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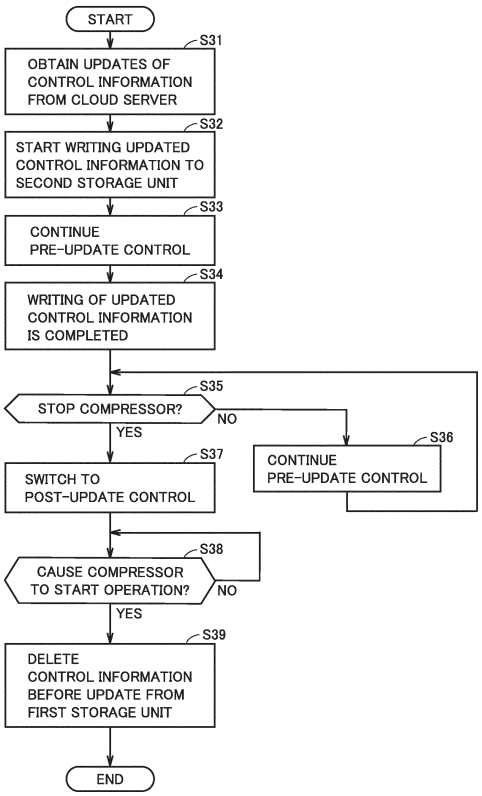
(54) **REFRIGERATION CYCLE DEVICE**

(57) A refrigeration cycle apparatus includes: a refrigerant circuit which includes a compressor; a communication device that receives control information from a cloud server; and a controller having a storage unit for storing the control information received by the communication device. The controller controls the compressor, using the control information stored in the storage unit. As the communication device starts receiving, from a cloud server, updated control information that is newer than the control information before the update stored in the storage unit, the controller continues a pre-update control of causing the compressor to operate, using the already-received control information before the update, without forcibly stopping the operation of the compressor, until writing of the updated control information to the storage unit is completed.

FIG.3



EP 4 163 571 A1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to a refrigeration cycle apparatus.

BACKGROUND ART

[0002] Refrigeration cycle apparatuses adopting a refrigeration cycle (such as air conditioners and refrigeration apparatuses) are widely used throughout the world. The information used to control the refrigeration cycle apparatus (hereinafter, also referred to as "control information") is, in general, recorded in a storage unit included in the refrigeration cycle apparatus. The storage unit is configured of a random access memory (RAM) and a read only memory (ROM), a programmable ROM (PROM) such as a flash memory, or a hard disk drive (HDD), etc.

[0003] In recent years, the press ahead with the internet of things (IoT) puts into practice the refrigeration cycle apparatus that includes a communication device connectable to a communication network. The refrigeration cycle apparatus being connected to the communication network enables the refrigeration cycle apparatus to download from a server connected to the communication network the control information updated (upgraded) to allow better operation of the refrigeration cycle apparatus.

[0004] For example, Japanese Patent No. 4106941 (PTL 1) discloses a refrigeration cycle apparatus that is connectable to a server via a communication network. This refrigeration cycle apparatus, after being firmly installed, can receive (download) updated control information from the server and rewrite the control information before the update with the updated control information.

CITATION LIST

PATENT LITERATURE

[0005] PTL 1: Japanese Patent No. 4106941

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0006] There are occasions where the outage of the refrigeration cycle apparatus is strictly not allowed. Therefore, it is desirable that the control information is rewritten, without forcibly stopping the operation of the refrigeration cycle apparatus. Japanese Patent No. 4106941 (PTL 1) fails to present such a problem and solution to the problem.

[0007] The present disclosure is made to solve the problem above, and an object of the present disclosure is to enable rewriting of the control information, without forcibly stopping the operation of the refrigeration cycle apparatus.

SOLUTION TO PROBLEM

[0008] A refrigeration cycle apparatus according to the present disclosure includes: a refrigerant circuit which includes a compressor; a communication device configured to receive control information from a server; a storage device configured to store the control information received by the communication device; and a controller configured to control the compressor, using the control information stored in the storage device. When the communication device starts receiving second control information newer than first control information stored in the storage device, the controller is configured to continue to perform a first control of causing the compressor to operate using the first control information, until writing of the second control information to the storage device is completed.

ADVANTAGEOUS EFFECTS OF INVENTION

[0009] According to the refrigeration cycle apparatus of the present disclosure, after the refrigeration cycle apparatus starts receiving the second control information, the compressor is caused to operate using the already-received first control information, without forcibly stopping the operation of the compressor, until completion of writing of the second control information to the storage device. Therefore, at an appropriate time after the completion of writing of the second control information (e.g., after the operation of the compressor is stopped by the user operation), the refrigeration cycle apparatus is allowed to rewrite the control information. As a result, the control information can be rewritten, without forcibly stopping the operation of the refrigeration cycle apparatus.

BRIEF DESCRIPTION OF DRAWINGS

[0010]

Fig. 1 is a diagram showing a configuration of a refrigeration cycle system.
Fig. 2 is a diagram showing a configuration of a storage unit included in the refrigeration cycle apparatus.
Fig. 3 is a flowchart of one example process performed by a controller included in the refrigeration cycle apparatus.
Fig. 4 is a sequence diagram illustrating one example overview of a process performed by the refrigeration cycle system.

DESCRIPTION OF EMBODIMENTS

[0011] Hereinafter, embodiments according to the present disclosure will be described, with reference to the accompanying drawings. Note that the same refer-

ence signs are used to refer to the same or like parts, and the description thereof will not be repeated.

[Configuration]

[0012] Fig. 1 is a diagram showing a configuration of a refrigeration cycle system 1 according to an embodiment. The refrigeration cycle system 1 includes a refrigeration cycle apparatus 100, a communication network 200, a cloud server 300, and a remote control 400.

[0013] The refrigeration cycle apparatus 100 includes a controller 110, a rewriting device 120, a communication device 140, and a refrigerant circuit 150.

[0014] The refrigerant circuit 150 is a circuit for air conditioning or refrigeration using a refrigerant and a refrigeration cycle. The refrigerant circuit 150 includes n actuators (e.g., a pressure control valve for controlling the pressure within the refrigerant circuit 150, etc.) 151_1 through 151_n, m sensors (e.g., a temperature sensor for detecting the temperature within the refrigerant circuit 150, etc.) 152_1 through 152_m, and a compressor 153 for compressing the refrigerant. Note that the refrigerant circuit 150 may employ a well-known configuration.

[0015] The controller 110 includes a control operation unit 111, an input processing unit 112, and a storage unit 113. The input processing unit 112 converts signals, input from the m sensors 152_1 through 152_m, into those that can be processed by the control operation unit 111, and outputs them to the control operation unit 111. Based on the signals input from the input processing unit 112, and the state amounts of the n actuators 151_1 through 151_n and the compressor 153, the control operation unit 111 controls the operation of the actuators 151_1 through 151_n and the compressor 153.

[0016] The storage unit 113 stores the information (hereinafter, also referred to as "control information") such as mathematical formulas, constants, and control programs that are used to control the refrigeration cycle apparatus 100 (processes by the input processing unit 112 and the control operation unit 111). The input processing unit 112 and the control operation unit 111 appropriately read the control information stored in the storage unit 113, and perform processes.

[0017] The storage unit 113 may store device information of the refrigeration cycle apparatus 100. The device information may include the model information of the refrigeration cycle apparatus 100, information of devices that are connected to the refrigeration cycle apparatus 100, the history information of operation of the compressor 153 of the refrigeration cycle apparatus 100, etc.

[0018] While Fig. 1 shows an example in which one storage unit 113 is disposed inside the controller 110, it should be noted that the number of storage units 113 and the arrangement thereof are not limited thereto. For example, all or some of the storage unit 113 may be divided into subunits and disposed external to the controller 110.

[0019] The rewriting device 120 is capable of rewriting the control information stored in the storage unit 113 of the controller 110. Note that the "rewriting" of the control information includes replacement of old information with new information, deletion of old information, and writing (adding) of new information. The communication device 140 is connectable to the communication network 200.

[0020] The remote control 400 is a device for a user of the refrigeration cycle apparatus 100 to remotely control the refrigeration cycle apparatus 100 in the space where the refrigeration cycle apparatus 100 is installed. The remote control 400 includes a display device 401 and an input device 402.

[0021] The input device 402 of the remote control 400 is capable of receiving operation commands by the user, such as the set temperature, the operation mode, the wind direction, and the volume of the air of the refrigeration cycle apparatus 100. The remote control 400 transmits the operation commands, input from the input device 402, to the controller 110 of the refrigeration cycle apparatus 100.

[0022] The operation commands transmitted from the remote control 400 to the refrigeration cycle apparatus 100 are reflected to the controller 110 controlling the refrigeration cycle apparatus 100. The remote control 400 is also capable of showing the information received from the controller 110 of the refrigeration cycle apparatus 100 on the display device 401. Note that, instead of or in addition to the remote control 400, smartphone having functions equivalent to those of the remote control 400 may be connectable to the refrigeration cycle apparatus 100 via the communication network 200.

[0023] The cloud server 300 includes a cloud storage unit 301 and a communication device 303. The communication device 303 is connectable to the communication network 200. Accordingly, the refrigeration cycle apparatus 100 and the cloud server 300 are capable of communications with each other via the communication network 200.

[0024] The cloud storage unit 301 includes a candidate storage unit 301a. The candidate storage unit 301a stores information that allows rewriting of the control information stored in the storage unit 113 of the refrigeration cycle apparatus 100. Note that the control information may be modified (upgraded) for updates by the manufacturer of the refrigeration cycle apparatus 100 or the like. Each time the control information is updated, the most-recent control information after the update is added to the candidate storage unit 301a. When the control information is updated, information (hereinafter, also referred to as "update information") indicating that the control information is updated is also stored into the candidate storage unit 301a.

[0025] Fig. 2 is a diagram showing a configuration of the storage unit 113 of the refrigeration cycle apparatus 100. The storage unit 113 includes a first storage unit 1131 and a second storage unit 1132. The first storage unit 1131 and the second storage unit 1132 are capable of storing the control information of the refrigeration cycle apparatus 100 independently of each other.

[Operations]

[0026] If the control information stored in the candidate storage unit 301a is updated, the cloud server 300 transmits the above-described updates to the refrigeration cycle apparatus 100.

[0027] In the following, already-received control information being used by the refrigeration cycle apparatus 100 will also be described as "control information before the update," and the control over the refrigeration cycle apparatus 100 using the control information before the update is also described as a "pre-update control." The control information before the update and the pre-update control can correspond to "first control information" and a "first control," respectively, according to the present disclosure.

[0028] Moreover, in the following, new control information in which the control information before the update is modified will also be described as "updated control information," and the control over the refrigeration cycle apparatus 100 using the updated control information is also described as a "post-update control." The updated control information and the post-update control correspond to "second control information" and "second control," respectively, according to the present disclosure.

[0029] In the following, assume that the control information before the update is stored into the first storage unit 1131, and the updated control information is written to the second storage unit 1132.

[0030] Fig. 3 is a flowchart of one example process performed by the controller 110 of the refrigeration cycle apparatus 100. The refrigeration cycle apparatus 100 receives updates of the control information from the cloud server 300 (step S31), in response to which the refrigeration cycle apparatus 100 obtains updated control information from the candidate storage unit 301a of the cloud server 300 and starts writing the updated control information to the second storage unit 1132 (step S32). Note that the control information before the update stored in the first storage unit 1131 is held in the first storage unit 1131 until being deleted by a process of step S39 described below.

[0031] Even after started writing the updated control information, the refrigeration cycle apparatus 100 continues the "pre-update control" controlling the refrigeration cycle apparatus 100 using the control information before the update (step S33). This causes the compressor 153 to continue the operation even after the writing of the updated control information is started during the operation of the compressor 153.

[0032] Upon completion of the writing of the updated control information (step S34), the refrigeration cycle apparatus 100 determines whether the compressor 153 is caused to stop the operation through, for example, an operation stop command by the user's manual operation or an operation stop command by a timer function set by the user (step S35). If the compressor 153 continues to operate (NO in step S35), the refrigeration cycle apparatus 100 continues the pre-update control (step S36). Subsequently, the process returns to step S35.

[0033] If the compressor 153 is caused to stop the operation (YES in step S35), the refrigeration cycle apparatus 100 switches its own control mode from the "pre-update control," in which the control information before the update is used, to the "post-update control," in which the updated control information is used (step S37).

[0034] Subsequently, the refrigeration cycle apparatus 100 determines whether the compressor 153 is caused to start the operation by the post-update control through, for example, an operation start command by the user's manual operation or an operation start command by the timer function set by the user (step S38). If the compressor 153 is not caused to start the operation by the post-update control (NO in step S38), the refrigeration cycle apparatus 100 waits for the compressor 153 to resume the operation.

[0035] If the compressor 153 is caused to start the operation by the post-update control (YES in step S38), the refrigeration cycle apparatus 100 deletes the control information before the update from the first storage unit 1131 (step S39).

[0036] Fig. 4 is a sequence diagram illustrating one example overview of a process performed by the refrigeration cycle system 1.

[0037] The refrigeration cycle apparatus 100 in the initial state of Fig. 4 performs the "pre-update control" using the already-received control information before the update stored in the first storage unit 1131 (step S30).

[0038] As the updated control information is added to the candidate storage unit 301a, the cloud server 300 obtains updates indicative of such from the candidate storage unit 301a (step S10), and transmits the updates to the refrigeration cycle apparatus 100 (step S11).

[0039] The refrigeration cycle apparatus 100 obtains the updates from the cloud server 300 (step S31), in response to which the refrigeration cycle apparatus 100 obtains the updated control information from the candidate storage unit 301a of the cloud server 300, and starts writing the updated control information to the second storage unit 1132 (step S32).

[0040] Subsequently, the refrigeration cycle apparatus 100 continues the pre-update control using the control information before the update stored in the first storage unit 1131, until the writing of the updated control information to the second storage unit 1132 is completed (step S33).

[0041] Then, upon completion of the writing of the updated control information to the second storage unit 1132 (step S34), the refrigeration cycle apparatus 100 confirms that the compressor 153 is stopped (step S35). The refrigeration cycle apparatus 100 continues to perform the pre-update control until the compressor 153 is stopped for the first time after the completion of the writing of the updated control information.

[0042] When the compressor 153 stops for the first time after the completion of the writing of the updated

control information, the refrigeration cycle apparatus 100 switches its control mode from the pre-update control to the "post-update control" that uses the updated control information stored in the second storage unit 1132 (step S37).

[0043] Subsequently, the refrigeration cycle apparatus 100 confirms that the compressor 153 is operated by the post-update control (step S38). Once confirmed that the compressor 153 is operated by the post-update control, the refrigeration cycle apparatus 100 deletes the control information before the update from the first storage unit 1131 (step S39).

[0044] While not described in Figs. 3 and 4, after step S39, the updated control information stored in the second storage unit 1132 is moved to the first storage unit 1131. This stores the already-received control information being used in the first storage unit 1131, causing no control information being stored in the second storage unit 1132. Note that, rather than moving the updated control information from the second storage unit 1132 to the first storage unit 1131, the control information stored in the second storage unit 1132 may be treated as the control information before the update (i.e., treating the second storage unit 1132 as the first storage unit 1131).

[0045] As described above, the refrigeration cycle apparatus 100 according to the present embodiment includes: the refrigerant circuit 150 which includes the compressor 153; the communication device 140 which receives the control information from the cloud server 300; and the controller 110 which: includes the storage unit 113 for storing the control information received by the communication device 140; and controls the compressor 153 using the control information stored in the storage unit 113.

[0046] If the communication device 140 starts receiving updated control information that is newer than the control information before the update stored in the storage unit 113, the controller 110 continues the pre-update control of causing the compressor 153 to operate using the already-received control information before the update with operating experience, without forcibly stopping the operation of the compressor 153, until the completion of writing of the updated control information to the storage unit 113. Therefore, the control information can be rewritten at an appropriate time after the completion of writing of the updated control information. This allows the control information to be rewritten, without forcibly stopping the operation of the refrigeration cycle apparatus 100.

[0047] In particular, the controller 110 according to the present embodiment continues to perform the pre-update control until the compressor 153 is caused to stop the operation for the first time after the completion of writing of the updated control information to the storage unit 113. Then, when the operation of the compressor 153 is stopped for the first time after the completion of writing of the updated control information, the controller 110 performs the post-update control of causing the compressor 153 to operate, using the updated control information, instead of using the pre-update control. Since the refrigeration cycle apparatus 100 switches its own mode from the pre-update control to the post-update control in such a manner while the operation of the compressor 153 is stopped, the refrigeration cycle apparatus 100 can smoothly switch its own mode from the pre-update control to the post-update control, without forcibly stopping the operation of the compressor 153.

[0048] Furthermore, after the compressor 153 is operated for the first time by the post-update control, the controller 110 according to the present embodiment deletes the control information before the update from the storage unit 113. Stated differently, the control information before the update stored in the storage unit 113 is held, without deleting it, until the operation of the compressor 153 by the post-update control is confirmed. Therefore, if the compressor 153 is not operated by the post-update control for some reason, the compressor 153 can be readily restored to the pre-update control.

[0049] The presently disclosed embodiment should be considered in all aspects as illustrative and not restrictive. The scope of the present disclosure is indicated by the appended claims, rather than by the description above, and all changes that come within the scope of the claims and the meaning and range of equivalency of the claims are intended to be embraced within their scope.

REFERENCE SIGNS LIST

[0050] 1 refrigeration cycle system; 100 refrigeration cycle apparatus; 110 controller; 111 control operation unit; 112 input processing unit; 113 storage unit; 120 rewriting device; 140, 303 communication device; 150 refrigerant circuit; 151 actuator; 152 sensor; 153 compressor; 200 communication network; 300 cloud server; 301 cloud storage unit; 301a candidate storage unit; 400 remote control; 401 display device; 402 input device; 1131 first storage unit; and 1132 second storage unit.

Claims

1. A refrigeration cycle apparatus, comprising:

a refrigerant circuit which includes a compressor;
a communication device configured to receive control information from a server;
a storage device configured to store the control information received by the communication device; and
a controller configured to control the compressor, using the control information stored in the storage device, wherein
when the communication device starts receiving second control information newer than first control information stored in the storage device, the

controller is configured to continue to perform a first control of causing the compressor to operate using the first control information, until writing of the second control information to the storage device is completed.

2. The refrigeration cycle apparatus according to claim 1, wherein
the controller is configured to:

continue to perform the first control, until the compressor is caused to stop operation for the first time after the writing of the second control information to the storage device is completed; and
when the compressor is caused to stop the operation for the first time after the writing of the second control information to the storage device is completed, perform a second control of causing the compressor to operate using the second control information, instead of performing the first control.

3. The refrigeration cycle apparatus according to claim 2, wherein
the controller is configured to delete the first control information from the storage device after the compressor is caused to operate by the second control for the first time.

4. The refrigeration cycle apparatus according to any one of claims 1 to 3, wherein
the storage device has:

a first storage unit configured to store the first control information; and
a second storage unit to which the second control information is written.

FIG.1

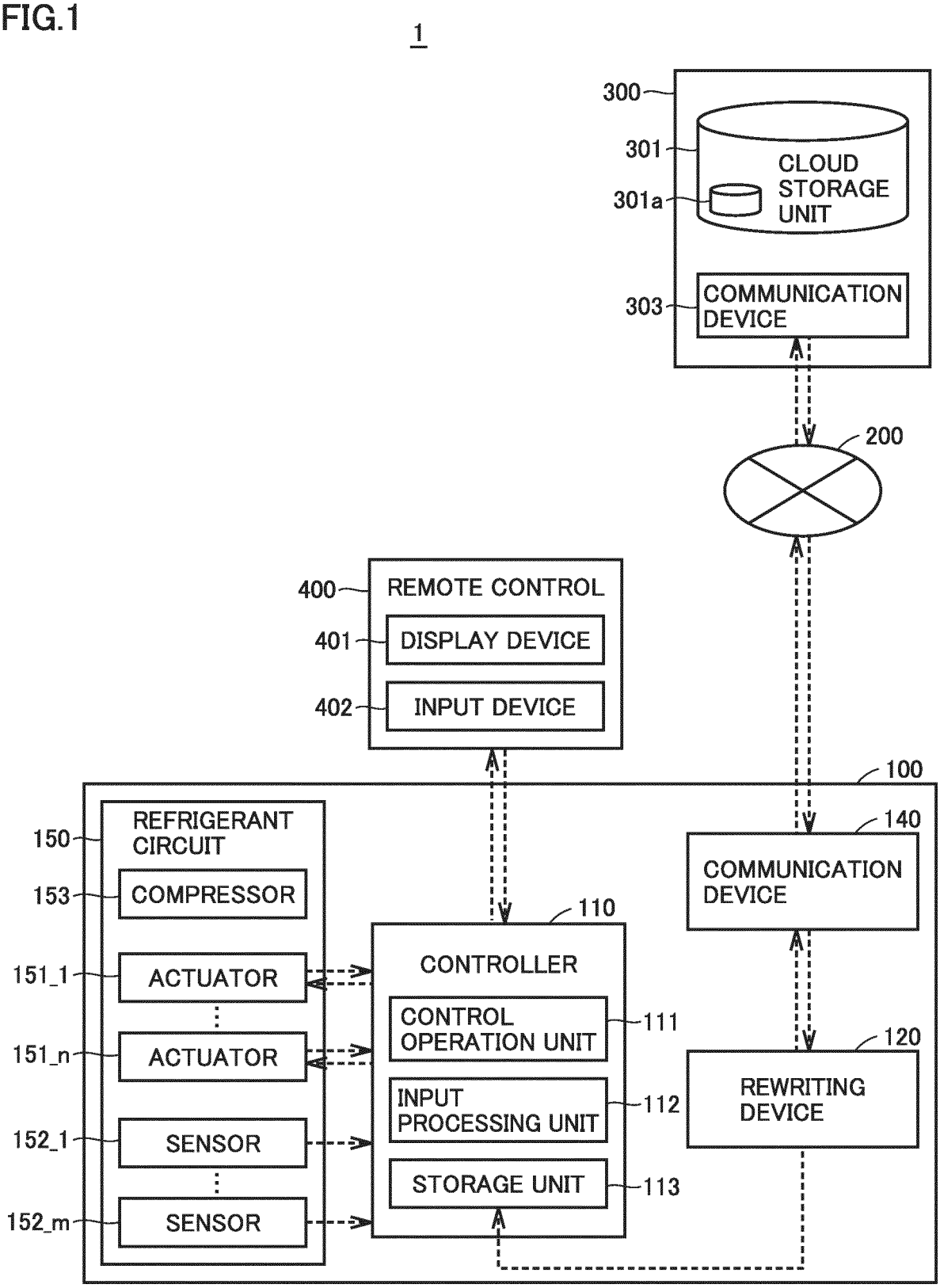

1
300
301
CLOUD STORAGE UNIT
301a
303
COMMUNICATION DEVICE
200
400
REMOTE CONTROL
401
DISPLAY DEVICE
402
INPUT DEVICE
100
150
REFRIGERANT CIRCUIT
153
COMPRESSOR
151_1
ACTUATOR
151_n
ACTUATOR
152_1
SENSOR
152_m
SENSOR
110
CONTROLLER
CONTROL OPERATION UNIT
111
INPUT PROCESSING UNIT
112
STORAGE UNIT
113
140
COMMUNICATION DEVICE
120
REWRITING DEVICE

FIG.2

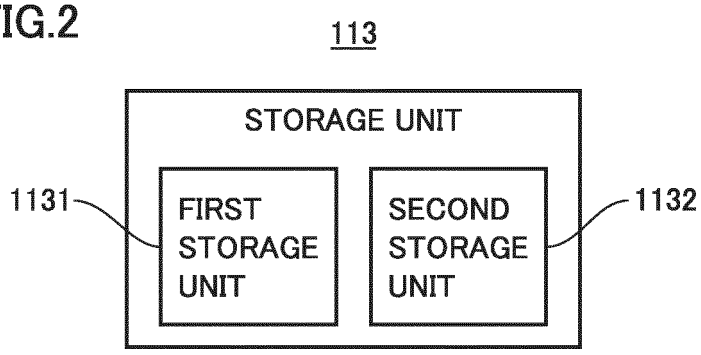

113
STORAGE UNIT
1131
FIRST STORAGE UNIT
SECOND STORAGE UNIT
1132

FIG.3

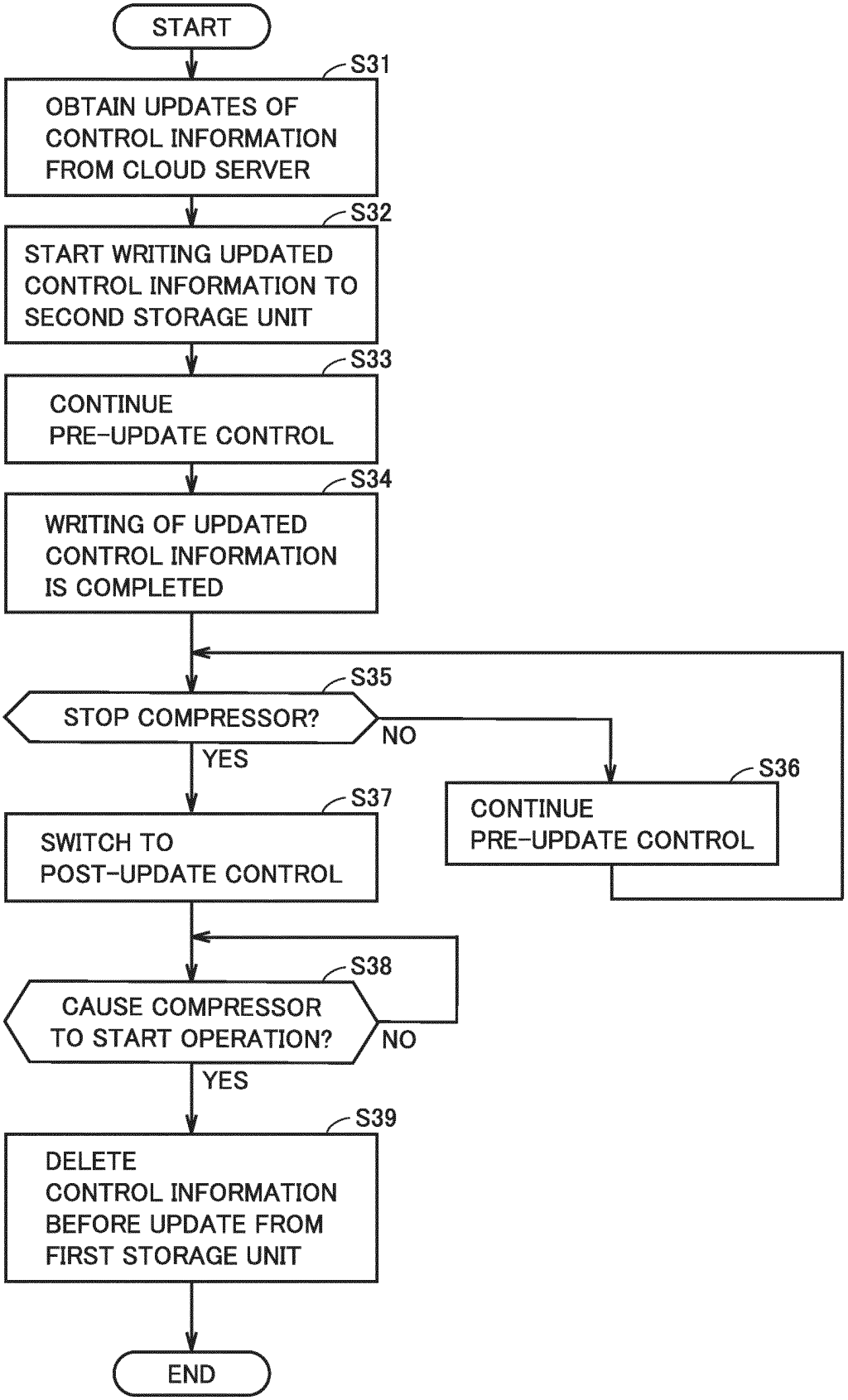
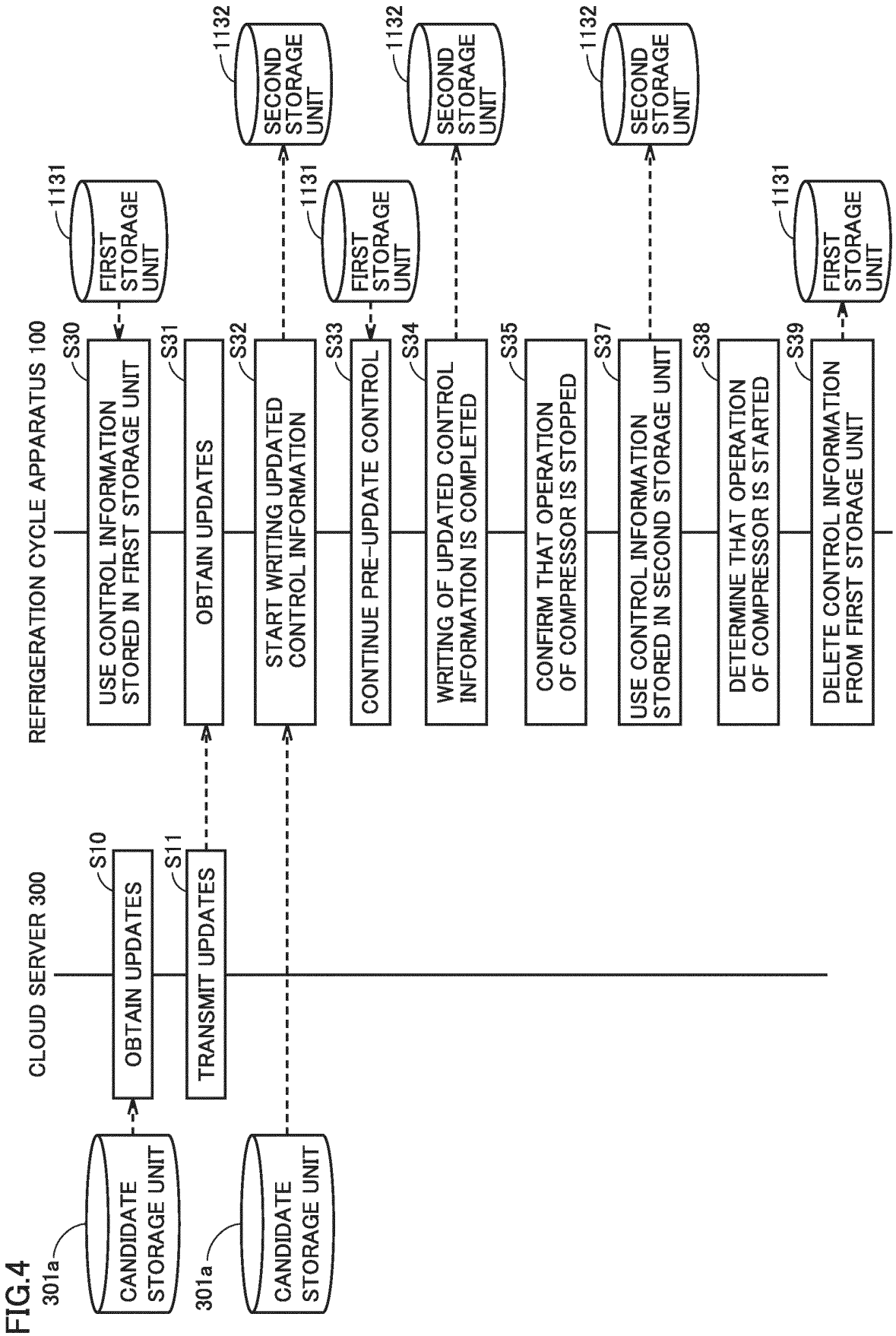

START
S31
OBTAIN UPDATES OF CONTROL INFORMATION FROM CLOUD SERVER
S32
START WRITING UPDATED CONTROL INFORMATION TO SECOND STORAGE UNIT
S33
CONTINUE PRE-UPDATE CONTROL
S34
WRITING OF UPDATED CONTROL INFORMATION IS COMPLETED
S35
STOP COMPRESSOR?
NO
YES
S36
CONTINUE PRE-UPDATE CONTROL
S37
SWITCH TO POST-UPDATE CONTROL
S38
CAUSE COMPRESSOR TO START OPERATION?
NO
YES
S39
DELETE CONTROL INFORMATION BEFORE UPDATE FROM FIRST STORAGE UNIT
END

FIG.4


CLOUD SERVER 300
REFRIGERATION CYCLE APPARATUS 100
301a
CANDIDATE STORAGE UNIT
301a
CANDIDATE STORAGE UNIT
S10
OBTAIN UPDATES
S11
TRANSMIT UPDATES
1131
FIRST STORAGE UNIT
S30
USE CONTROL INFORMATION STORED IN FIRST STORAGE UNIT
S31
OBTAIN UPDATES
1132
SECOND STORAGE UNIT
S32
START WRITING UPDATED CONTROL INFORMATION
1131
FIRST STORAGE UNIT
S33
CONTINUE PRE-UPDATE CONTROL
1132
SECOND STORAGE UNIT
S34
WRITING OF UPDATED CONTROL INFORMATION IS COMPLETED
S35
CONFIRM THAT OPERATION OF COMPRESSOR IS STOPPED
1132
SECOND STORAGE UNIT
S37
USE CONTROL INFORMATION STORED IN SECOND STORAGE UNIT
S38
DETERMINE THAT OPERATION OF COMPRESSOR IS STARTED
1131
FIRST STORAGE UNIT
S39
DELETE CONTROL INFORMATION FROM FIRST STORAGE UNIT

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/022528

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F25B1/00(2006.01)i, F24F11/86(2018.01)i
FI: F25B1/00 341S, F24F11/86

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. F25B, F24F

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2020
Registered utility model specifications of Japan	1996-2020
Published registered utility model applications of Japan	1994-2020

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2020/044447 A1 (MITSUBISHI ELECTRIC CORP.) 05 March 2020, paragraphs [0013]-[0051], fig. 1-7	1-4
A	JP 2002-317995 A (HITACHI, LTD.) 31 October 2002, paragraph [0025], fig. 4	1-4
A	JP 2001-355951 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 26 December 2001, paragraphs [0052], [0055], fig. 7	1-4

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18.08.2020	01.09.2020

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/022528

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
WO 2020/044447 A1	05.03.2020	(Family: none)	
JP 2002-317995 A	31.10.2002	US 2002/0154057 A1 paragraph [0034], fig. 4 US 2004/0183722 A1 TW 500896 B KR 10-2002-0082737 A	
JP 2001-355951 A	26.12.2001	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 4106941 B **[0004] [0005] [0006]**