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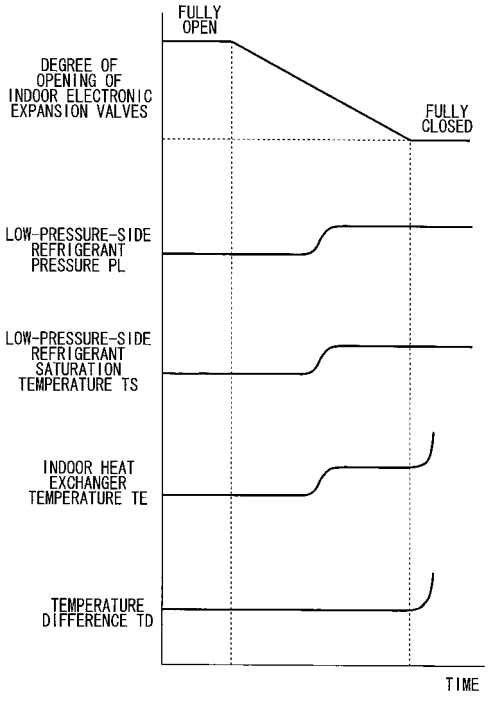
(54) MULTI-TYPE AIR CONDITIONER, METHOD FOR CHECKING OPERATION OF INDOOR ELECTRONIC EXPANSION VALVES OF INDOOR UNITS, COMPUTER PROGRAM, AND FAULT DIAGNOSIS SYSTEM

(57) Provided are a multi-type air conditioner, a method for checking the operation of indoor-side electronic expansion valves of indoor units, a computer program, and a fault diagnosis system that allow the operation of electronic expansion valves of indoor units to be reliably checked. A saturation temperature (TS) is calculated from a refrigerant pressure (PL) detected on the low-pressure side of an outdoor unit by a pressure sensor, and the operation of electronic expansion valves is checked using temperature differences (TD) between the calculated saturation temperature (TS) and the temperatures (TE) of indoor heat exchangers detected by temperature sensors. This allows the effect of variations in refrigerant pressure (PL) to be canceled so that the operation of the electronic expansion valves is reliably checked.

FIG. 4



EP 2 256 423 A1

Description

Technical Field

[0001] The present invention relates to multi-type air conditioners, methods for checking the operation of indoor-side electronic expansion valves of indoor units, computer programs, and fault diagnosis systems.

Background Art

[0002] Multi-type air conditioners in which a plurality of indoor units are connected to a single outdoor unit with a gas pipe and a liquid pipe are available as air conditioners for buildings.

[0003] Upon installation, such multi-type air conditioners are subjected to test operation to check the operation of various parts. To check the operation of an electronic expansion valve included in an indoor unit, the degree of opening of the electronic expansion valve is changed during an air-conditioning mode, a temperature sensor is used to detect a change in the temperature of refrigerant and a heat exchanger in the indoor unit at this time (see, for example, Patent Citation 1). For example, if a control section generates a command signal for increasing or decreasing the degree of opening of the electronic expansion valve, the temperature of the refrigerant and the heat exchanger falls or rises so as to follow it. On the other hand, if the degree of opening of the electronic expansion valve does not, for example, change or become fully closed or open for some reason such as intrusion of foreign matter despite the command signal for changing the degree of opening of the electronic expansion valve from the control section, the temperature of the heat exchanger does not change and fails to respond to the command for changing the degree of opening. In this way, the command signal for changing the degree of opening of the electronic expansion valve and the change in the temperature of the heat exchanger are monitored to check the operation of the electronic expansion valve.

Patent Citation 1:

> Japanese Unexamined Patent Application, Publication No. SHO-63-6351

Disclosure of Invention

[0004] However, when the electronic expansion valve is actually opened or closed, the refrigerant pressure is varied by the flow of the refrigerant during the opening/closing operation. For a multi-type air conditioner including a plurality of indoor units, the refrigerant pressure is also varied by the effect of the operation of other indoor units.

The refrigerant temperature at the heat exchanger section varies with variations in refrigerant pressure because, as is well known, the evaporation temperature (saturation temperature) of a refrigerant differs depending on the refrigerant pressure. Even if the refrigerant temperature is detected at a site other than the heat exchanger, the refrigerant temperature is affected by the variations. As the degree of opening of the electronic expansion valve is reduced to finally become fully closed, the heat exchanger temperature is supposed to rise when it reaches a fully closed state; however, the heat exchanger temperature rises due to the variations in refrigerant pressure even though the electronic expansion valve is not fully closed.

This makes it difficult to accurately check whether or not the electronic expansion valve is operating reliably despite monitoring of the command signal for changing the degree of opening of the electronic expansion valve and the change in the temperature of the heat exchanger.

[0005] An object of the present invention, which has been made in light of such circumstances, is to provide a multi-type air conditioner, a method for checking the operation of indoor-side electronic expansion valves of indoor units, etc. that allow the operation of electronic expansion valves of indoor units to be reliably checked.

[0006] To solve the above problem, a multi-type air conditioner of the present invention employs the following solutions. That is, a multi-type air conditioner according to a first aspect of the present invention includes an outdoor unit and a plurality of indoor units. The outdoor unit includes a compressor, a four-way switching valve, an outdoor heat exchanger, outdoor refrigerant pipes connected therebetween, a refrigerant gas pipe extending from the four-way switching valve to an indoor side, and a refrigerant liquid pipe extending from the outdoor heat exchanger to the indoor side. The indoor units include indoor heat exchangers and indoor-side electronic expansion valves and are connected in parallel between the refrigerant gas pipe and the refrigerant liquid pipe extending from the outdoor unit via indoor refrigerant pipes. In addition, the multi-type air conditioner according to the first aspect of the present invention includes a pressure sensor for detecting refrigerant pressure on a low-pressure side in the outdoor unit, temperature sensors for detecting the temperatures of the indoor heat exchangers of the indoor units, and a control section for checking the operation of the indoor-side electronic expansion valves based on changes in the refrigerant pressure on the low-pressure side and the temperatures of the indoor heat exchangers occurring as the degree of opening of the indoor-side electronic expansion valves is changed.

[0007] This multi-type air conditioner checks the operation of the indoor-side electronic expansion valves based on changes in the refrigerant pressure on the low-pressure side and the temperatures of the indoor heat exchangers occurring as the degree of opening of the indoor-side electronic expansion valves is changed. This allows the effect of variations in refrigerant pressure to be canceled when the operation of the indoor-side electronic expansion valves are checked.

[0008] In the above first aspect, the control section may

calculate the saturation temperature of the refrigerant corresponding to the refrigerant pressure detected by the pressure sensor and check the operation of the indoor-side electronic expansion valves based on changes in the differences between the calculated saturation temperature and the temperatures of the indoor heat exchangers.

[0009] A second aspect of the present invention is a method for checking the operation of indoor-side electronic expansion valves of indoor units for a multi-type air conditioner including an outdoor unit and a plurality of indoor units. This method includes a step of changing the degree of opening of the indoor-side electronic expansion valves, a step of detecting the temperatures of indoor heat exchangers of the indoor units, a step of detecting refrigerant pressure on a low-pressure side of the outdoor unit, a step of calculating the saturation temperature of the refrigerant corresponding to the detected refrigerant pressure and correcting the temperatures of the indoor heat exchangers, and a step of checking the operation of the indoor-side electronic expansion valves based on changes in the corrected temperatures of the indoor heat exchangers occurring as the degree of opening of the indoor-side electronic expansion valves is changed.

[0010] In the above method of the second aspect for checking the operation of indoor-side electronic expansion valves of indoor units, the operation of the indoor-side electronic expansion valves may be checked while the multi-type air conditioner is in a cooling mode.

[0011] In the above method of the second aspect for checking the operation of indoor-side electronic expansion valves of indoor units, additionally, the degree of opening of the indoor-side electronic expansion valves may be changed from an open state to a fully closed state in the step of changing the degree of opening of the indoor-side electronic expansion valves.

It is possible to check whether the electronic expansion valves are operating reliably because the temperatures of the indoor heat exchangers rise when the indoor-side electronic expansion valves become fully closed.

[0012] In addition, a third aspect of the present invention is a computer program executed by a computer system to check the operation of indoor-side electronic expansion valves of indoor units for a multi-type air conditioner including an outdoor unit and a plurality of indoor units. The computer program includes a step of changing the degree of opening of the indoor-side electronic expansion valves, a step of detecting the temperatures of indoor heat exchangers of the indoor units, a step of detecting refrigerant pressure on a low-pressure side of the outdoor unit, a step of calculating the saturation temperature of the refrigerant corresponding to the detected refrigerant pressure and correcting the temperatures of the indoor heat exchangers, and a step of checking the operation of the indoor-side electronic expansion valves based on changes in the corrected temperatures of the indoor heat exchangers occurring as the degree of opening of the indoor-side electronic expansion valves is changed.

[0013] This computer program can be installed in a control section of the multi-type air conditioner to allow self-diagnosis of the operation of the indoor-side electronic expansion valves in the multi-type air conditioner. This computer program can also be installed in a control section of an existing multi-type air conditioner.

[0014] In addition, a fourth aspect of the present invention is a fault diagnosis system for checking the operation of indoor-side electronic expansion valves of indoor units for a multi-type air conditioner including an outdoor unit and a plurality of indoor units. The fault diagnosis system executes a step of changing the degree of opening of the indoor-side electronic expansion valves, a step of detecting the temperatures of indoor heat exchangers of the indoor units, a step of detecting refrigerant pressure on a low-pressure side of the outdoor unit, a step of calculating the saturation temperature of the refrigerant corresponding to the refrigerant pressure and correcting the temperatures of the indoor heat exchangers, and a step of checking the operation of the indoor-side electronic expansion valves based on changes in the corrected temperatures of the indoor heat exchangers occurring as the degree of opening of the indoor-side electronic expansion valves is changed.

[0015] This fault diagnosis system can be implemented by a control section of the multi-type air conditioner, or can be a discrete fault diagnosis system externally connected to the control section of the multi-type air conditioner to execute the above operation diagnosis process.

[0016] According to the present invention, the operation of the indoor-side electronic expansion valves is checked based on changes in the temperatures of the indoor heat exchangers corrected based on the refrigerant pressure on the low-pressure side of the outdoor unit. This allows the effect of variations in refrigerant pressure to be canceled so that the operation of the electronic expansion valves can be reliably checked.

Brief Description of Drawings

[0017]

[FIG. 1] Fig. 1 is a diagram showing the configuration of an outdoor unit of a multi-type heat-pump air conditioner according to an embodiment of the present invention.

[FIG. 2] Fig. 2 is a diagram showing the flow of a process for checking the operation of indoor-side electronic expansion valves.

[FIG. 3] Fig. 3 is a diagram showing changes in the temperatures of indoor heat exchangers occurring as the degree of opening of the indoor-side electronic expansion valves is changed, illustrating the case where the refrigerant pressure on the low-pressure side of the outdoor unit does not vary.

[FIG. 4] Fig. 4 is a diagram showing changes in the temperatures of the indoor heat exchangers occurring as the degree of opening of the indoor-side electronic expansion valves is changed, illustrating the case where the refrigerant pressure on the low-pressure side of the outdoor unit varies.

Explanation of Reference:

[0018]

1: multi-type heat-pump air conditioner
2: outdoor unit
3: indoor unit
4A: discharge pipe (outdoor cooling pipe)
4B: refrigerant pipe (outdoor cooling pipe)
4C: refrigerant liquid pipe (outdoor cooling pipe)
4D: refrigerant gas pipe (outdoor cooling pipe)
4E: intake pipe (outdoor cooling pipe)
4F: intake pipe (outdoor cooling pipe)
5: compressor
7: four-way switching valve
8: outdoor heat exchanger
20: indoor heat exchanger
21: expansion valve
22: indoor-side refrigerant pipe
30: temperature sensor
31: pressure sensor

Best Mode for Carrying Out the Invention

[0019] An embodiment of the present invention will be described below with reference to the drawings.
Fig. 1 shows a refrigerant circuit diagram of a multi-type heat-pump air conditioner 1 according to this embodiment.
The multi-type heat-pump air conditioner 1 is configured such that a plurality of indoor units 3 are connected in parallel to a single outdoor unit 2, or a plurality thereof. In this embodiment, the number of indoor units 3 connected is not particularly limited; at least two, or in some cases several tens of, indoor units 3 are connected.

[0020] The outdoor unit 2 includes an inverter-driven compressor 5, a four-way switching valve 7 having a first port 7A to which a discharge pipe 4A connected to the compressor 5 is connected, an outdoor heat exchanger 8 connected to a second port 7B of the four-way switching valve 7 via a refrigerant pipe 4B, a refrigerant liquid pipe 4C extending from the outdoor heat exchanger 8 to the indoor unit 3 side, a refrigerant gas pipe 4D extending from a third port 7C of the four-way switching valve 7 to the indoor unit 3 side, and an accumulator 10 connected to a fourth port 7D of the four-way switching valve 7 via an intake pipe 4E and connected to the compressor 5 via an intake pipe 4F, which are connected with the discharge pipes 4A to 4F, as described above, thereby constituting a circuit of outdoor-side refrigerant piping.

[0021] The outdoor heat exchanger 8 has an outdoor-side electronic expansion valve 9, and the degree of opening of the outdoor-side electronic expansion valve 9 is adjusted to adjust the amount of refrigerant circulated through the circuit.
The refrigerant liquid pipe 4C has a receiver 12 for storing liquid refrigerant and a double-pipe heat exchanger 13. The double-pipe heat exchanger 13 is configured to include a shunt pipe 14 for shunting some of the liquid refrigerant from the refrigerant liquid pipe 4C at the exit of the receiver 12 and guiding it into an inner pipe 13A of the double-pipe heat exchanger 13, and an electronic expansion valve (EEVSC) 15 provided in the shunt pipe 14.

[0022] The double-pipe heat exchanger 13 reduces the pressure of the refrigerant shunted into the shunt pipe 14 through the electronic expansion valve 15 and evaporates the refrigerant in the inner pipe 13A of the double-pipe heat exchanger 13 to cool the main flow of refrigerant through the outer-pipe side (refrigerant liquid pipe 4C) of the double-pipe heat exchanger 13, thus supercooling the refrigerant. The refrigerant evaporated in the inner pipe 13A of the double-pipe heat exchanger 13 is sent to the accumulator 10 via a pipe 16.

[0023] The indoor units 3 each include an indoor heat exchanger 20, an indoor-side electronic expansion valve 21 for adjusting the amount of refrigerant flowing through the indoor heat exchanger 20, and an indoor-side refrigerant pipe 22 connected therebetween. In addition, the individual indoor units 3 are connected in parallel between the refrigerant liquid pipe 4C and the refrigerant gas pipe 4D extending from the outdoor unit 2 via gas-side splitters 23A and 23B and liquid-side splitters 23C and 23D.

[0024] Next, the operation of the multi-type heat-pump air conditioner 1 according to this embodiment will be described. The operation/working of the multi-type heat-pump air conditioner 1 shown below is automatically executed by a control section (not shown) controlling various parts of the multi-type heat-pump air conditioner 1 in response to the selection of an operation mode, such as a cooling mode or a heating mode, by the user.

[0025] The above control section includes a CPU, a main storage device such as a RAM, and a computer-readable recording medium on which a program for implementing all or some of the above processes is recorded. The CPU reads the program recorded on the storage medium and executes information processing/operations to implement various processes described later.
A computer-readable recording medium refers to a magnetic disk, a magneto-optical disk, a CD-ROM, a DVD-ROM, a semiconductor memory, etc. The computer program may also be transmitted to a computer via communication lines, and the computer, upon receiving the program, executes it.

[0026] First, the cooling mode will be described. In cooling, the four-way switching valve 7 is switched to a state in which the first port 7A communicates with the second port 7B and the third port 7C communicates with

the fourth port 7D. Accordingly, high-temperature, high-pressure refrigerant gas compressed by the compressor 5 flows through the discharge pipe 4A, the four-way switching valve 7, and the refrigerant pipe 4B into the outdoor heat exchanger 8. This refrigerant gas is subjected to heat exchange with the outside air in the outdoor heat exchanger 8 to release heat to the outside air, thus condensing and liquefying. The liquefied refrigerant flows in one direction through the refrigerant liquid pipe 4C into the receiver 12 and is temporarily stored in the receiver 12.

[0027] The refrigerant flowing out from the receiver 12 is cooled while passing through the double-pipe heat exchanger 13 so that the refrigerant is further supercooled. As is known to those skilled in the art, such supercooling of refrigerant improves the refrigeration capacity.

The refrigerant evaporated in the inner pipe 13A of the double-pipe heat exchanger 13 is sent from the exit thereof to the accumulator 10 via the pipe 16.

[0028] On the other hand, the refrigerant supercooled in the double-pipe heat exchanger 13 flows into the indoor units 3 via the refrigerant liquid pipe 4C. The refrigerant flowing into the indoor units 3 flows into the indoor heat exchangers 20 of the indoor units 3 and is subjected to heat exchange with indoor air circulated into the indoor heat exchangers 20 by a fan (not shown) to cool the indoor air. The cooled indoor air is used for cooling.

[0029] The refrigerant evaporated while cooling the indoor air in the indoor heat exchangers 20 returns to the outdoor unit 2 again via the refrigerant gas pipe 4D and is taken into the compressor 5 through the four-way switching valve 7, the intake pipe 4E, the accumulator 10, and the intake pipe 4F. This refrigerant circulation cycle is repeated to implement the cooling mode.

[0030] The heating mode will then be described. In heating, the four-way switching valve 7 is switched to a state in which the first port 7A communicates with the third port 7C and the second port 7B communicates with the fourth port 7D. Accordingly, high-temperature, high-pressure refrigerant gas compressed by the compressor 5 flows through the discharge pipe 4A, the four-way switching valve 7, and the refrigerant gas pipe 4D into the individual indoor units 3. The refrigerant gas flowing into the indoor units 3 is subjected to heat exchange with indoor air circulated by the fan (not shown) in the indoor heat exchangers 20 to heat the indoor air. The heated indoor air is used for heating.

[0031] The refrigerant condensed and liquefied while releasing heat to the indoor air in the indoor heat exchangers 20 returns to the outdoor unit 2 again via the refrigerant liquid pipe 4C. The refrigerant returning to the outdoor unit 2 flows in one direction through the refrigerant liquid pipe 4C into the receiver 12 and is temporarily stored in the receiver 12.

[0032] The refrigerant flowing out from the receiver 12 flows into the outdoor heat exchanger 8 and evaporates by absorbing heat from the outside air. Subsequently, the refrigerant is taken into the compressor 5 through the refrigerant pipe 4B, the four-way switching valve 7, the intake pipe 4E, the accumulator 10, and the intake pipe 4F. This refrigerant circulation cycle is repeated to implement the heating mode.

[0033] Upon installation, the multi-type heat-pump air conditioner 1 as described above is subjected to test operation to check the operation of various parts. The test operation is carried out by a control section (computer system or fault diagnosis system), which is not shown, executing a predetermined process based on a predetermined computer program.

In this embodiment, in the course of the test operation, a process of checking the opening/closing operation of the indoor-side electronic expansion valves 21 of the indoor units 3 is executed. The details will be described below.

[0034] To execute the process of checking the opening/closing operation of the indoor-side electronic expansion valves 21, the multi-type heat-pump air conditioner 1 of this embodiment includes temperature sensors 30 for detecting the temperatures of the indoor heat exchangers 20 and a pressure sensor 31 disposed in the intake pipe 4E of the accumulator 10 of the outdoor unit 2 to detect the refrigerant pressure on the low-pressure side.

[0035] Fig. 2 shows the flow of the process of checking the opening/closing operation of the indoor-side electronic expansion valves 21 executed in the course of the test operation.

First, the multi-type heat-pump air conditioner 1 enters the cooling mode.

During the cooling mode, the control section outputs a command signal for changing the degree of opening of the indoor-side electronic expansion valves 21 to the indoor-side electronic expansion valves 21 (Step S101). The degree of opening of the indoor-side electronic expansion valves 21 is changed, for example, from a fully open state to a fully closed state.

[0036] After the command signal is output in Step S101, each time a predetermined short duration t elapses (Step S102), the temperatures TE of the indoor heat exchangers 20 detected by the temperature sensors 30 and the refrigerant pressure PL on the low-pressure side of the outdoor unit 2 detected by the pressure sensor 31 are acquired (Step S103).

[0037] The saturation temperature TS at the detected refrigerant pressure PL on the low-pressure side is then calculated (Step S104). The saturation temperature TS can be easily calculated based on a psychrometric chart.

[0038] Subsequently, temperature differences TD between the temperatures TE of the indoor heat exchangers 20 detected in Step S103 and the saturation temperature TS calculated in Step S104 are calculated by:

$$TD = TE - TS$$

These temperature differences TD are stored in a memory of the control section (Step S105).

[0039] Steps S103 to S105 described above are repeated each time the predetermined short duration t elapses, so that information on the change in temperature difference TD after the output of the command signal for changing the degree of opening of the indoor-side electronic expansion valves 21 is accumulated in the memory of the control section.

[0040] The control section determines whether or not the indoor-side electronic expansion valves 21 are operating abnormally based on the stored information on the change in temperature difference TD (Steps S106 and S107). If the degree of opening of the indoor-side electronic expansion valves 21 is changed from a fully open state to a fully closed state, the determination can be made depending on whether or not the temperature differences TD have risen at the time when the indoor-side electronic expansion valves 21 become fully closed. The determination that the temperature differences TD have risen is preferably made at the time when the temperature differences TD increase from those at the start of calculation to a predetermined threshold or higher, allowing for a certain degree of error.

[0041] This determination process may be executed after the completion of the degree-of-opening changing operation of the indoor-side electronic expansion valves 21, as shown in Step S106 and S107 in Fig. 2, or may be sequentially executed in real time during the opening/closing operation of the indoor-side electronic expansion valves 21. In the latter case, the indoor-side electronic expansion valves 21 are determined to be operating abnormally if the values of the temperature differences TD rise before the indoor-side electronic expansion valves 21 become fully closed.

[0042] As shown in Fig. 3, without the effect of variations in refrigerant pressure PL (the refrigerant pressure PL is constant), if the indoor-side electronic expansion valves 21 are operating normally, as the degree of opening of the indoor-side electronic expansion valves 21 is changed from a fully open state to a fully closed state, the temperature differences TD (= the temperatures TE of the indoor heat exchangers 20) should rise only after the indoor-side electronic expansion valves 21 become fully closed.

[0043] As shown in Fig. 4, on the other hand, if the refrigerant pressure PL varies as the degree of opening of the indoor-side electronic expansion valves 21 is changed from a fully open state to a fully closed state, the temperatures TE of the indoor heat exchangers 20 change (rise) with the variation in refrigerant pressure PL even though the indoor-side electronic expansion valves 21 are operating normally. Hence, the technique discussed in Patent Citation 1 could determine the change in the temperatures TE of the indoor heat exchangers 20 with the variation in refrigerant pressure PL as a result of the operation of the indoor-side electronic expansion valves 21.

[0044] In contrast, according to the configuration of this embodiment, even if the refrigerant pressure PL varies, the temperature differences TD between the saturation temperature TS corresponding to the refrigerant pressure PL and the temperatures TE of the indoor heat exchangers 20 are used to check the operation of the indoor-side electronic expansion valves 21. The temperature differences TD, which are the temperatures TE of the indoor heat exchangers 20 corrected by the refrigerant pressure PL, that is, the values obtained by canceling the effect of the variation in refrigerant pressure PL, rise only after the indoor-side electronic expansion valves 21 become fully closed. In Step S106 described above, therefore, the change in temperature difference TD can be detected to reliably detect the opening/closing operation of the indoor-side electronic expansion valves 21.

[0045] As above, the multi-type heat-pump air conditioner 1 according to this embodiment calculates the saturation temperature TS from the refrigerant pressure PL detected on the low-pressure side of the outdoor unit 2 by the pressure sensor 31 and checks the operation of the indoor-side electronic expansion valves 21 using the temperature differences TD between the calculated saturation temperature TS and the temperatures TE of the indoor heat exchangers 20 detected by the temperature sensors 30. This allows the effect of variations in refrigerant pressure PL to be canceled so that the operation of the indoor-side electronic expansion valves 21 can be reliably checked.

[0046] While various parts of the multi-type heat-pump air conditioner 1 have been described in the embodiment described above, the present invention is not limited thereto; for example, the outdoor unit 2 and the indoor units 3 may have any configurations.

Claims

1. A multi-type air conditioner comprising:

an outdoor unit including a compressor, a four-way switching valve, an outdoor heat exchanger, outdoor refrigerant pipes connected therebetween, a refrigerant gas pipe extending from the four-way switching valve to an indoor side, and a refrigerant liquid pipe extending from the outdoor heat exchanger to the indoor side;

a plurality of indoor units including indoor heat exchangers and indoor-side electronic expansion valves and connected in parallel between the refrigerant gas pipe and the refrigerant liquid pipe extending from the outdoor unit via indoor refrigerant pipes;

a pressure sensor for detecting refrigerant pressure on a low-pressure side in the outdoor unit;

temperature sensors for detecting the temperatures of the indoor heat exchangers of the indoor units; and

a control section for checking the operation of the indoor-side electronic expansion valves based on changes in the refrigerant pressure on the low-pressure side and the temperatures of the indoor heat exchangers occurring as the degree of opening of the indoor-side electronic expansion valves is changed.

2. The multi-type air conditioner according to Claim 1, wherein the control section calculates the saturation temperature of the refrigerant corresponding to the refrigerant pressure detected by the pressure sensor and checks the operation of the indoor-side electronic expansion valves based on changes in the differences between the calculated saturation temperature and the temperatures of the indoor heat exchangers.

3. A method for checking the operation of indoor-side electronic expansion valves of indoor units for a multi-type air conditioner including an outdoor unit and a plurality of indoor units, the method comprising:

a step of changing the degree of opening of the indoor-side electronic expansion valves;
a step of detecting the temperatures of indoor heat exchangers of the indoor units;
a step of detecting refrigerant pressure on a low-pressure side of the outdoor unit;
a step of calculating the saturation temperature of the refrigerant corresponding to the refrigerant pressure and correcting the temperatures of the indoor heat exchangers; and
a step of checking the operation of the indoor-side electronic expansion valves based on changes in the corrected temperatures of the indoor heat exchangers occurring as the degree of opening of the indoor-side electronic expansion valves is changed.

4. The method according to Claim 3 for checking the operation of indoor-side electronic expansion valves of indoor units, wherein the operation of the indoor-side electronic expansion valves is checked while the multi-type air conditioner is in a cooling mode.

5. The method according to Claim 3 or 4 for checking the operation of indoor-side electronic expansion valves of indoor units, wherein the degree of opening of the indoor-side electronic expansion valves is changed from an open state to a fully closed state in the step of changing the degree of opening of the indoor-side electronic expansion valves.

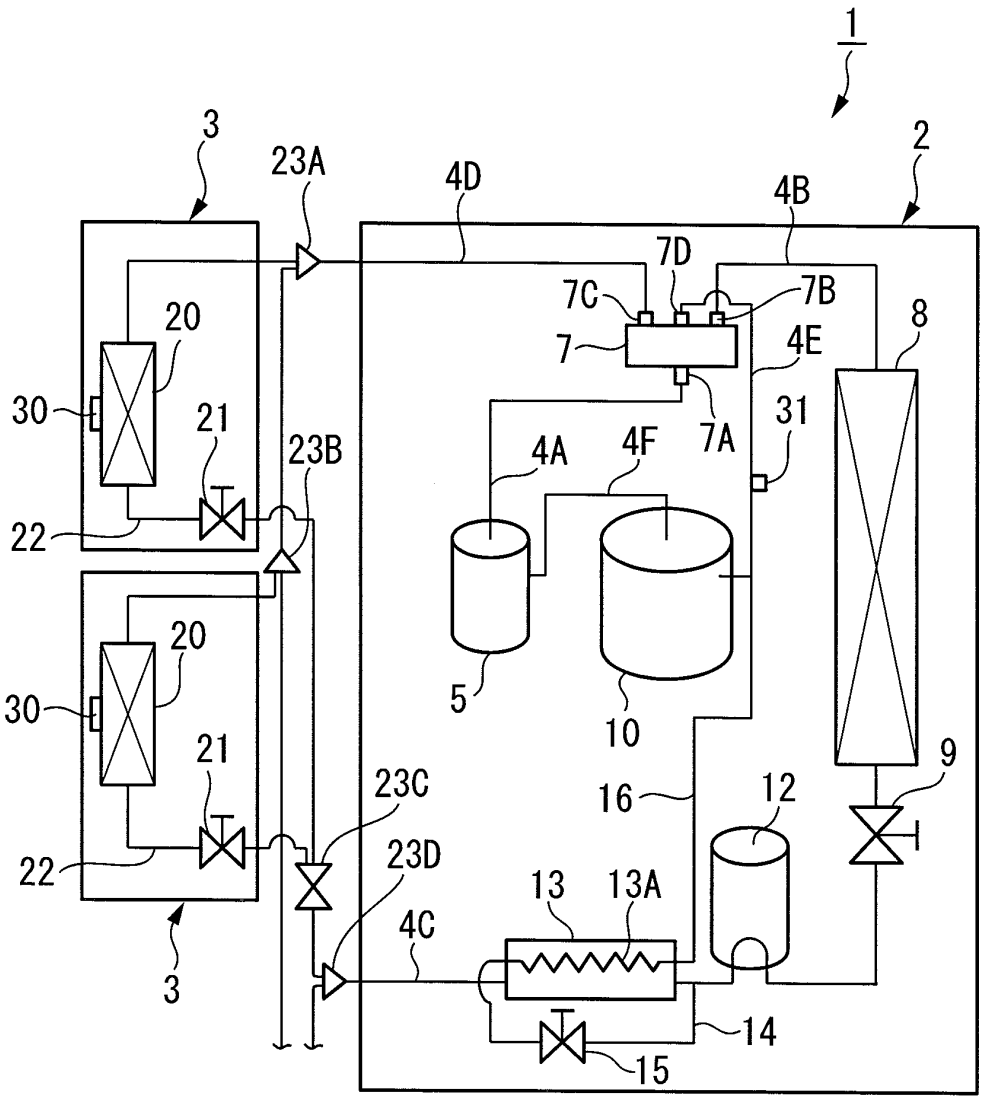
6. A computer program executed by a computer system to check the operation of indoor-side electronic expansion valves of indoor units for a multi-type air conditioner including an outdoor unit and a plurality of indoor units, the computer program comprising:

a step of changing the degree of opening of the indoor-side electronic expansion valves;
a step of detecting the temperatures of indoor heat exchangers of the indoor units;
a step of detecting refrigerant pressure on a low-pressure side of the outdoor unit;
a step of calculating the saturation temperature of the refrigerant corresponding to the refrigerant pressure and correcting the temperatures of the indoor heat exchangers; and
a step of checking the operation of the indoor-side electronic expansion valves based on changes in the corrected temperatures of the indoor heat exchangers occurring as the degree of opening of the indoor-side electronic expansion valves is changed.

7. A fault diagnosis system for checking the operation of indoor-side electronic expansion valves of indoor units for a multi-type air conditioner including an outdoor unit and a plurality of indoor units, the fault diagnosis system executing:

a step of changing the degree of opening of the indoor-side electronic expansion valves;
a step of detecting the temperatures of indoor heat exchangers of the indoor units;
a step of detecting refrigerant pressure on a low-pressure side of the outdoor unit;
a step of calculating the saturation temperature of the refrigerant corresponding to the refrigerant pressure and correcting the temperatures of the indoor heat exchangers; and
a step of checking the operation of the indoor-side electronic expansion valves based on changes in the corrected temperatures of the indoor heat exchangers occurring as the degree of opening of the indoor-side electronic expansion valves is changed.

FIG. 1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20
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22
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23A
23B
23C
23D
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4D
4E
4F
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7D
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10
12
13
13A
14
15
16
31

FIG. 2

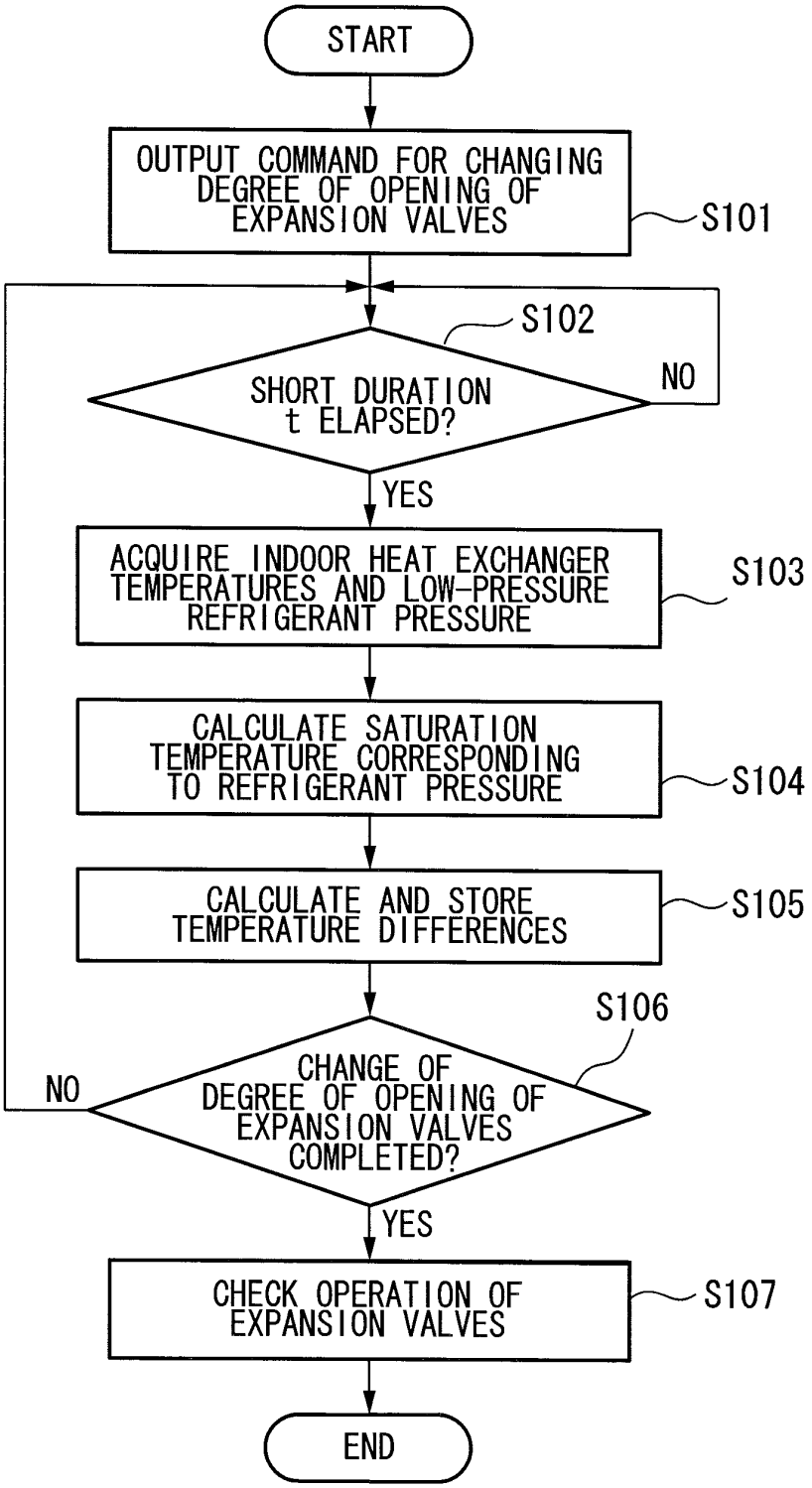

START
OUTPUT COMMAND FOR CHANGING DEGREE OF OPENING OF EXPANSION VALVES
S101
S102
SHORT DURATION t ELAPSED?
NO
YES
ACQUIRE INDOOR HEAT EXCHANGER TEMPERATURES AND LOW-PRESSURE REFRIGERANT PRESSURE
S103
CALCULATE SATURATION TEMPERATURE CORRESPONDING TO REFRIGERANT PRESSURE
S104
CALCULATE AND STORE TEMPERATURE DIFFERENCES
S105
S106
CHANGE OF DEGREE OF OPENING OF EXPANSION VALVES COMPLETED?
NO
YES
CHECK OPERATION OF EXPANSION VALVES
S107
END

FIG. 3

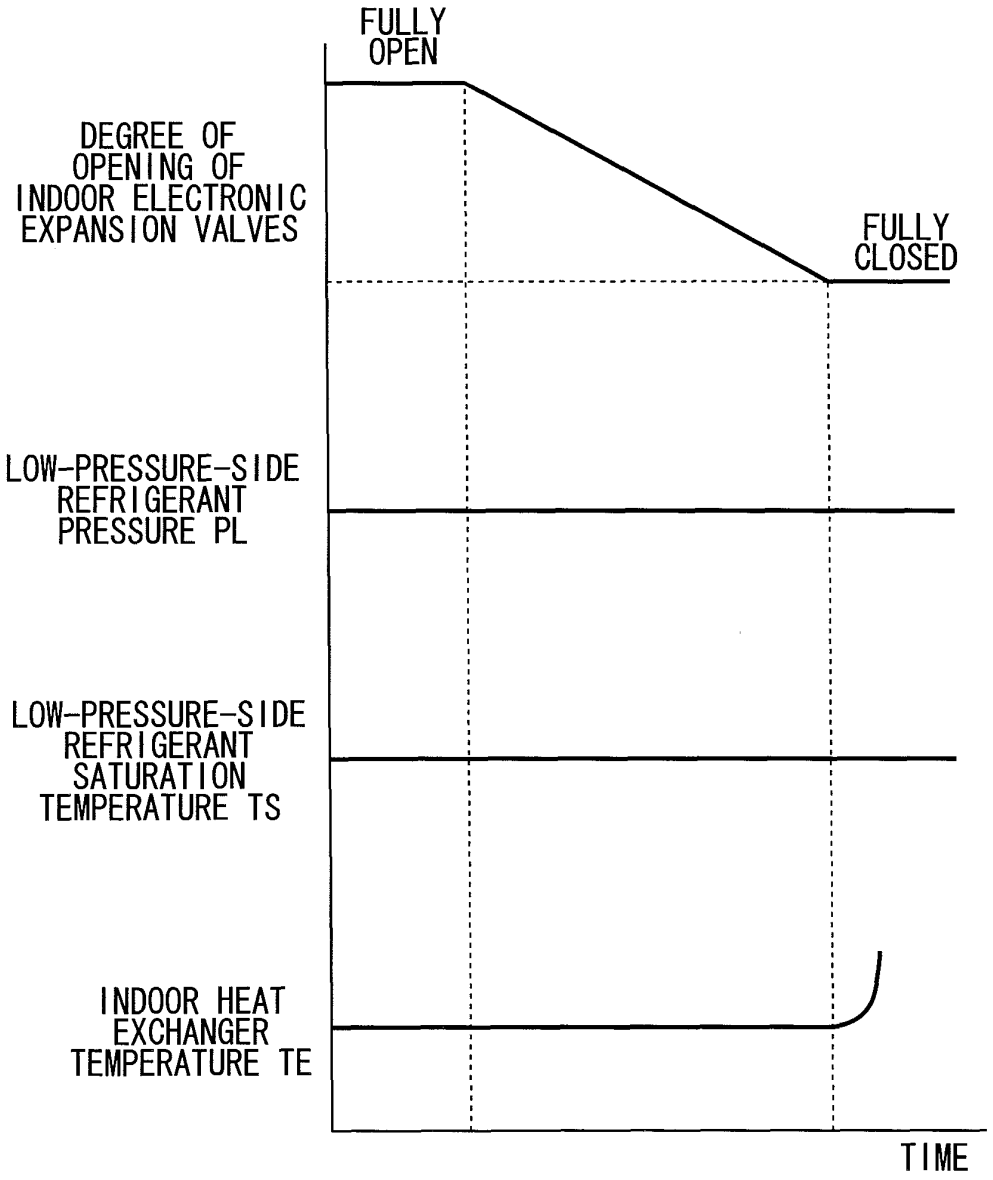
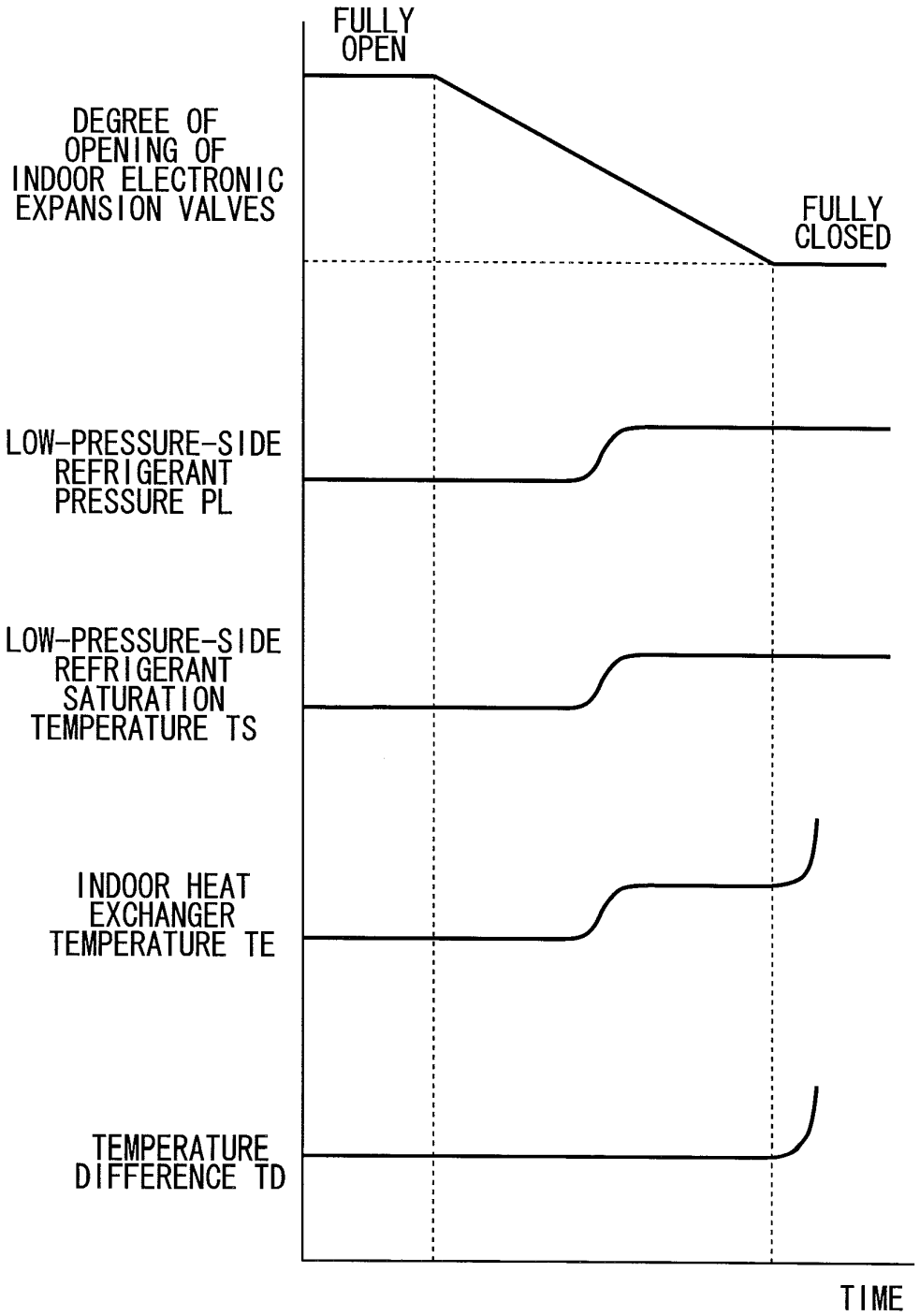

FULLY OPEN
DEGREE OF OPENING OF INDOOR ELECTRONIC EXPANSION VALVES
FULLY CLOSED
LOW-PRESSURE-SIDE REFRIGERANT PRESSURE PL
LOW-PRESSURE-SIDE REFRIGERANT SATURATION TEMPERATURE TS
INDOOR HEAT EXCHANGER TEMPERATURE TE
TIME

FIG. 4


FULLY OPEN
DEGREE OF OPENING OF INDOOR ELECTRONIC EXPANSION VALVES
FULLY CLOSED
LOW-PRESSURE-SIDE REFRIGERANT PRESSURE PL
LOW-PRESSURE-SIDE REFRIGERANT SATURATION TEMPERATURE TS
INDOOR HEAT EXCHANGER TEMPERATURE TE
TEMPERATURE DIFFERENCE TD
TIME

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/050182

A. CLASSIFICATION OF SUBJECT MATTER
F24F11/02(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)
F24F11/02

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 1996-2009
Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 63-6351 A (Daikin Industries, Ltd.), 12 January, 1989 (12.01.89), Claims; page 4, upper left column, line 11 to page 5, lower right column, line 7; Figs. 6, 7 (Family: none)	1,3-7 2
Y A	JP 2-282673 A (Daikin Industries, Ltd.), 20 November, 1990 (20.11.90), Claim 2; page 2, lower right column, line 12 to page 4, upper left column, line 9; Figs. 1 to 3 (Family: none)	1,3-7 2

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

* Special categories of cited documents:
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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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
03 April, 2009 (03.04.09)	14 April, 2009 (14.04.09)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/050182

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 149723/1988(Laid-open No. 70168/1990) (Mitsubishi Heavy Industries, Ltd.), 25 May, 1990 (25.05.90), Claims; page 3, line 15 to page 7, line 16; Fig. 1 (Family: none)	1,3-7 2
Y A	JP 2004-286267 A (Hitachi, Ltd.), 14 October, 2004 (14.10.04), Par. Nos. [0016], [0017]; Fig. 3 (Family: none)	1,3-7 2
A	JP 11-325662 A (Mitsubishi Electric Corp.), 26 November, 1999 (26.11.99), Claim 1; Fig. 1 (Family: none)	1-7

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP SHO636351 B **[0003]**