagnation operation can be performed by warming the compression mechanism using a heater. Therefore, refrigerant stagnation can be eliminated without driving a compressor. For this reason, the time that a compressor is driven can be reduced and the service life of a compressor can be extended because a compressor is not required to be driven during the refrigerant de-stagnation operation.

[0029] The air conditioner according to a twelfth aspect is the air conditioner according to any of the first to eleventh aspects, wherein the operation controller further performs an oil-return operation immediately after the refrigerant de-stagnation operation. The oil-return operation is an operation for returning oil pooled in the refrigerant circuit to the compression mechanism.

[0030] In the air conditioner, an oil-return operation is further carried out after the refrigerant de-stagnation operation. Therefore, oil that is pooled in the refrigerant circuit can be returned to the compression mechanism by further carrying out an oil-return operation. The refrigerant quantity judgment operation can accordingly be carried out with greater precision.

[0031] The air conditioner according to a thirteenth aspect is the air conditioner according to the twelfth aspect, wherein the oil-return operation is an operation for controlling the refrigerant that flows through the refrigerant circuit so that the refrigerant flows inside the pipes at or above a prescribed rate.

[0032] In the air conditioner, the oil-return operation is an operation for controlling the refrigerant so that the refrigerant flows inside the pipes at or above a prescribed rate. Therefore, oil pooled in the refrigerant circuit can be reliably returned to the compression mechanism. The refrigerant quantity judgment operation can accordingly be carried out with greater precision.

EFFECT OF THE INVENTION

[0033] In the air conditioner according to the first aspect, the refrigerant quantity judging operation can be carried out after the stagnation of refrigerant has been eliminated in the refrigeration machine oil inside the compression mechanism. The quantity of refrigerant that has dissolved in the refrigeration machine oil inside the compression mechanism can accordingly be reduced to the extent possible at the time of the refrigerant quantity judging operation, and the prediction error of the refrigerant quantity can be reduced. A more precise refrigerant quantity judgment operation is made possible because the refrigerant stagnation can be eliminated in the refrigeration machine oil inside the compression mechanism during the refrigerant quantity judgment operation.

[0034] In the air conditioner according to the second aspect, the refrigerant can be judged to have stagnated in the refrigeration machine oil inside the compression mechanism when the temperature inside the compression mechanism is low. For this reason, the decision as to whether the refrigerant has stagnated in the refrigeration machine oil inside the compression mechanism can be made on the basis of the temperature inside the compression mechanism.

[0035] In the air conditioner according to the third aspect, the temperature inside the compression mechanism can be predicted because the temperature of the outside air can be measured. Accordingly, it can be judged that the refrigerant

has stagnated in the refrigeration machine oil inside the compression mechanism when the temperature inside the compression mechanism can be predicted to be low. It can thereby be judged whether the refrigerant has stagnated in the refrigeration machine oil inside the compression mechanism.

[0036] In the air conditioner according to the fourth aspect, the temperature of the outside air can be acquired from weather information and the temperature inside the compression mechanism can be predicted. Accordingly, it can be judged that the refrigerant has stagnated in the refrigeration machine oil inside the compression mechanism when the temperature inside the compression mechanism can be predicted to be low. It can thereby be judged whether the refrigerant has stagnated in the refrigeration machine oil inside the compression mechanism.

[0037] In the air conditioner according to the fifth aspect, a user sets a length of time in which the temperature inside the compression mechanism is predicted to be low, whereby refrigerant stagnation can be predicted without measuring the temperature inside the compression mechanism. It is thereby possible to judge whether refrigerant has stagnated in the refrigeration machine oil inside the compression mechanism. Production costs can be reduced because there is no longer a need to install a temperature sensor or the like.

[0038] In the air conditioner according to the sixth aspect, the interior of the compression mechanism can be warmed by operating a compressor for a first prescribed length of time. For this reason, refrigerant stagnation in the refrigeration machine oil inside the compression mechanism can be eliminated.

[0039] In the air conditioner according to the seventh aspect, the service life of the entire system can be extended without placing the load exclusively on a single unit even during low-load operation because the heat source units in the system can be placed in a rotation and driven at fixed intervals of time one unit at a time.

[0040] In the air conditioner according to the eighth aspect, all of the heat source units can be operated continuously and the pooling of refrigerant and oil in the refrigerant circuit can be prevented to the extent possible even when the operating load of the utilization units is low, because the capacity of the compression mechanism can be varied by controlling the number of compressors. The remaining compressors can handle the load even if one of the compressors malfunctions. For this reason, a complete stoppage of the air conditioner can be avoided.

[0041] In the air conditioner according to the ninth aspect, the energy that is used can be reduced because all of the compressors are not required to operate. Also, the time required for the refrigerant de-stagnation operation can be reduced.

[0042] In the air conditioner according to the tenth aspect, all of the compressors can be driven in advance by operating the compressors for a second prescribed time interval one unit at a time. In the air conditioner according to the eleventh aspect, stagnation of the refrigerant can be eliminated without driving a compressor. The time a compressor is driven can be reduced and the service life of the compressors can be extended because a compressor is not required to be driven during the refrigerant de-stagnation operation.

[0043] In the air conditioner according to the twelfth aspect, oil that has pooled in the refrigerant circuit can be returned to the compression mechanism by further performing an oil-return operation. The refrigerant quantity judging operation can accordingly be carried out with greater precision.

[0044] In the air conditioner according to the thirteenth aspect, oil that has pooled inside the refrigerant circuit can be reliably returned to the compression mechanism. The refrigerant quantity judging operation can accordingly be carried out with greater precision.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045]

FIG. 1 is a schematic diagram of a refrigerant circuit of an air conditioner related to an embodiment of the present invention;

FIG. 2 is a flowchart showing the flow of a refrigerant leak detection operation related to an embodiment of the present invention;

FIG. 3 is a flowchart showing the flow of an automatic refrigerant charging operation related to an embodiment of the present invention;

FIG. 4 is a flowchart showing the flow of a refrigerant quantity judging preparatory operation related to an embodiment of the present invention;

FIG. 5 is a flowchart showing the flow of a refrigerant de-stagnation operation related to an embodiment of the present invention;

FIG. 6 is a flowchart showing the flow of an oil-return operation related to an embodiment of the present invention; and

FIG. 7 is a schematic diagram of a weather information acquisition network of an air conditioner related a modified example (E) of an embodiment of the present invention.

DESCRIPTION OF THE REFERENCE SYMBOLS

[0046]

5	1	Air conditioner
	2a to 2c	Heat source units
	3a, 3b,	Utilization units
	4, 5	Refrigerant communication pipes
	6a to 6c	Operation controllers
10	8a to 8c	Refrigerant stagnation judging means
	21a to 21c	Compression mechanisms
	22a to 22c, 27a to 27c, 28a to 28c	Compressors
	24a to 24c	Heat source side heat exchangers
	29a to 29c	Heat source side expansion valves
15	31 a, 31 b,	Utilization side expansion valves
	32a, 32c,	Utilization side heat exchangers

BEST MODE FOR CARRYING OUT THE INVENTION

(1) Configuration of the air conditioner

[0047] FIG. 1 shows a schematic diagram of refrigerant circuit of an air conditioner 1 related to a first embodiment of the present invention. The air conditioner 1 is used for conditioning the air of a building or the like, and has a configuration in which a plurality (three, in the present embodiment) of air-cooled heat source units 2a to 2c and numerous utilization units 3a, 3b, ... are connected in parallel to a liquid refrigerant communication pipe 4 and a gas refrigerant communication pipe 5, respectively. In this case, only two utilization units 3a and 3b are shown. The plurality of heat source units 2a to 2c are provided with compression mechanisms 21 a to 21c that each have single variable-capacity compressors 22a to 22c and a plurality (two, in the present embodiment) fixed-capacity compressors 27a to 27c, and 28a to 28c.

[0048] The utilization units 3a, 3b, ... are mainly composed of utilization side expansion valves 31a, 31b, ... , utilization side heat exchangers 32a, 32b, ... , and pipes that connect thereto, respectively. In the present embodiment, the utilization side expansion valves 31a, 31b, ... are electrically driven expansion valves connected to the liquid refrigerant communication pipe 4 side (hereinafter referred to as a liquid side) of the utilization side heat exchangers 32a, 32b, ... in order to adjust the refrigerant pressure, adjust the refrigerant flow rate, and perform other operations. In the present embodiment, the utilization side heat exchangers 32a, 32b, ... are cross-fin tube heat exchangers and are devices for exchanging heat with indoor air. In the present embodiment, the utilization units 3a, 3b, ... are provided with a indoor fan (not shown) for taking indoor air into the units and discharging air, and can exchange heat between the indoor air and the refrigerant that flows through the utilization side heat exchangers 32a, 32b,

[0049] The heat source units 2a to 2c are mainly composed of compression mechanisms 21 a to 21 c, four-way switching valves 23a to 23c, heat source side heat exchangers 24a to 24c, liquid side stop valves 25a to 25c, gas side stop valves 26a to 26c, heat source side expansion valves 29a to 29c, and pipes that connect thereto, respectively. In the present embodiment, the heat source side expansion valves 29a to 29c are electrically driven expansion valves connected to the liquid refrigerant communication pipe 4 side (hereinafter referred to as a liquid side) of the heat source side expansion valves 29a to 29c in order to adjust the refrigerant pressure, adjust the refrigerant flow rate, and perform other operations. The compression mechanisms 21a to 21c have variable-capacity compressors 22a to 22c, two fixed-capacity compressors 27a to 27c and 28a to 28c, and an oil separator (not shown).

[0050] The compressors 22a to 22c, 27a to 27c, and 28a to 28c are devices for compressing refrigerant gas that has been taken in, and, in the present embodiment, are composed of a single variable-capacity compressor in which the operating capacity can be changed by inverter control, and two fixed-capacity compressors.

[0051] The four-way switching valves 23a to 23c are valves for switching the direction of the flow of the refrigerant when a switch is made between cooling and heating operations; during cooling operation, are capable of connecting the compression mechanisms 21a to 21c and the gas refrigerant communication pipe 5 side (hereinafter referred to as gas side) of the heat source side heat exchangers 24a to 24c, and connecting a suction side of the compressors 21 a to 21c and the gas refrigerant communication pipe 5 (see the solid lines of the four-way switching valves 23a to 23c of FIG. 1); and, during heating operation, are capable of connecting the outlets of the compression mechanisms 21a to 21c and the gas refrigerant communication pipe 5, and connecting the suction side of the compression mechanisms 21 a to 21c and the gas side of the heat source side heat exchangers 24a to 24c (see the broken lines of the four-way switching valves 23a to 23c of FIG. 1).

[0052] In the present embodiment, the heat source side heat exchangers 24a to 24c are cross-fin tube heat exchangers

and are devices for exchanging heat between the refrigerant and outside air as a heat source. In the present embodiment, the heat source units 2a to 2c are provided with an outdoor fan (not shown) for taking outdoor air into the units and discharging air, and can exchange heat between the outdoor air and the refrigerant that flows through the heat source side heat exchangers 24a to 24c.

[0053] The liquid side stop valves 25a to 25c and the gas side stop valves 26a to 26c of the heat source units 2a to 2c are connected in parallel to the liquid refrigerant communication pipe 4 and the gas refrigerant communication pipe 5. The liquid refrigerant communication pipe 4 is connected between the liquid side of the utilization side heat exchangers 32a, 32b, ... of the utilization units 3a, 3b, ... and the liquid side of the heat source side heat exchangers 24a to 24c of the heat source units 2a to 2c. The gas refrigerant communication pipe 5 is connected between the gas side of the utilization side heat exchangers 32a, 32b, ... of the utilization units 3a, 3b, ... and the four-way switching valves 23a to 23c of the heat source units 2a to 2c.

[0054] The air conditioner 1 is further provided with refrigerant stagnation judging means 8a to 8c and operation controllers 6a to 6c. The refrigerant stagnation judging means 8a to 8c judges whether refrigerant has stagnated inside the compression mechanisms 21a to 21c. The operation controllers 6a to 6c carry out in advance a refrigerant de-stagnation operation for resolving stagnation of the refrigerant when the refrigerant has stagnated in the compression mechanisms 21a to 21c when a refrigerant quantity judging operation for judging the of refrigerant quantity inside the refrigerant circuit 7 is carried out. In the present embodiment, the refrigerant stagnation judging means and the operation controllers 6a to 6c are housed in the heat source units 2a to 2c. Operation control such as that described above can be performed using only the operation controller (6a, in this case) of the heat source unit (2a, in this case) set as the parent device. The operation controllers (6b and 6c, in this case) of the heat source units (2a and 2b, in this case) set as the other subordinate devices can send the operating state of the compression mechanism and other devices and detection data in the various sensors to the parent operation controller 6a, and can function so as to send operation and stop commands to the compression mechanism and other devices via commands from the parent operation controller 6a. In this case, temperature sensors 61a to 61c (see FIG. 1) are provided, the temperature of the outside air is measured by the temperature sensors, and the temperature data is sent to the parent operation controller 6a. In the operation controller 6a, a judgment is made whether to perform the refrigerant de-stagnation operation.

(2) Operation of the air conditioner

[0055] Next, the operation of the air conditioner 1 will be described with reference to FIG. 1.

<Normal operation>

(Cooling operation)

[0056] The cooling operation will be described first. During the cooling operation, the four-way switching valves 23a to 23c in all of the heat source units 2a to 2c are in the state indicated by the solid lines in FIG. 1, i.e., the discharge side of the compression mechanisms 21a to 21c is connected to the gas side of the heat source side heat exchangers 24a to 24c, and the suction side of the compression mechanisms 21a to 21c is connected to the gas side of the utilization side heat exchangers 32a, 32b, ... via the gas refrigerant communication pipe 5. Also, the liquid side stop valves 25a to 25c and the gas side stop valves 26a to 26c are opened and the opening position of the utilization side expansion valves 31a, 31b, ... is adjusted so as to reduce the pressure of the refrigerant.

[0057] In this state of the refrigerant circuit 7 of the air conditioner 1, the refrigerant gas is taken into the compression mechanisms 21a to 21c and compressed when the outdoor fans (not shown) of the heat source units 2a to 2c and the indoor fans (not shown) and the compression mechanisms 21a to 21c of the utilization units 3a, 3b, ... are started up, whereupon the refrigerant gas is sent to the heat source side heat exchangers 24a to 24c via the four-way switching valves 23a to 23c, exchanges heat with the outside air, and is condensed. The condensed refrigerant liquid is merged with the liquid refrigerant communication pipe 4 and sent to the utilization units 3a, 3b, The refrigerant fluid sent to the utilization units 3a, 3b, ... is reduced in pressure by the utilization side expansion valves 31a, 31b, ... , is then subjected to heat exchange with indoor air in the utilization side heat exchangers 32a, 32b, ... , and is then caused to evaporate. The evaporated refrigerant gas is sent through the gas refrigerant communication pipe 5 to the heat source units 2a to 2c side. The refrigerant gas that flows through the gas refrigerant communication pipe 5 passes through the four-way switching valves 23a to 23c of the heat source units 2a to 2c, and is thereafter taken into the compression mechanisms 21a to 21c again. The cooling operation is carried out in this manner.

(Heating operation)

[0058] The heating operation will be described next. During the heating operation, the four-way switching valves 23a

to 23c in all of the heat source units 2a to 2c are in the state indicated by the broken lines in FIG. 1, i.e., the discharge side of the compression mechanisms 21a to 21c is connected to the gas side of the utilization side heat exchangers 32a, 32b, ... via the gas refrigerant communication pipe 5 and the suction side of the compression mechanisms 21a to 21c is connected to the gas side of the heat source side heat exchangers 24a to 24c. Also, the liquid side stop valves 25a to 25c and the gas side stop valves 26a to 26c are opened and the opening position of the heat source side expansion valves 29a to 29c is adjusted so as to reduce the pressure of the refrigerant.

[0059] In this state of the refrigerant circuit 7 of the air conditioner 1, the refrigerant gas is taken into the compression mechanisms 21a to 21c and compressed when the outdoor fans (not shown) of the heat source units 2a to 2c and the indoor fans (not shown) and the compression mechanisms 21a to 21c of the utilization units 3a, 3b, ... are started up, whereupon the refrigerant gas is merged with the gas refrigerant communication pipe 5 via the four-way switching valves 23a to 23c of the heat source units 2a to 2c and sent to the utilization units 3a, 3b, ... side. The refrigerant gas sent to the utilization units 3a, 3b, ... , exchanges heat with the indoor air via the utilization side heat exchangers 32a, 32b, ... , and is condensed. The condensed refrigerant is merged with the liquid refrigerant communication pipe 4 via the utilization side expansion valves 31a, 31b, ... , and is sent to the heat source units 2a to 2c side. The refrigerant liquid that flows through the liquid refrigerant communication pipe 4 is made to exchange heat with the outside air via the heat source side heat exchangers 24a to 24c of the heat source units 2a to 2c, and is caused to evaporate. The evaporated refrigerant gas is taken into the compression mechanisms 21a to 21c again via the four-way switching valves 23a to 23c of the heat source units 2a to 2c. The heating operation is carried out in this manner.

<Refrigerant quantity judging operation>

[0060] Next, the refrigerant quantity judging operation will be described. The refrigerant quantity judging operation includes a refrigerant leakage detection operation and an automatic refrigerant charging operation.

(Refrigerant leak detection operation)

[0061] The refrigerant leak detection operation, which is one of the refrigerant quantity judging operation, will be described with reference to FIGS. 1 and 2. Here, FIG. 2 is a flowchart of the refrigerant leak detection operation.

[0062] As an example, a case will be described in which operation is periodically (e.g., once per month, when load processing is not required in the air conditioning space, or at another time) switched to the refrigerant leak detection operation, which is a refrigerant quantity judging operation, during cooling operation or heating operation in normal operation, whereby detection is performed to determine whether refrigerant inside the refrigerant circuit 7 has leaked to the exterior due to an unknown cause.

[0063] First, in step S1, a refrigerant quantity judging preparatory operation is carried out prior to refrigerant leak detection operation. The refrigerant quantity judging preparatory operation will be described later.

[0064] Next, in step S2, a judgment is made whether an operation in normal operation such as the cooling operation or the heating operation described above has continued for a fixed length of time (e.g., one month), and the process proceeds to the next step S2 when an operation in normal operation has continued for a fixed length of time.

[0065] In step S3, when an operation in normal operation has continued for a fixed length of time, the refrigerant circuit 7 enters a state in which the four-way switching valves 23a to 23c of the heat source units 2a to 2c are in the state indicated by the solid lines of FIG. 1, the utilization side expansion valves 31a, 31b, ... of the utilization units 3a, 3b, ... are opened, the compression mechanisms 21a to 21c and the outdoor fan (not shown) are actuated, and a cooling operation is forcibly carried out in all of the utilization units 3a, 3b,

[0066] In step S4, condensation pressure control by an outdoor fan, overheating control by the utilization side expansion valves 31a, 31b, ... , and evaporation pressure control by the compression mechanisms 21a to 21c are carried out and the state of the refrigerant that circulates inside the refrigerant circuit 7 is stabilized.

[0067] In step S5, subcooling degree is detected at the outlets of the heat source side heat exchangers 24a to 24c.

[0068] In step S6, the subcooling degree detected in step S5 is used to judge whether the refrigerant quantity is adequate. The adequacy of the refrigerant quantity charged in the refrigerant circuit 7 can be judged when subcooling degree is detected in step S5 by using the subcooling degree of the refrigerant at the outlets of the heat source side heat exchangers 24a to 24c without relation to the mode of the utilization units 3a, 3b, ... and the length of the liquid refrigerant communication pipe 4 and gas refrigerant communication pipe 5.

[0069] The refrigerant quantity in the heat source side heat exchangers 24a to 24c is at a low level when the quantity of additional refrigerant charging is low and the required refrigerant quantity is not attained (specifically indicating that the subcooling degree detected in step S5 is less than a subcooling degree that corresponds to the refrigerant quantity that is required for condensation pressure of the heat source side heat exchangers 24a to 24c). It is judged that there is no refrigerant leakage when the subcooling degree detected in step S5 is substantially the same degree (e.g., the difference between the detected subcooling degree and the target subcooling degree is less than a prescribed degree)

as the target subcooling degree, and the refrigerant leak detection operation is ended.

[0070] On the other hand, when the subcooling degree detected in step S5 is a degree that is less than the target subcooling degree (e.g., the difference between the detected subcooling degree and the target subcooling degree is a prescribed degree or greater), it is judged that refrigerant leakage has occurred. The process proceeds to the processing of step S7, and a warning that provides notification that refrigerant leakage has been detected is displayed, whereupon the refrigerant leak detection operation is ended.

(Automatic refrigerant charging operation)

[0071] The automatic refrigerant charging operation as one of the refrigerant quantity judging operation will be described with reference to FIGS. 1 and 3. Here, FIG. 3 is a flowchart of the automatic refrigerant charging operation.

[0072] As an example, a case will be described in which a refrigerant circuit 7 is assembled at the installation site by connecting the utilization units 3a, 3b, ... and the heat source units 2a to 2c filled with refrigerant in advance are connected by way of the liquid refrigerant communication pipe 4 and gas refrigerant communication pipe 5, and refrigerant that is lacking is thereafter added and charged in the refrigerant circuit 7 in accordance with the length of the liquid refrigerant communication pipe 4 and the gas refrigerant communication pipe 5.

[0073] First, the liquid side stop valves 25a to 25c and the gas side stop valves 26a to 26c of the heat source units 2a to 2c are opened, and the refrigerant charged in advance in the heat source units 2a to 2c is filled into the refrigerant circuit 7.

[0074] Next, the person who carries out the refrigerant charging work sends a command to carry out an automatic refrigerant charging operation, which is one of the refrigerant quantity judging operation, via remote control or directly to utilization side controllers (not shown) of the utilization units 3a, 3b, ... or to the operation controllers 6a to 6c of the heat source units 2a to 2c, whereupon the automatic refrigerant charging operation is carried out in the sequence of step S11 to step S14.

[0075] In step S11, the refrigerant quantity judging preparatory operation is carried out prior to the automatic refrigerant charging operation. The refrigerant quantity judging preparatory operation will be described later.

[0076] In step S12, when a command has been issued for the automatic refrigerant charging operation to begin, the refrigerant circuit 7 enters a state in which the four-way switching valves 23a to 23c of the heat source units 2a to 2c are in the state indicated by the solid lines of FIG. 1, the utilization side expansion valves 31a, 31b, ... of the utilization units 3a, 3b, ... are opened, the compression mechanisms 21a to 21c and the outdoor fan (not shown) are actuated, and a cooling operation is forcibly carried out in all of the utilization units 3a, 3b,

[0077] In step S13, condensation pressure control by an outdoor fan, overheating control by the utilization side expansion valves 31a, 31b, ..., and evaporation pressure control by the compression mechanisms 21a to 21c are carried out and the state of the refrigerant that circulates inside the refrigerant circuit 7 is stabilized.

[0078] In step S14, subcooling degree is detected at the outlets of the heat source side heat exchangers 24a to 24c.

[0079] In step S15, the subcooling degree detected in step S14 is used to judge whether the amount of refrigerant is adequate. Specifically, when the subcooling degree detected in step S14 is less than the target subcooling degree and refrigerant charging is not completed, the processing of step S13 and step S14 is repeated until the subcooling degree reaches the target subcooling degree.

[0080] The automatic refrigerant charging operation can be carried out when refrigerant is charged during a test operation after onsite installation, and can also be used to perform additional refrigerant charging when the quantity of refrigerant charged in the refrigerant circuit 7 has been reduced due to refrigerant leakage or the like.

<Refrigerant quantity judging preparatory operation>

[0081] In the refrigerant quantity judging operation described above, refrigerant stagnation judging means 8a to 8c judges that the refrigerant has stagnated inside the compression mechanisms 21a to 21c when the temperature detected by temperature sensors 61a to 61c is lower than a prescribed temperature, and sends a signal indicating the stagnation of the refrigerant to the operation controller 6a. The operation controller 6a, which has received a signal from the refrigerant stagnation judging means 8a to 8c, performs a control (refrigerant de-stagnation operation) preliminarily so that the compressors 22a to 22c, 27a to 27c, and 28a to 28c are sufficiently warmed.

[0082] In FIG. 4, the operation controller 6a judges in step S21 whether the temperature inside the compression mechanisms 21a to 21c measured by the temperature sensors 61a to 61c is lower than a prescribed temperature. When the compressor temperature is lower than the prescribed temperature, the process proceeds to step S22, and when the temperature is not lower than the prescribed temperature, the process proceeds to step S23. The refrigerant de-stagnation operation is carried out in step S22 and the process proceeds to step S23. An oil-return operation is carried out in step S23. When the oil-return operation is completed, the process proceeds to step S2 in the case that the refrigerant quantity judging operation is a refrigerant leak detection operation, and the process proceeds to step S12 in

the case that the refrigerant quantity judging operation is an automatic refrigerant charging operation.

(Refrigerant de-stagnation operation)

[0083] Here, the refrigerant de-stagnation operation of step S22 described above will be described. The operation controller 6a issues a drive command to all of the compression mechanisms 21a to 21c of the heat source units 2a to 2c when a signal is received from the refrigerant stagnation judging means 8a to 8c. In relation to the heat source units 2b and 2c, however, the operation controllers 6b and 6c, which are subordinate devices, receive the commands of the parent operation controller 6a and issue a drive command to the compression mechanisms 21b and 21c.

[0084] In FIG. 5, the compressors 22a to 22c are driven in step S31 and the process proceeds to step S32. In step S32, the compressors 22a to 22c are stopped 15 minutes after step S31, the compressors 27a to 27c are driven, and the process proceeds to step S33. In step S33, the compressors 27a to 27c are stopped 15 minutes after step S32, the compressors 28a to 28c are driven, and the process proceeds to step S34. In step S34, the compressors 28a to 28c are stopped 15 minutes after step S33, and the refrigerant de-stagnation operation is ended.

(Oil-return operation)

[0085] The oil-return operation of step S23 is carried out when the refrigerant de-stagnation operation described above is ended, or when the temperature of the compressors in step S21 is higher than a prescribed temperature. Here, the oil-return operation will be described with reference to FIG. 6.

[0086] In step S41, the operation controller 6a issues a command to drive one of the compressors (i.e., compressors 22a to 22c) of the heat source units 2a to 2c. In relation to the heat source units 2b and 2c, however, the operation controllers 6b and 6c, which are subordinate devices, receive the commands of the parent operation controller 6a and the subordinate operation controllers 6b and 6c issue a drive command to the compression mechanisms 22b and 22c. When step S41 is ended, the process proceeds to step S42. In step S42, the operation controller 6a issues a command to stop after the compressors 22a to 22c have been driven for 5 minutes. The oil pooled in the refrigerant circuit 7 can thereby be returned to the compression mechanisms 21 a to 21 c.

<Characteristics>

[0087]

(1) In the air conditioner 1, the refrigerant stagnation judging means makes a judgment in advance whether refrigerant has stagnated in the refrigeration machine oil inside compressors 22a to 22c, 27a to 27c, and 28a to 28c when the refrigerant quantity judgment operation is carried out. The operation controller 6a performs the refrigerant de-stagnation operation when the refrigerant stagnation judging means judges that refrigerant has stagnated in the refrigeration machine oil inside the compression mechanisms 21 a to 21 c. Therefore, in the air conditioner 1, the judgment operation can be performed after refrigerant pooling has been eliminated in the refrigeration machine oil inside the compression mechanisms 21a to 21c. For this reason, the refrigerant quantity that dissolves into the refrigeration machine oil inside the compression mechanisms 21a to 21c can be reduced and the prediction error of the refrigerant quantity can be reduced during refrigerant quantity judgment operation. Since the stagnation of refrigerant in the refrigeration machine oil can accordingly be prevented in the compression mechanisms 21a to 21c during the refrigerant quantity judgment operation, a more precise refrigerant quantity judging operation is made possible.

(2) In the air conditioner 1, the judgment of the refrigerant stagnation judgment means is performed based on the temperature inside the compression mechanisms 21a to 21c. For this reason, the temperature inside the compressors 22a to 22c, 27a to 27c, and 28a to 28c can be measured and it is possible to judge whether refrigerant has stagnated in the refrigeration machine oil inside the compression mechanisms 21a to 21 c.

(3) In the air conditioner 1, the compressors 22a to 22c, 27a to 27c, and 28a to 28c are warmed up for a first prescribed length of time in the refrigerant de-stagnation operation. Therefore, the refrigerant de-stagnation operation entails operating the compressors 22a to 22c, 27a to 27c, and 28a to 28c for a first prescribed length of time, whereby the compression mechanisms 21a to 21c can be warmed (warm-up operation). The interior of the compression mechanisms 21a to 21c can accordingly be sufficiently warmed up and the stagnation of refrigerant in the refrigeration machine oil inside the compression mechanisms 21 a to 21 c can be eliminated.

(4) A plurality of heat source units 2a to 2c is present in the air conditioner 1. Therefore, the service life of the entire system can be extended without placing a load exclusively on a single unit even during low-load operation because the heat source units 2a to 2c in the system can be placed in a rotation and driven at fixed intervals of time one unit at a time.

(5) In the air conditioner 1, the compression mechanisms 21a to 21c have a plurality of compressors 22a to 22c,

27a to 27c, and 28a to 28c. Therefore, the capacity of the compression mechanisms 21a to 21c can be varied by controlling the number of compressors 22a to 22c, 27a to 27c, and 28a to 28c. Therefore, all of the heat source units 2a to 2c can be continuously operated and the pooling of refrigerant and oil in the refrigerant circuit 7 can be prevented to the extent possible even when the operating load of the utilization units 3a, 3b, ... has been reduced.

Also, the remaining compressors can handle the load even if one of the compressors 22a to 22c, 27a to 27c, and 28a to 28c malfunctions. For this reason, a complete stoppage of the air conditioner can be avoided.

(6) In the air conditioner 1, all of the compressors 22a to 22c, 27a to 27c, and 28a to 28c can be operated in a rotation of one unit at a time for a second prescribed length of time when a plurality of compressors 22a to 22c, 27a to 27c, and 28a to 28c is present. Since the cooling operation can be performed when the temperature of the outside is low during the refrigerant de-stagnation operation, it is difficult to operate the all of the compressors 22a to 22c, 27a to 27c, and 28a to 28c at the same time because of the low level of the load. For this reason, units are operated one unit at a time for a second prescribed length of time, whereby all of the compressors 22a to 22c, 27a to 27c, and 28a to 28c can be driven in advance.

(7) In the air conditioner 1, an oil-return operation is further carried out after the refrigerant de-stagnation operation. In the oil-return operation, a control is performed so that the flow rate of refrigerant in the pipes can be set to be a prescribed flow rate or higher. Therefore, oil that is pooled in the refrigerant circuit 7 can be returned by further carrying out an oil-return operation. The oil pooled in the refrigerant circuit 7 can be reliably returned to the compressors 22a to 22c, 27a to 27c, and 28a to 28c. The refrigerant quantity judgment operation can accordingly be carried out with greater precision.

<Other embodiments>

[0088] An embodiment of the present invention was described above with reference to the drawings; however, the specific configuration is not limited to the embodiment, and modifications can be made in a range that does not depart from the main point of the invention.

(A) In the embodiment described above, air-cooled heat source units 2a to 2c for which outside air is used as a heat source are used as the heat source units 2a to 2c of the air conditioner 1, but a water-cooled or an ice-storage heat source unit may also be used.

(B) In the embodiment described above, the air conditioner 1 is capable of switching between cooling and heating operation, but it is also possible to use a cooling-dedicate air conditioner or an air conditioner that is capable of simultaneous cooling and heating operation.

(C) In the embodiment described above, three heat source units 2a to 2c having the same air conditioning capacity were connected in parallel, but heat source units having different air conditioning capacity may also be used, and two or more heat source units without restriction to three units may also be connected in parallel.

(D) In the embodiment described above, operation controllers 6a to 6c are housed in the heat source units 2a to 2c, but it is possible to have a single operation controller as the entire air conditioner.

(E) In the embodiment described above, the refrigerant stagnation judgment means judged whether the refrigerant has stagnated in the compressors 22a to 22c, 27a to 27c, and 28a to 28c on the basis of the temperature of the outside air, but the judgment can be performed based on the temperature inside the compression mechanisms 21a to 21c, may be performed by acquiring weather information from an external server 10 that provides weather information via the Internet or another communication line 9 and making a judgment based on the weather information (FIG. 7), or may be performed based on a refrigerant stagnation time interval in which the refrigerant is predicted to readily stagnate in the compressors 22a to 22c, 27a to 27c, and 28a to 28c.

(F) In the embodiment described above, a plurality of heat source units 2a to 2c was used, but no limitation is imposed by a plurality of units, and a single unit may be used.

(G) In the embodiment described above, three compressors 22a to 22c, 27a to 27c, and 28a to 28c were driven for 15 minutes each during the refrigerant de-stagnation operation, but the length of time may be 5, 10, 20, or 30, without being limited to 15 minutes. All of the compressors 22a to 22c, 27a to 27c, and 28a to 28c are not required to be driven, and at least a compressor that has not been driven may be driven and operated during the refrigerant quantity judging operation.

(H) In the embodiment described above, the refrigerant de-stagnation operation was carried out by using a warm-up operation in which the compressors 22a to 22c, 27a to 27c, and 28a to 28c are driven to warm up the compression mechanisms 21a to 21c, but no limitation is imposed thereby, and the compression mechanisms 21a to 21c may be warmed up using a heater.

(I) In the embodiment described above, an oil-return operation is carried out immediately after the refrigerant de-stagnation operation, but an oil-return operation does not necessarily have to be performed.

INDUSTRIAL APPLICABILITY

[0089] The air conditioner of the present invention can eliminate the stagnation of refrigerant in refrigeration machine oil inside a compression mechanism prior to a refrigerant quantity judging operation. Since a highly precise refrigerant quantity judging operation can be performed, the present invention is useful as a refrigerant circuit of an air conditioner, an air conditioner provided therewith, and other air conditioners.

Claims

1. An air conditioner (1) comprising:

a refrigerant circuit (7) having a heat source unit (2a to 2c) that has a compression mechanism (21a to 21 c) and a heat source side heat exchanger (24a to 24c), a refrigerant communication pipe (4, 5) to which the heat source unit is connected, an expansion mechanism (29a to 29c, 31a, 31b, ...), and a utilization unit (3a, 3b, ...) that has a utilization side heat exchanger (32a, 32b, ...) and that is connected to the refrigerant communication pipe;

refrigerant stagnation judging means (8a to 8c) that can judge whether a refrigerant is stagnant inside the compression mechanism; and

an operation controller (6a to 6c) that performs a refrigerant de-stagnation operation for eliminating stagnation of the refrigerant in the case that the refrigerant stagnation judging means has judged in advance that the refrigerant is stagnant inside the compression mechanism when a refrigerant quantity judging operation for judging a quantity of refrigerant inside the refrigerant circuit is carried out.

2. The air conditioner (1) as recited in Claim 1, wherein the refrigerant stagnation judging means (8a to 8c) makes a judgment on the basis of a temperature inside the compression mechanism (21a to 21 c).

3. The air conditioner (1) as recited in Claim 1, wherein the refrigerant stagnation judging means (8a to 8c) makes a judgment on the basis of the outside air temperature.

4. The air conditioner (1) as recited in Claim 1, wherein the refrigerant stagnation judging means (8a to 8c) is connected to a network (9), acquires weather information via the network, and makes a judgment on the basis of the weather information.

5. The air conditioner (1) as recited in Claims 1, wherein the refrigerant stagnation judgment means (8a to 8c) makes judgment on the basis of a refrigerant stagnation interval in which the refrigerant is predicted to readily stagnate inside the compression mechanism (21a to 21c).

6. The air conditioner (1) as recited in any of Claims 1 to 5, wherein the operation controller (6a to 6c) performs a control for driving the compression mechanism (21a to 21c) for a first prescribed time as the refrigerant de-stagnation operation.

7. The air conditioner (1) as recited in any of Claims 1 to 6, wherein a plurality of the heat source units (2a to 2c) is present.

8. The air conditioner (1) as recited in any of Claims 1 to 7, wherein the compression mechanism (21a to 21 c) has a plurality of compressors (22a to 22c, 27a to 27c, 28a to 28c).

9. The air conditioner (1) as recited in Claim 8, wherein the refrigerant de-stagnation operation is an operation for driving at least a compressor that is not driven during the refrigerant quantity judgment operation.

10. The air conditioner (1) as recited in Claim 8, wherein the refrigerant de-stagnation operation is an operation in which the operation controller (6a to 6c) operates all of the compressors (22a to 22c, 27a to 27c, 28a to 28c) one at a time in sequence for a second prescribed time interval.

11. The air conditioner (1) as recited in Claim 1, further comprising a heater for warming the compression mechanism (21a to 21c), wherein the refrigerant de-stagnation operation is an operation for warming the compression mechanism using the heater.

12. The air conditioner (1) as recited in any of Claims 1 to 11, wherein the operation controller (6a to 6c) further performs an oil-return operation immediately after the refrigerant de-stagnation operation.
- 5 13. The air conditioner (1) as recited in Claim 12, wherein the oil-return operation is an operation for controlling the refrigerant that flows through the refrigerant circuit (7) so that the refrigerant flows inside the pipes at or above a prescribed rate.

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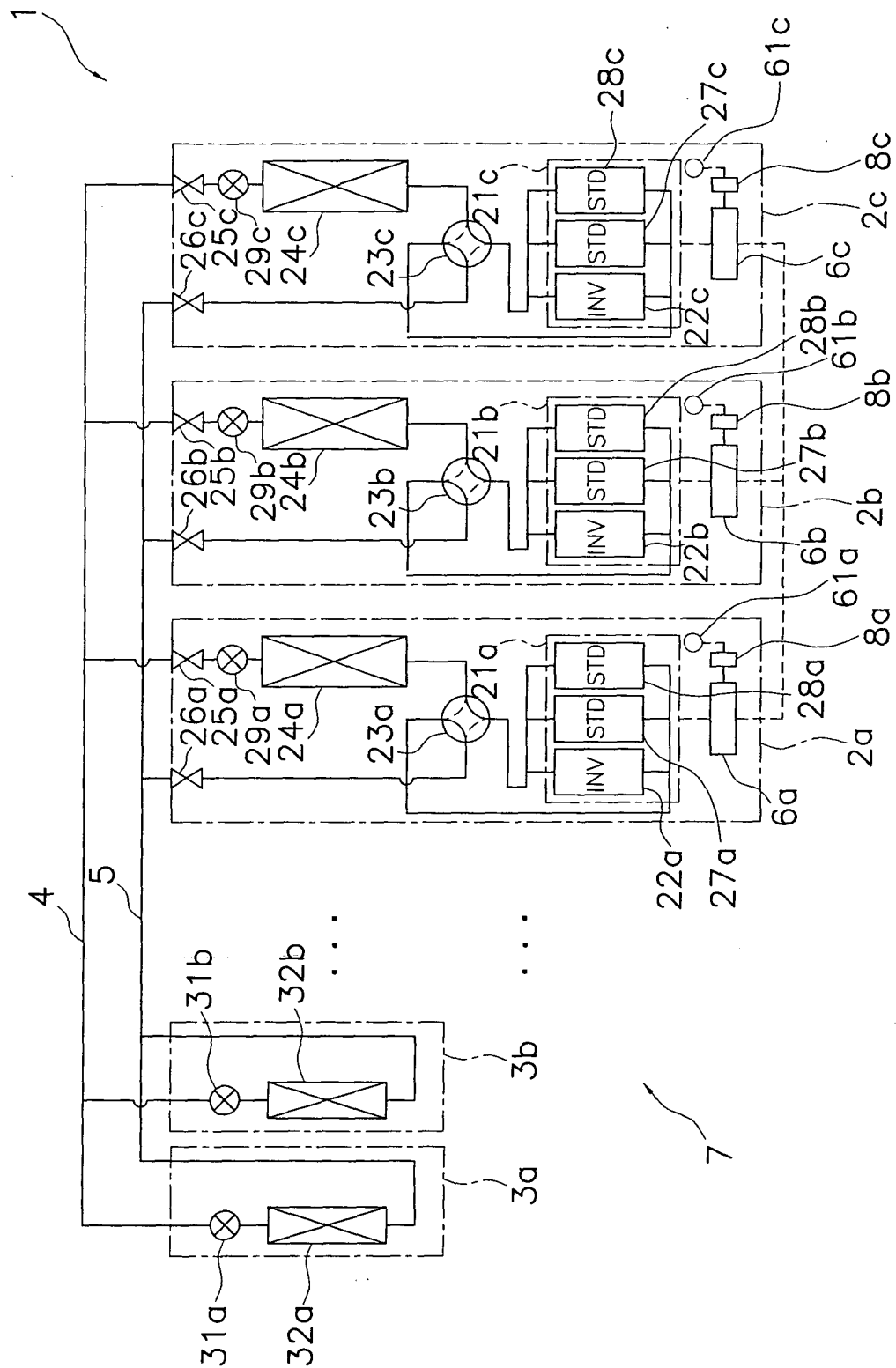
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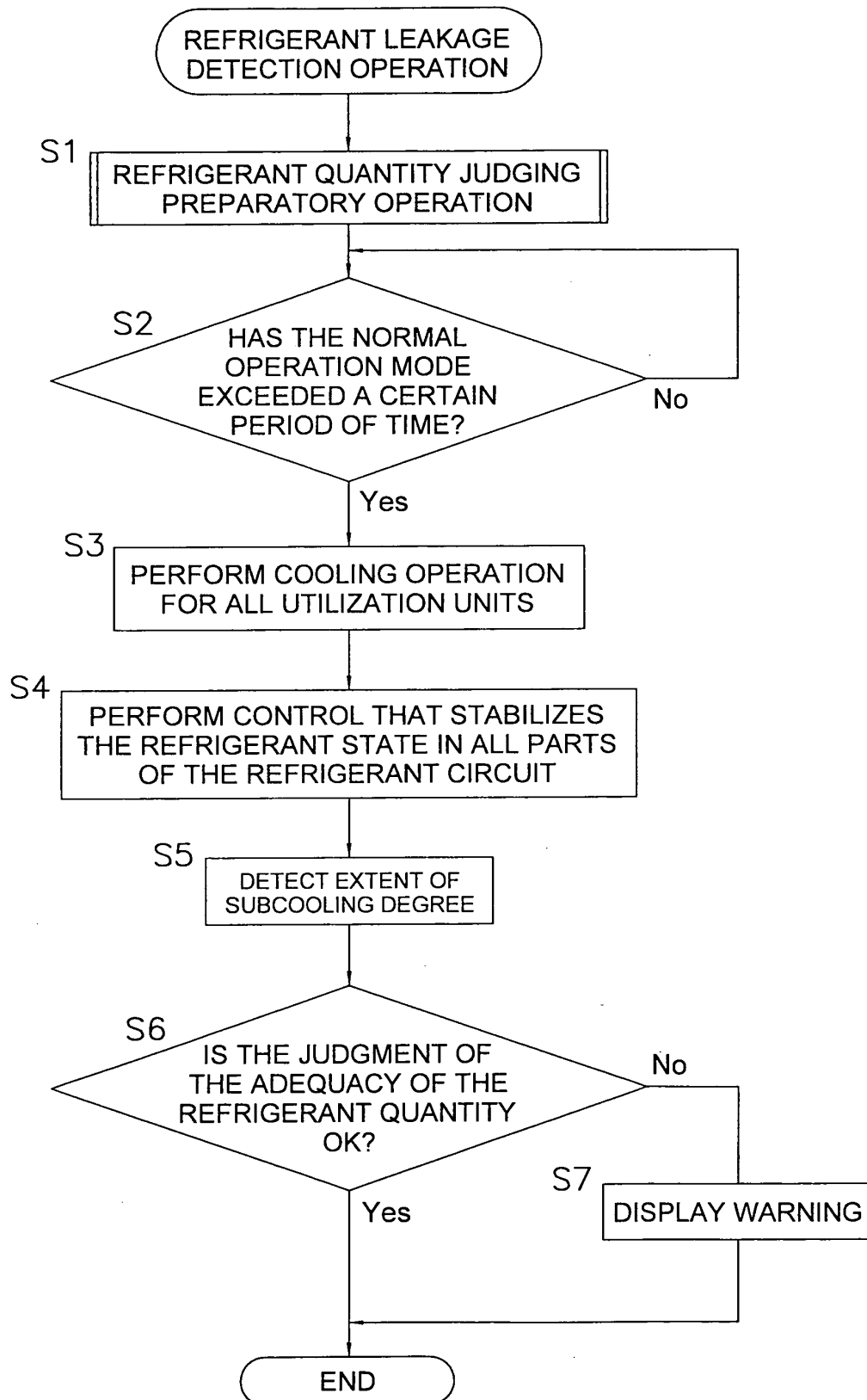


FIG. 2

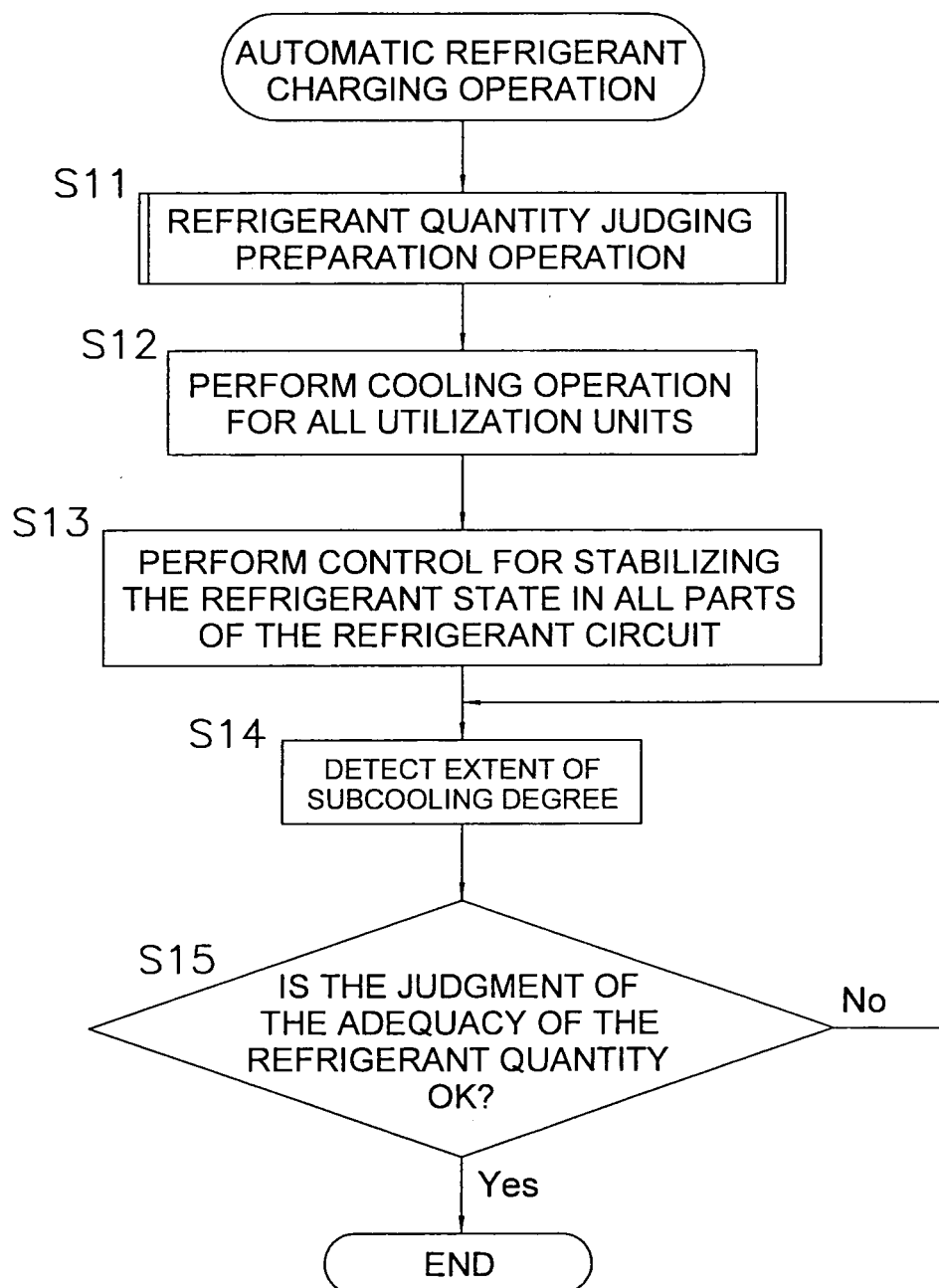


FIG. 3

FIG. 4

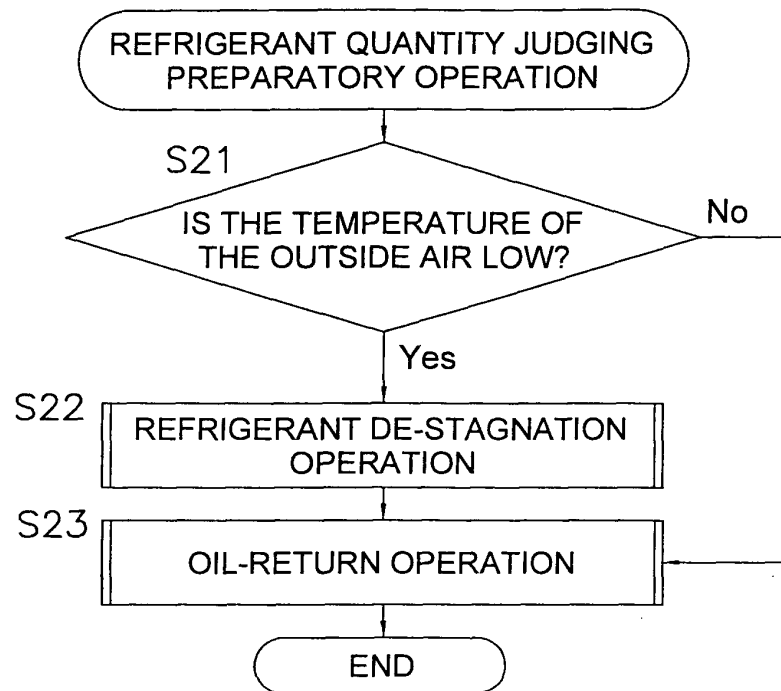
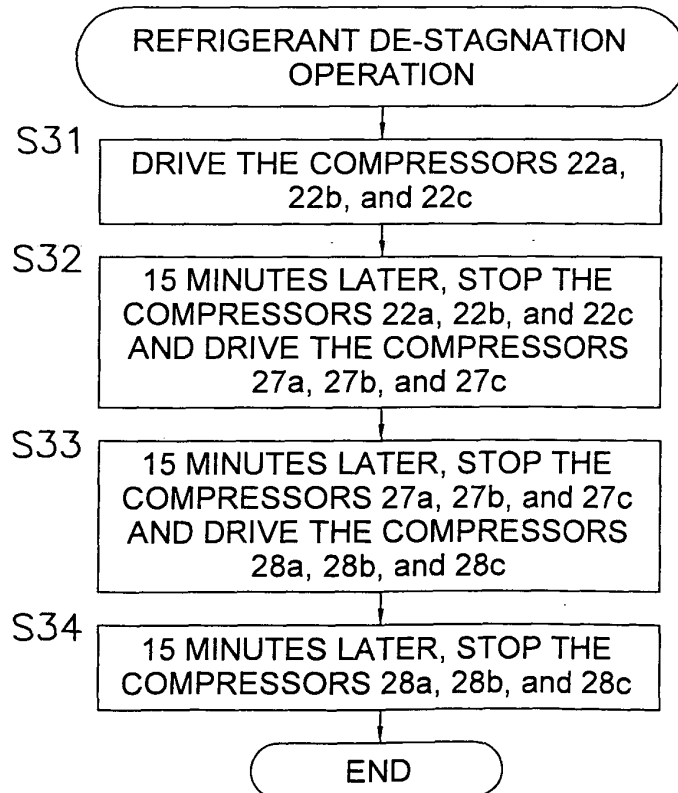


FIG. 5



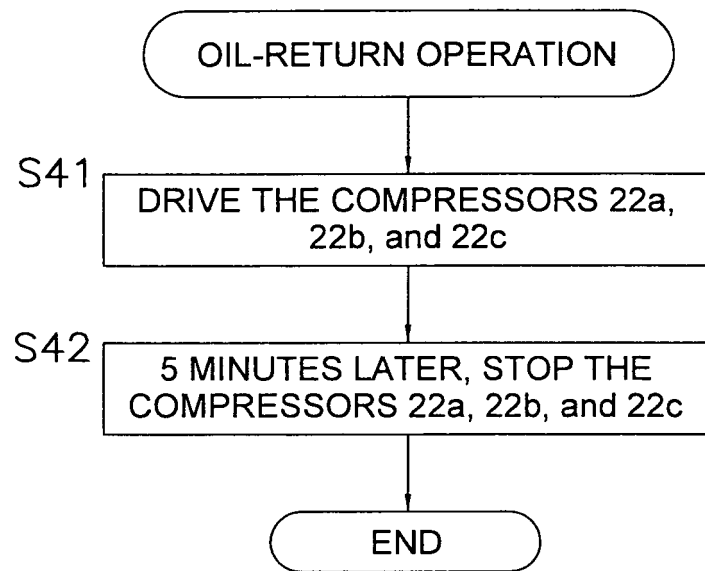


FIG. 6

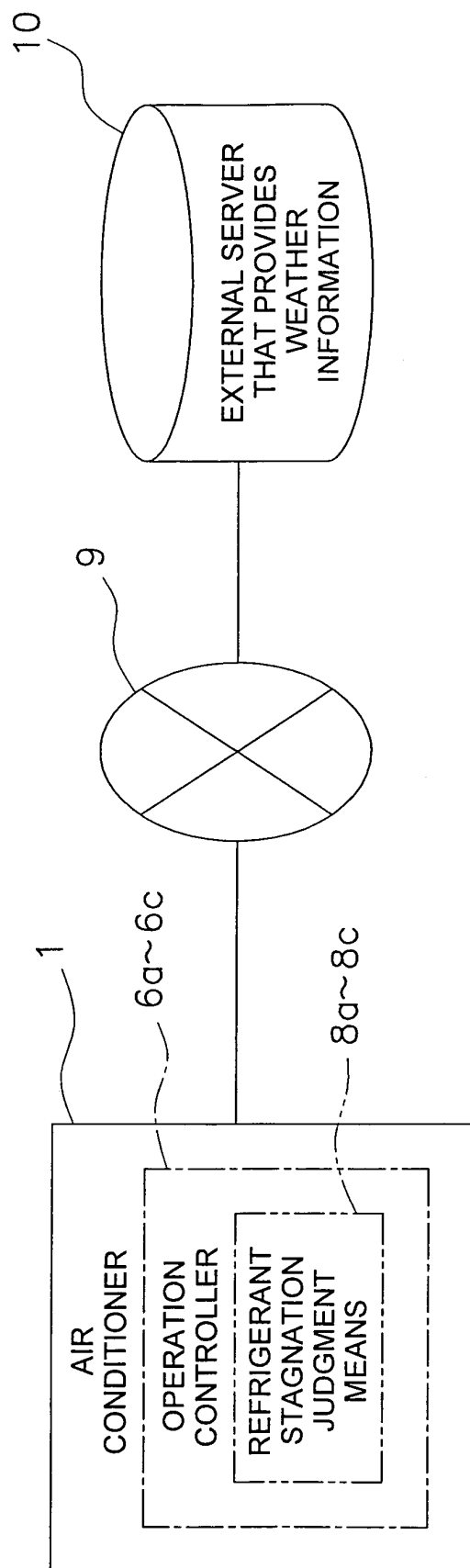


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/324806

A. CLASSIFICATION OF SUBJECT MATTER

F25B49/02 (2006.01) i, F25B1/00 (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)

F25B49/02, F25B1/00

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	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

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.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 196749/1986 (Laid-open No. 101755/1988) (Toshiba Corp.), 02 July, 1988 (02.07.88), Full text; Figs. 1 to 3 (Family: none)	1-13
A	JP 2004-28503 A (Mitsubishi Heavy Industries, Ltd.), 29 January, 2004 (29.01.04), Full text; Figs. 1 to 4 (Family: none)	1-13

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

* Special categories of cited documents:

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Date of the actual completion of the international search
23 February, 2007 (23.02.07)Date of mailing of the international search report
06 March, 2007 (06.03.07)Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/324806

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2001-263885 A (Japan Climate Systems Corp.), 26 September, 2001 (26.09.01), Full text; Figs. 1, 2 (Family: none)	1-13
A	JP 2005-43008 A (Denso Corp.), 17 February, 2005 (17.02.05), Full text; Figs. 1 to 9 (Family: none)	1-13
A	JP 6-18103 A (Toshiba Corp.), 25 January, 1994 (25.01.94), Full text; Figs. 1 to 5 (Family: none)	1-13

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

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