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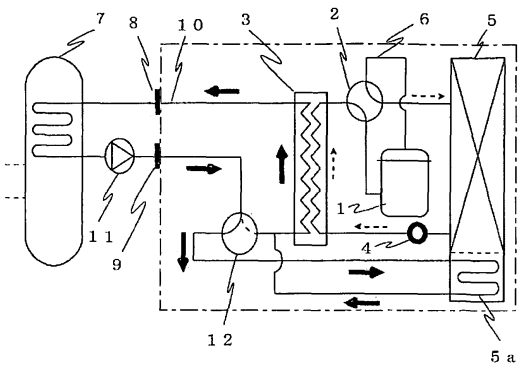
(54) HEAT PUMP TYPE WATER HEATER

(57) A heat pump water heater in which the number of components is small, a measure against drain pan freezing is realized with a simple structure, and a drain reservoir is difficult to be generated in the drain pan is obtained.

This heat pump water heater is provided with a refrigerating cycle in which a compressor 1, a four-way valve 2 that switches a flow direction of a refrigerant, a water heat exchanger 3 that exchanges heat between the refrigerant and water, an expansion valve 4 that adjusts and decompresses a flow rate of the refrigerant, and an air heat exchanger 5 that exchanges heat between air and the refrigerant are connected sequentially by a refrigerant pipeline, a water circuit in which the water heat exchanger 3, a hot water tank 7 which reserves water heated by the water heat exchanger 3, and a pump 11 are connected sequentially, and a three-way valve 12 disposed between the pump 11 and the water heat exchanger 3 so that a water circuit flows to a lower-stage path 5a of the air heat exchanger and returns to the water heat exchanger 3, and a control portion that switches the three-way valve 12 of the water circuit so that high-temperature water in the hot water tank flows to the lower-stage path 5a of the air heat exchanger during defrosting operation is disposed.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to a heat pump water heater which employs a reverse-type defrosting method.

Background Art

[0002] In a prior-art heat pump water heater which employs a reverse-type defrosting method, a method is proposed that freezing and growth on a drain pan of drained water dropped from the surface of an evaporator due to a defrosting operation function under a temperature condition of a low outside temperature is prevented by distributing a part of a high-pressure side refrigerant pipeline of a heat pump cycle or a part of a water pipeline for supplying hot water on the drain pan (See Patent Literature 1, for example).

Citation List

Patent Literature

[0003]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2004-218861 (pages 3 to 4, Figs. 2, 4 to 5)

Summary of Invention

Technical Problem

[0004] However, with the anti-freezing method using the drain pan of the above prior-art heat pump water heater, it is important to distribute the part of the high-pressure side refrigerant pipeline or the part of the water pipeline for supplying hot water in close contact on the drain pan for efficient heat transfer, but there is a problem that a mounting structure of the refrigerant pipeline or the water pipeline becomes complicated. Also, since the part of the high-pressure side refrigerant pipeline or the part of the water pipeline for supplying hot water is distributed on the drain pan, it is likely that a water discharge path of the drained water generated during the defrosting operation is blocked by the distributed refrigerant pipeline or the water pipeline or a gradient of the water distribution path becomes difficult, whereby a drain reservoir might be generated, which is a problem.

[0005] The present invention was made in order to solve the above problems and has a first object to obtain a heat pump water heater provided with a drain pan anti-freezing method with a smaller number of components and in a simple structure.

A second object of the present invention is to obtain a heat pump water heater provided with a drain pan anti-freezing method in which a discharge path of the drained water generated during the defrosting operation is not blocked and a drain reservoir is difficult to be generated.

Solution to Problem

[0006] A heat pump water heater according to the present invention is provided with a refrigerating cycle in which a compressor, a four-way valve that switches a flow direction of a refrigerant, a water heat exchanger that performs heat exchange between the refrigerant and water, an expansion mechanism that adjusts a flow rate of the refrigerant and decompresses, and an air heat exchanger that performs heat exchange between the air and the refrigerant are sequentially and circularly connected by a pipeline, a water circuit in which the water heat exchanger, a hot water tank that reserves water heated by the water heat exchanger, and a pump are sequentially and circularly connected by a pipeline, a water channel pipeline disposed in a lower stage of the air heat exchanger, a path switching valve disposed in the water circuit between the pump and the water heat exchanger, a bypass circuit connected between the path switching valve and an inlet of the water channel pipeline and connecting an outlet of the water channel pipeline to the water circuit between the path switching valve and an inlet of the water heat exchanger, and a control portion that executes switching control of the four-way valve and the path switching valve, in which the control portion switches the flow direction of the refrigerant in the refrigerating cycle by switching the four-way valve on the basis of predetermined information during the defrosting operation and allows high-temperature water in the hot water tank to flow through the water channel pipeline of the air heat exchanger via the bypass circuit by switching the path switching valve.

Advantageous Effects of Invention

[0007] In the heat pump water heater according to the present invention, since freezing of the drain pan is prevented by circulating the high-temperature circulating water in the hot water tank to a lower-stage path in the air heat exchanger during the defrosting operation and by heating the drained water generated in an upper stage of the air heat exchanger and then allowing it to flow into the drain pan, there is no need to distribute the part of the high-pressure side refrigerant pipeline or the part of the water pipeline for supplying hot water on the drain pan, which has an advantage that the mounting structure is simplified.

Also, since the part of the high-pressure side refrigerant pipeline or the part of the water pipeline for supplying hot water is not distributed on the drain pan, the discharge path of the drained water is not blocked, the drain reservoir is hardly generated, and the drained water is smoothly drained, which has an advantage that cooling and freezing of the drained water in the drain reservoir during

the heating operation is suppressed.

Brief Description of Drawings

[0008]

[Fig. 1] Fig. 1 is a circuit diagram during a defrosting operation of a heat pump water heater according to Embodiment 1 of the present invention.
[Fig. 2] Fig. 2 is a block diagram illustrating a configuration relating to control of an operation of the heat pump water heater according to Embodiment 1 of the present invention.
[Fig. 3] Fig. 3 is a flowchart illustrating a behavior of a control portion relating to control of an operation of the heat pump water heater according to Embodiment 1 of the present invention (1).
[Fig. 4] Fig. 4 is a flowchart illustrating a behavior of a control portion relating to control of an operation of a pump type water heater according to Embodiment 2 of the present invention (2).
[Fig. 5] Fig. 5 is an exploded perspective view of the heat pump water heater according to Embodiment 2 of the present invention.

Description of Embodiments

Embodiment 1

[0009] Fig. 1 is a circuit diagram during a defrosting operation of a heat pump water heater according to Embodiment 1 of the present invention.

[0010] As shown in Fig. 1, the heat pump water heater according to Embodiment 1 of the present invention is composed of a compressor 1, a four-way valve 2 that switches a refrigerant circuit during the defrosting operation, a water heat exchanger 3 that performs heat exchange between water and a refrigerant, an electronic expansion valve 4 that adjusts a flow rate of the refrigerant and decompresses, and an air heat exchanger 5 that performs heat exchange between the air and the refrigerant connected sequentially by a refrigerant pipeline 6.

[0011] A water circuit 10 between the water heat exchanger 3 and a hot water tank 7 is connected at a water-outlet side connection joint 8 and a water-inlet side connection joint 9, and water is circulated by a pump 11. Between the water-inlet side connection joint 9 and the water heat exchanger 3, a three-way valve 12 that switches to the water heat exchanger 3 during a heating operation and to the water circuit 10 so as to be connected to the water heat exchanger 3 via a lower-stage path 5a of the air heat exchanger during the defrosting operation is disposed. The three-way valve 12 constitutes a path switching valve. Also, the lower-stage path 5a of the air heat exchanger constitutes a water channel pipeline. Also, a bypass circuit 14 is constituted by connecting the three-way valve 12 (path switching valve) to an inlet of the lower-stage path 5a of the air heat exchanger (water channel pipeline), and connecting an outlet of the lower-stage path 5a of the air heat exchanger (water channel pipeline) to the water circuit 10 between the three-way valve 12 (path switching valve) and an inlet of the water heat exchanger 3.

[0012] Also, bold arrows in Fig. 1 indicate directions in which water (or hot water) flows, while broken lines indicate directions in which a refrigerant flows.

[0013] Fig. 2 is a block diagram illustrating a configuration relating to control of an operation of the heat pump water heater according to Embodiment 1 of the present invention.

[0014] In Fig. 2, reference numeral 21 designates a control portion, which is composed of a microcomputer, a DSP or the like. Also, reference numeral 22 designates a memory, which stores various types of data, tables and the like. Reference numeral 23 designates a ROM, which stores a program executed by the control portion 21 and fixed data. Reference numeral 24 designates an input/output bus, and information of all the devices is exchanged with the control portion 21 through this input/output bus 24.

[0015] Reference numeral 25 designates a four-way valve driving portion, which drives switching of the four-way valve 2 on the basis of an instruction from the control portion 24. Also, reference numeral 26 designates a three-way valve driving portion, which drives switching of the three-way valve 12 on the basis of an instruction from the control portion 24. Reference numeral 27 designates a communication portion, which receives setting information from a remote controller (hereinafter referred to as remote in some cases) 28 and transmits it to the control portion through the input/output bus 24.

[0016] The lower-stage path 5a of the air heat exchanger constitutes a water channel pipeline.

[0017] Subsequently, a behavior of Embodiment 1 will be described.

Fig. 3 is a flowchart illustrating the behavior of the control portion 21 concerning the control of the operation of the heat pump water heater according to Embodiment 1 of the present invention. Subsequently, the behavior of the control portion 21 in Embodiment 1 will be described using Figs. 1 to 3.

While a power switch of the water heater is on, an operation of the water heater is performed, but since this operation is not related to the present application, it will not be described here. During the operation of the water heater, processing shown in Fig. 3 is cyclically started in a relatively short cycle (a cycle of several milli seconds to several seconds, for example). If the processing of Fig. 3 is started, the control portion 21 executes initial value setting such as clearing of a timer value (Step S301) and then, executes reception from the remote controller 28 (Step 302). Then, the control portion 21 examines contents received from the remote controller 28 and determines whether there is a defrosting operation start instruction or not (Step S303).

In the heat pump water heater, if an operation is per-

formed at a low outside temperature, the air heat exchanger 5 which works as an evaporator and performs heat exchanger between the air and a refrigerant becomes a low temperature at 0°C or below, the air passing through the air heat exchanger 5 is cooled, and moisture in the air is condensed on surface of the air heat exchanger 5 and forms frost, which blocks the air passage. In order to ensure preferable performance of the air heat exchanger 5, an operation to remove the frost adhering to the surface of the air heat exchanger 5 is needed, and the defrosting operation should be performed. As for the defrosting operation, if a defrosting operation start instruction signal is transmitted from the remote controller 28 on the basis of a manipulation of the remote controller by a user and this instruction is received by the control portion 21 sequentially through the communication portion 27 and the input/output bus 24, the control portion 21 recognizes the defrosting operation start by this instruction signal, controls the four-way valve driving portion 25 and the three-way valve driving portion 26 on the basis of defrosting operation information set in the memory 22 in advance and switches the four-way valve 2 and the three-way valve 12 (Steps S304 to S305). Then, the control portion 21 drives the compressor 1 and starts the defrosting operation (Step S306). At the same time, a timer is counted and the defrosting operation is continuously performed until a predetermined time has elapsed (Steps S307 to S308). By means of this defrosting operation, the frost adhering to the surface of the air heat exchanger is heated and becomes drained water, which drops onto the drain pan 13 running down on the fin, flows through a water discharge groove of the drain pan 13 and is discharged to the outside of the unit through a water outlet. After a predetermined time has elapsed, the control portion 21 switches the four-way valve 2 and the three-way valve 12 back to the original positions and further stops the compressor so as to stop the defrosting operation (Step S309) and finishes the processing. After that, the operation of the water heater is performed.

[0018] As described above, by allowing the high-temperature water supplied from the hot water tank 7 to flow to the lower-stage path 5a of the air heat exchanger by switching the three-way valve 12 during the defrosting operation, the drained water running down on the fin is heated in the lower stage of the air heat exchanger 5 so that the drained water can be prevented from freezing on the drain pan 13.

In the above example, the case in which the defrosting operation is instructed by the remote controller 28 has described, but it is needless to say that the instruction can be made by a switch operation on an operation panel on the main body side of the water heater.

Also, it may be so configured that the defrosting operation is started automatically if the control portion 21 calculates operation efficiency of the heat pump water heater resulting in equal or less than predetermined operation efficiency or if the temperature of hot water in the water heater is not raised to a predetermined temperature or above.

Subsequently, an operation of the control portion 21 in that case will be described.

Fig. 4 is a flowchart illustrating the behavior of the control portion concerning control of an operation of a heat pump water heater according to Embodiment 2 of the present invention. In Fig. 4, the flow is the same in Fig. 3 except that Steps S301 to S302 in Fig. 3 are replaced by Steps S401 to S402.

Subsequently, the behavior of the control portion 21 will be described using Fig. 4.

The control portion 21 sets an initial value (Step S301) and then calculates operation efficiency of the heat pump water heater (Step S401). As a calculation method of the operation efficiency, a known method is used. For example, the operation efficiency is calculated on the basis of a rotation speed of the compressor 1. This rotation speed of the compressor 1 is detected by a rotation detector, not shown, mounted on a rotation shaft of the compressor 1. Alternatively, the rotation speed of the compressor 1 may be calculated on the basis of an output of an inverter output current detector, not shown, using the current detector (such as a current transducer and the like), not shown.

Subsequently, the control portion 21 compares the calculated operation efficiency with a predetermined reference value set (Step S402). If the operation efficiency is not less than the reference value, the routine returns to Step S401, where the calculation of the operation efficiency and the comparison with the reference value are repeated. In the comparison at Step S402, if the operation efficiency falls below the predetermined reference value set, an operation is performed similarly to Step S304 and after in Fig. 3.

As a result, since the defrosting operation is performed automatically, users don't have to make manipulation to instruct the defrosting operation. Also, since the defrosting operation is performed reliably, an efficient operation is made possible all the time.

Embodiment 2

[0019] Fig. 5 is an exploded perspective view of the heat pump water heater according to Embodiment 2 of the present invention.

[0020] By disposing the water heat exchanger 3, the lower-stage path 5a of the air heat exchanger, and the water-inlet side connection joint 9 in the vicinity of the three-way valve 12 used for switching of the water circuit during the defrosting operation, a piping length of the water circuit 10 that connects them to each other can be made shorter and simple in configuration, and a manufacturing cost can be kept low.

[0021] Also, by disposing the three-way valve 12 used for switching of the water circuit during the defrosting operation on the inlet side of the water heat exchanger 3, the high-temperature water circulated from the hot water tank 7 in the water heat exchanger 3, which is an

evaporator during the defrosting operation, can be supplied to the lower-stage path 5a of the air heat exchanger without lowering the temperature.

[0022] Also, at the fin disposed in the air heat exchanger 5, by eliminating a cut-and-raised portion of the fins in the path portion through which the refrigerant flows, water removal performance of the fin in the periphery of the path portion, which becomes an evaporator during heating operation and through which the low-temperature refrigerant flows, is improved, and growth of frost can be suppressed.

Reference Signs List

[0023]

1	compressor
2	four-way valve
3	water heat exchanger .
4	electronic expansion valve
5	air heat exchanger
5a	lower path of air heat exchanger
6	refrigerant pipeline
7	hot water tank
8	water-outlet side connection joint
9	water-inlet side connection joint
10	water circuit
11	pump
12	three-way valve
13	drain pan
14	bypass circuit
21	control portion
22	memory
23	ROM
24	input/output bus
25	four-way valve driving portion
26	three-way valve driving portion
27	communication portion
28	remote controller

Claims

1. A heat pump water heater, comprising:

a refrigerating cycle in which a compressor (1), a four-way valve (2) that switches a flow direction of a refrigerant, a water heat exchanger (3) that performs heat exchange between said refrigerant and water, an expansion mechanism that adjusts a flow rate of the refrigerant and decompresses, and an air heat exchanger (5) that performs heat exchange between the air and the refrigerant are sequentially and circularly connected by a pipeline;

a water circuit (10) in which said water heat exchanger (3), a hot water tank (7) that reserves water heated by said water heat exchanger (3), and a pump (11) are sequentially and circularly connected by a pipeline;

a water channel pipeline (5a) disposed in a lower stage of said air heat exchanger (5);

a path switching valve (12) disposed in the water circuit (10) between said pump (11) and said water heat exchanger (3);

a bypass circuit connected between said path switching valve (12) and an inlet of said water channel pipeline (5a) and connecting an outlet of said water channel pipeline (5a) to the water circuit (10) between said path switching valve (12) and an inlet of said water heat exchanger (3); and

a control portion that executes switching control of said four-way valve (2) and said path switching valve (12), wherein

said control portion switches a flow direction of the refrigerant in said refrigerating cycle by switching said four-way valve (2) on the basis of predetermined information during defrosting operation and allows high-temperature water in said hot water tank (7) to flow through the water channel pipeline (5a) of said air heat exchanger (5) via said bypass circuit by switching said path switching valve (12).

2. The heat pump water heater of claim 1, further comprising

a drain pan that collects drained water heated by the water channel pipeline (5a) of said air heat exchanger (5) and dropped from said air heat exchanger (5), in the lower part of said air heat exchanger (5).

3. The heat pump water heater of claim 1 or 2, wherein a cut-and-raised portion is not disposed in the fin of the water channel pipeline portion of said air heat exchanger (5).

4. The heat pump water heater of any one of claims 1 to 3, wherein

in the vicinity of said channel switching valve, said water heat exchanger (3), the water channel pipeline (5a) of said air heat exchanger (5), and a circuit connection joint on the water inlet side are disposed.

5. The heat pump water heater of any one of claims 1 to 4, wherein

said path switching valve (12) is disposed on the inlet side of said water heat exchanger (3).

6. The heat pump water heater of any one of claims 1 to 5, wherein

said path switching valve (12) is a three-way valve.

7. The heat pump water heater of any one of claims 1 to 6, wherein

said control portion executes defrosting operation on

the basis of an instruction from a user.

8. The heat pump water heater of any one of claims 1 to 6, wherein
said control portion executes the defrosting operation when efficiency falls below a reference value set in advance.

FIG. 1

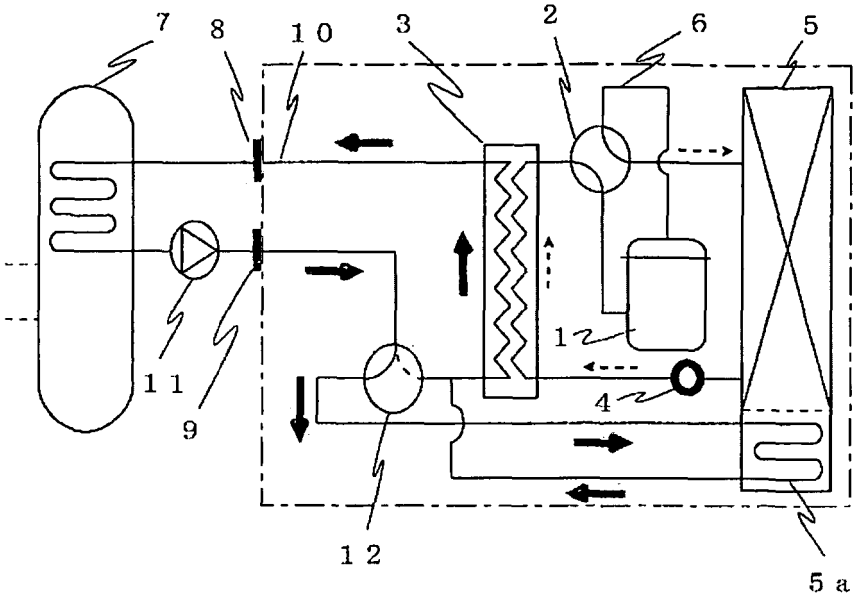


FIG. 2

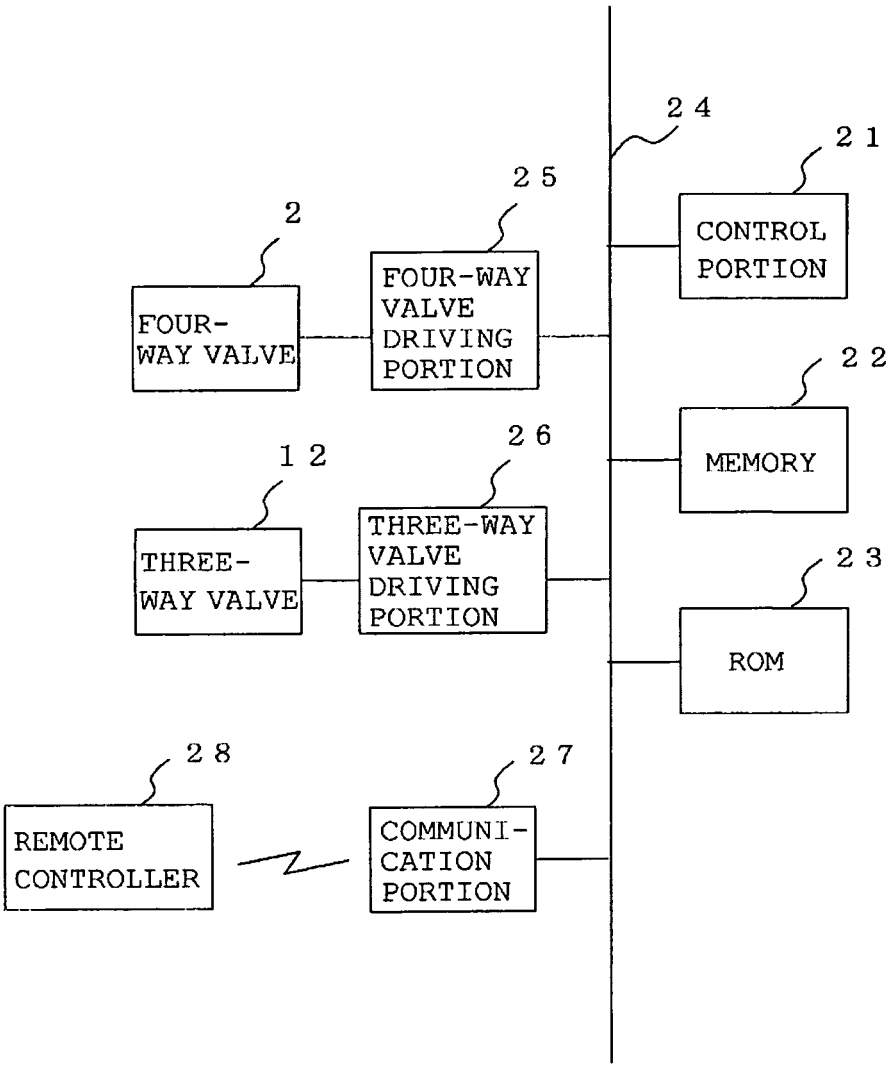

24
21
25
2
CONTROL PORTION
FOUR-WAY VALVE DRIVING PORTION
FOUR-WAY VALVE
22
MEMORY
26
12
THREE-WAY VALVE DRIVING PORTION
THREE-WAY VALVE
23
ROM
28
27
REMOTE CONTROLLER
COMMUNI-CATION PORTION

FIG. 3

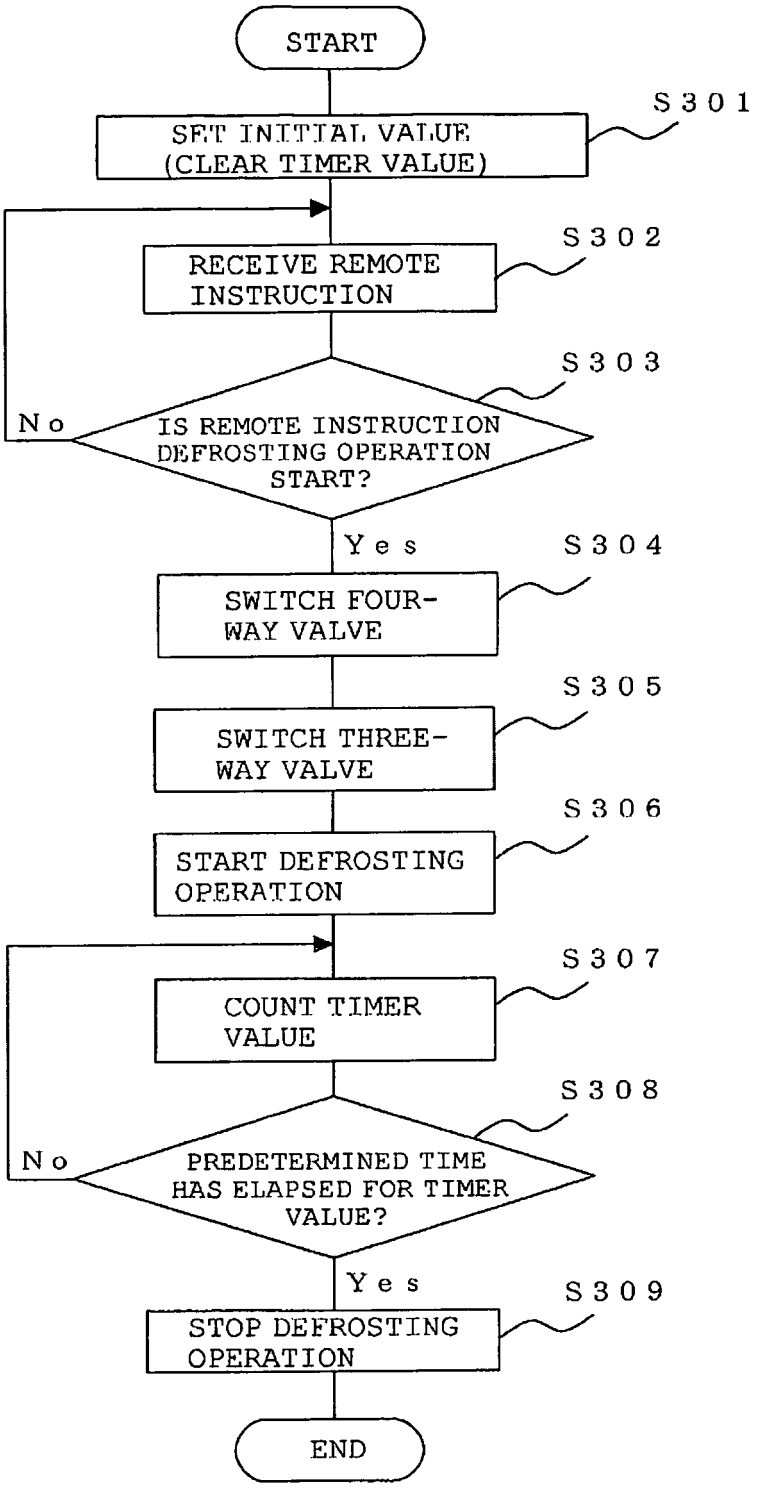

START
S301
SET INITIAL VALUE (CLEAR TIMER VALUE)
S302
RECEIVE REMOTE INSTRUCTION
S303
No
IS REMOTE INSTRUCTION DEFROSTING OPERATION START?
Yes
S304
SWITCH FOUR-WAY VALVE
S305
SWITCH THREE-WAY VALVE
S306
START DEFROSTING OPERATION
S307
COUNT TIMER VALUE
S308
No
PREDETERMINED TIME HAS ELAPSED FOR TIMER VALUE?
Yes
S309
STOP DEFROSTING OPERATION
END

FIG. 4

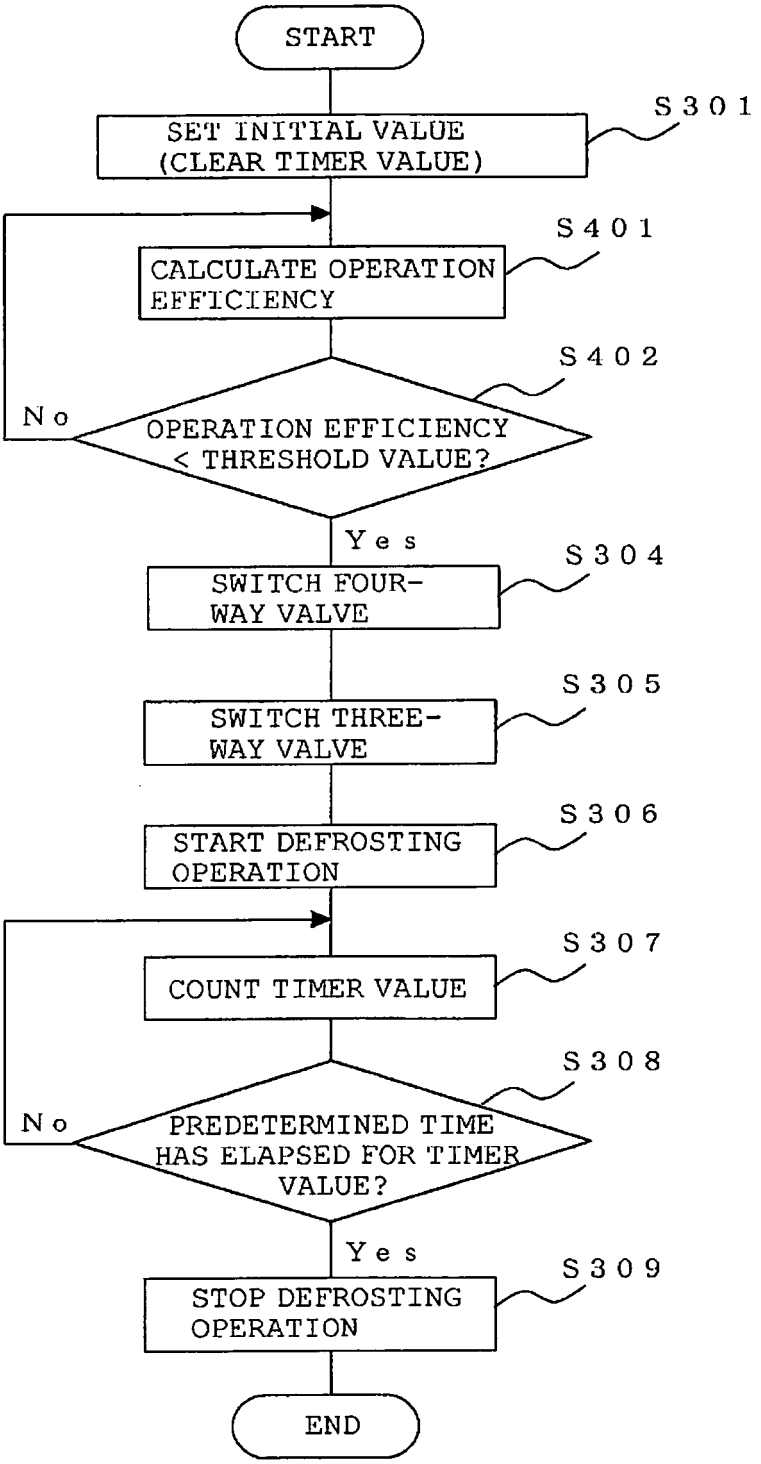
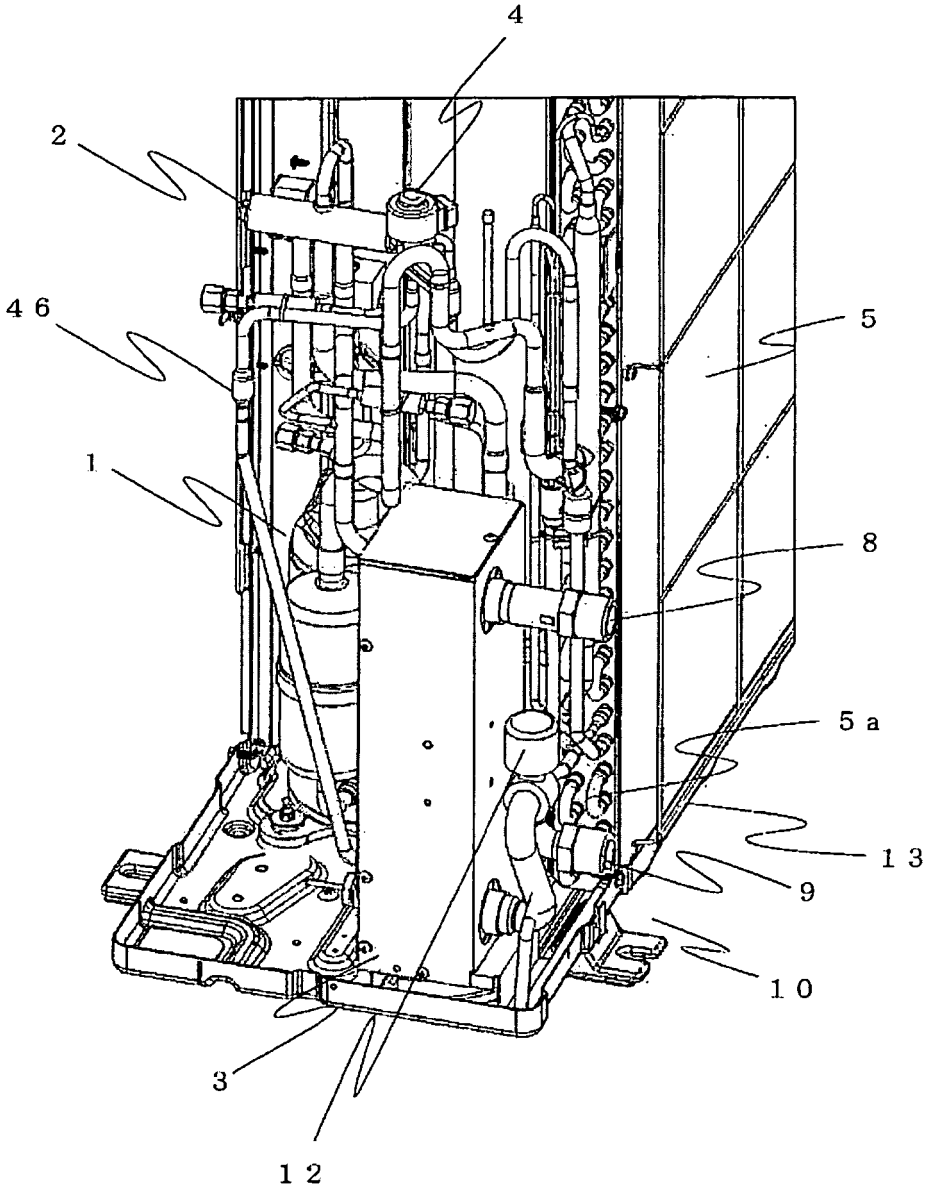

START
SET INITIAL VALUE (CLEAR TIMER VALUE)
S301
CALCULATE OPERATION EFFICIENCY
S401
OPERATION EFFICIENCY < THRESHOLD VALUE?
S402
No
Yes
SWITCH FOUR-WAY VALVE
S304
SWITCH THREE-WAY VALVE
S305
START DEFROSTING OPERATION
S306
COUNT TIMER VALUE
S307
PREDETERMINED TIME HAS ELAPSED FOR TIMER VALUE?
S308
No
Yes
STOP DEFROSTING OPERATION
S309
END

FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/061944

A. CLASSIFICATION OF SUBJECT MATTER
F25B47/02(2006.01)i, *F24H1/00*(2006.01)i, *F24H1/18*(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)
F25B47/02, F24H1/00, F24H1/18

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	JP 2004-218861 A (Denso Corp.), 05 August, 2004 (05.08.04), Par. Nos. [0013] to [0016]; Figs. 5 to 8 (Family: none)	1-8
Y	JP 2004-218944 A (Matsushita Electric Industrial Co., Ltd.), 05 August, 2004 (05.08.04), Par. Nos. [0030] to [0033]; Fig. 3 (Family: none)	1-8
Y	JP 2008-249298 A (Daikin Industries, Ltd.), 16 October, 2008 (16.10.08), Par. No. [0003] (Family: none)	3-8

☒ 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 04 August, 2009 (04.08.09)	Date of mailing of the international search report 18 August, 2009 (18.08.09)
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/JP2009/061944

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2007-225158 A (Mitsubishi Electric Corp.), 06 September, 2007 (06.09.07), Par. Nos. [0018] to [0022]; Figs. 2 to 6 (Family: none)	8

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2004218861 A **[0003]**