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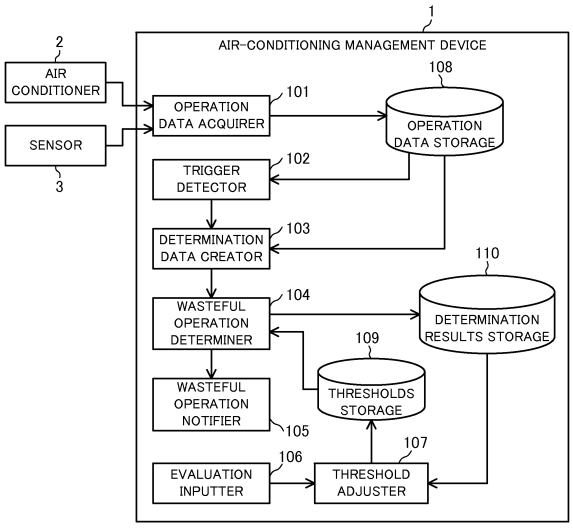
(54) AIR-CONDITIONING MANAGEMENT DEVICE, AIR-CONDITIONING MANAGEMENT METHOD, AND PROGRAM

(57) A wasteful operation determiner (104) compares wasteful operation determination data created based on operation data with thresholds stored in a thresholds storage (109) to determine whether an air conditioner (2) is conducting wasteful operation. When the wasteful operation determiner (104) determines the presence of wasteful operation, a wasteful operation notifier (105) notifies the user so. An evaluation inputter (106) receives from the user the result of evaluation as to whether the wasteful operation is actually taking place. A threshold adjuster (107) adjusts the thresholds for determining the presence/absence of wasteful operation based on the evaluation result entered from the evaluation inputter (106) and past determination results stored in a determination results storage (110).

FIG. 2



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Description

Technical Field

[0001] The present invention relates to an air-conditioning management device, air-conditioning management method, and program.

Background Art

[0002] Most of the air warmed (cooled) by an air conditioner escapes from an air-conditioned room if some windows and/or doors are opened while the air conditioner is in operation. Under such a circumstance, the air conditioner has to be operated in an inefficient and wasteful manner such as having the power increased and operated for a prolonged time, which hinders energy saving.

[0003] Patent Literature 1 discloses a monitoring device for an air conditioner for preventing such wasteful operation. This monitoring device calculates the moving average of the opening level of the air conditioner expansion valve and when the moving average is above a given threshold for a predetermined time period, determines that the air conditioner is conducting wasteful operation and notifies the administrator so.

[0004] By the way, air conditioners are installed under diverse circumstances (different in number and size of windows and doors). Therefore, with the monitoring device described in the Patent Literature 1, the above threshold must be set to a proper value in accordance with the circumstance in which the air conditioner is installed. In this regard, the monitoring device described in the Patent Literature 1 changes the threshold based on the tendency of temperature change within a day, outdoor temperature, and/or history of monitoring parameters over a given number of preceding days for automatically setting a proper threshold.

Citation List

Patent Literature

[0005] Patent Literature 1: Unexamined Japanese Patent Application Kokai Publication No. 2006-336901.

Summary of Invention

Technical Problem

[0006] However, the invention described in the Patent Literature 1 does not take into account the case in which the result of determination made by the monitoring device on wasteful operation is different from the fact. Therefore, in such a case, the threshold may not properly be set and the presence/absence of wasteful operation cannot be determined.

[0007] The present invention is invented in view of the above situation and an exemplary objective of the present invention is to provide an air-conditioning management device, air-conditioning management method, and program that allow for determining the presence/absence of wasteful operation more accurately than in the prior art.

Solution to Problem

[0008] In order to achieve the above objective, the air-conditioning management device of the present invention comprises:

operation data acquisition means acquiring operation data of an air conditioner;
wasteful operation determination means determining whether the air conditioner is conducting wasteful operation based on the acquired operation data and given criteria;
wasteful operation notification means giving notice of wasteful operation when the wasteful operation determination means determines the presence of wasteful operation; and
criteria adjustment means adjusting the given criteria based on the result of user evaluation on the determination of wasteful operation.

Advantageous Effects of Invention

[0009] The present invention automatically adjusts the criteria for the determination of wasteful operation based on the result of user evaluation on the determination of wasteful operation. Therefore, the presence/absence of wasteful

operation can be determined more accurately than in the prior art.

Brief Description of Drawings

[0010]

FIG. 1 is an illustration showing the configuration of a system comprising the air-conditioning management device according to Embodiment 1 of the present invention;
FIG. 2 is a block diagram showing the functional configuration of the air-conditioning management device according to Embodiment 1 of the present invention;
FIG. 3 is an illustration showing exemplary operation data;
FIG. 4 is a graphical representation showing the relationship between the temperature in an air-conditioned area and the time;
FIG. 5A and 5B are an illustration showing exemplary determination result data;
FIG. 6A and 6B are an illustration showing exemplary threshold data;
FIG. 7 is a flowchart for explaining the initial operation procedure in Embodiment 1;
FIG. 8 is a flowchart for explaining the normal operation procedure in Embodiment 1;
FIG. 9 is an illustration for explaining the threshold adjustment procedure;
FIG. 10 is a block diagram showing the functional configuration of the air-conditioning management device according to Embodiment 2 of the present invention; and
FIG. 11 is a flowchart for explaining the normal operation procedure in Embodiment 2.

Description of Embodiments

[0011] Embodiments of the present invention will be described in detail hereafter with reference to the figures. The same or equivalent components are referred to by the same reference number in the figures.

<<Embodiment 1>>

[0012] An air-conditioning management device 1 according to Embodiment 1 of the present invention will be described. The air-conditioning management device 1 is, as shown in FIG. 1, connected to an air conditioner 2 installed in an air-conditioned area and a sensor 3 measuring the temperature and/or humidity in the air-conditioned area. The air-conditioning management device 1 controls the operation of the air conditioner 2 and determines wasteful operation based on the current operation state of the air conditioner 2 and the measurements of the sensor 3. The air-conditioning management device 1 is physically a computer comprising a CPU (central processing unit), ROM (read only memory), RAM (random access memory), a readable/writable semiconductor memory such as a hard disk drive or flash memory, a communication interface, and the like.

[0013] The air-conditioning management device 1 functionally comprises, as shown in FIG. 2, an operation data acquirer 101, a trigger detector 102, a determination data creator 103, a wasteful operation determiner 104, a wasteful operation notifier 105, an evaluation inputter 106, a threshold adjuster 107, an operation data storage 108, a thresholds storage 109, and a determination results storage 110. Here, the configuration for controlling the operation of the air conditioner 2 is not part of the core configuration of the present invention and therefore not shown.

[0014] The operation data acquirer 101 acquires information indicating the operation state of the air conditioner 2 and measurements measured by the sensor 3 (for example, the temperature (room temperature) in the air-conditioned area and the like) at given time intervals (for example, every 5 minutes). Then, the operation data acquirer 101 stores in the operation data storage 108 operation data in which the acquired information is associated with current date/time information.

[0015] The trigger detector 102 monitors the operation data stored in the operation data storage 108 and detects triggers for starting the procedure to determine the wasteful operation. In this embodiment, the triggers are detected when the air conditioner 2 starts the cooling operation from the non-operating state (power-off state) and when the stabilized state in which the room temperature is kept constant by the cooling operation occurs. In the following explanation, the start of cooling operation from the power-off state is referred to as the "cooling operation start" trigger and occurrence of the stabilized condition in which the room temperature is kept constant by the cooling operation is referred to as the "stabilized cooling" trigger.

[0016] As the trigger detector 102 detects one of the above triggers, the determination data creator 103 acquires from the operation data storage 108 the operation data for a given elapsed time since the time of detection of the trigger. Then, the determination data creator 103 creates wasteful operation determination data from the acquired operation data.

[0017] The wasteful operation determiner 104 compares the wasteful operation determination data created by the

determination data creator 103 with the threshold data stored in the thresholds storage 109 to determine the presence/absence of wasteful operation and stores the determination result in the determination results storage 110.

[0018] When the wasteful operation determiner 104 determines the presence of wasteful operation, the wasteful operation notifier 105 notifies the user so in a given manner. For example, the wasteful operation notifier 105 comprises a LED lamp or speaker and turns on the LED lamp or outputs sound from the speaker to notify the user of occurrence of the wasteful operation.

[0019] The evaluation inputter 106 comprises, for example, given buttons and receives from the user the result of evaluation as to whether the wasteful operation is actually taking place. For example, assuming that the evaluation inputter 106 comprises a button "Yes" and a button "No" as the given buttons, the user presses the button "Yes" if the wasteful operation is actually taking place or presses the button "No" if not so as to enter the result of evaluation on the wasteful operation. The evaluation inputter 106 outputs the evaluation result entered by the user through button operation or the like to the threshold adjuster 107.

[0020] The threshold adjuster 107 adjusts the thresholds for determining the presence/absence of wasteful operation based on the evaluation result entered from the evaluation inputter 106 and the past determination results stored in the determination results storage 110.

[0021] The operation data storage 108 stores, as shown in FIG. 3, operation data acquired by the operation data acquirer 101 at given time intervals (every 5 minutes in this example). In the example shown in FIG. 3, the operation data include "date/time," "operation mode," "set temperature," and "room temperature" associated with one another. Here, the "operation mode" and "set temperature" are information acquired from the controller of the air conditioner 2. Furthermore, the "room temperature" is the temperature (room temperature) in the air-conditioned area measured by the sensor 3. Furthermore, the "operation mode" is information indicating in what mode the air conditioner 2 is operating and can be, for example, "cool," "heat," "dehumidification," "fan," "power-off," or the like.

[0022] Returning to FIG. 2, the determination results storage 110 stores the results of determination by the wasteful operation determiner 104 on the presence/absence of wasteful operation. More specifically, the determination results storage 110 stores determination result data in which information indicating a trigger, information indicating the result of determination on wasteful operation upon detection of the trigger, and determination data used in the determination are associated with one another. In this embodiment, the temperature change rates 5, 10, and 15 minutes after detection of a trigger are used as the determination data. In this embodiment, the ratio of the room temperature change from detection of a trigger to a target time to the difference between the room temperature and set temperature at the start-up of the air conditioner 2 is calculated as the temperature change rate at the target time.

[0023] A specific case of the temperature change rate will be described hereafter. FIG. 4 is a graphical representation showing the relationship between the temperature (room temperature) in an air-conditioned area where the air conditioner 2 is installed and time. The room temperature is T_a at a time t_a. At the time t_a, the air conditioner 2 starts operating and the "cooling operation start" trigger is detected. The room temperature reaches a set temperature T_c at a time t_c. The room temperature is T_b 15 minutes after the time t_a. In this case, the temperature change rate at the time t_b can be calculated as follows:

$$(\text{Temperature change rate at the time } t_b) = (T_b - T_a) / |T_a - T_c|$$

[0024] FIG. 5 shows exemplary determination result data.

[0025] FIG. 5A shows determination result data presenting the result of determination on wasteful operation when the "cooling operation start" trigger is detected. It is understood from this figure that the temperature change rates 5, 10, and 15 minutes after the trigger detection are "-30 %," "-50 %," and "-70 %," respectively, and no wasteful operation (the absence of wasteful operation) is determined from these temperature change rates.

[0026] FIG. 5B shows determination result data presenting the result of determination of wasteful operation when the "stabilized cooling" trigger is detected. It is understood from this figure that the temperature change rates 5, 10, and 15 minutes after the trigger detection are "0 %," "-10 %," and "0 %," respectively, and the absence of wasteful operation is determined from these temperature change rates.

[0027] Returning to FIG. 2, the thresholds storage 109 stores the wasteful operation determination thresholds. More specifically, the thresholds storage 109 stores information indicating triggers and threshold data for the determination of wasteful operation when the triggers are detected.

[0028] FIG. 6 shows exemplary threshold data.

[0029] The threshold data shown in FIG. 6A are threshold data for use in the determination of wasteful operation when the "cooling operation start" trigger is detected. It is understood from this figure that the absence of wasteful operation is determined when the absolute value of the temperature change rate 5 minutes after detection of the "cooling operation start" trigger is "20 % or higher," the temperature change rate 10 minutes later is "30 % or higher," and the temperature

change rate 15 minutes later is "40 % or higher."

[0030] The threshold data shown in FIG. 6B are threshold data for use in the determination of wasteful operation when the "stabilized cooling" trigger is detected. It is understood from this figure that the absence of wasteful operation is determined when the absolute value of the temperature change rate 5 minutes after detection of the "stabilized cooling" trigger is "10 % or lower," the temperature change rate 10 minutes later is "10 % or lower," and the temperature change rate 15 minutes later is "30 % or lower."

[0031] The procedures executed by the air-conditioning management device 1 will be described hereafter using the case of cooling operation of the air conditioner 2 by way of example.

(Initial operation procedure)

[0032] Immediately after the air-conditioning management device 1 is installed, the thresholds for determining the presence/absence of wasteful operation are not stored in the thresholds storage 109. Then, the air-conditioning management device 1 executes the initial operation procedure to set temporary thresholds. Details of the initial operation procedure will be described with reference to the flowchart of FIG. 7.

[0033] The initial operation procedure starts, for example, when the air-conditioning management device 1 is activated with no thresholds (threshold data) stored in the thresholds storage 109. Here, in parallel to the initial operation procedure, the operation data acquirer 101 1 periodically acquires operation data and stores them in the operation data storage 108.

[0034] As the initial operation procedure starts, first, the trigger detector 102 monitors the operation data stored in the operation data storage 108 and determines whether any trigger to start the determination of wasteful operation is detected (Step S101).

[0035] If any trigger is detected (Step S101; Yes), the determination data creator 103 waits until the operation data for use in the determination are accumulated (stored) in the operation data storage 108 since the trigger is detected (Step S102). In this embodiment, the determination data creator 103 waits until the operation data 5, 10, and 15 minutes later are stored.

[0036] After the operation data for use in the determination are stored, the determination data creator 103 creates (calculates) wasteful operation determination data (the temperature change rates) from the contents of the operation data (Step S103).

[0037] Subsequently, the wasteful operation determiner 104 stores in the determination results storage 110 determination result data in which information indicating the trigger detected in the Step S101, the wasteful operation determination data (the temperature change rates 5, 10, and 15 minutes after the trigger detection) created in the Step S103, and information indicating the absence of wasteful operation are associated with one another (Step S 104). In the initial operation procedure, the wasteful operation determiner 104 always stores the determination result data indicating the absence of wasteful operation without conducting the procedure to determine the wasteful operation because no wasteful operation determination thresholds are stored in the thresholds storage 109.

[0038] Subsequently, the threshold adjuster 107 creates temporary wasteful operation determination thresholds (threshold data) and stores them in the thresholds storage 109 (Step S105).

[0039] For example, as for the wasteful operation determination thresholds upon detection of the "cooling operation start" trigger, the threshold adjuster 107 can store in the thresholds storage 109 the absolute values of the temperature change rates 5, 10, and 15 minutes later acquired in the Step 103 from which 10 % points, 20 % points, and 30 % points are subtracted, respectively, as the thresholds for 5, 10, and 15 minutes later in the determination upon detection of the trigger. Then, the threshold data shown in FIG. 6A are created from the determination result data shown in FIG. 5A.

[0040] Furthermore, for example, as for the wasteful operation determination thresholds upon detection of the "stabilized cooling" trigger, the threshold adjuster 107 stores in the thresholds storage 109 the values that are 10 % points, 20 % points, and 30 % points greater than the temperature change rates 5, 10, and 15 minutes later acquired in the Step 103, respectively, as the thresholds for 5, 10, and 15 minutes later in the determination upon detection of the trigger. Then, the threshold data shown in FIG. 6B are created from the determination result data shown in FIG. 5B.

[0041] Subsequently, the threshold adjuster 107 determines whether an at-end condition is satisfied (Step S106). For example, the threshold adjuster 107 determines that the at-end condition is satisfied when the thresholds for both the "cooling operation start" trigger and the "stabilized cooling" trigger are set.

[0042] If the at-end condition is not satisfied (Step S 106; No), the processing returns to the Step S101. If the at-end condition is satisfied (Step S106; Yes), the initial operation procedure ends.

[0043] A specific case of the initial operation procedure will be described hereafter. For example, it is assumed that the operation data shown in FIG. 3 are stored in the operation data storage 108 and the "cooling operation start" trigger is detected at 12 o'clock on August 1st, 2011. In such a case, the temperature change rates as wasteful operation determination data are calculated from the operation data at 12:05, 12:10, and 12:15, which are 5, 10, and 15 minutes after the trigger detection. The temperature change at 12:05, 12:10, and 12:15 since the trigger detection (12:00) is -3°C, -5°C, and -7°C, respectively. Furthermore, the difference between the set temperature and room temperature when the

air conditioner 2 is started (at 12:00) is 10°C. Therefore, the temperature change rates at 12:05, 12:10, and 12:15 are "-30 %," "-50 %," and "-70 %," respectively. Furthermore, the absence of wasteful operation is always determined because this is the initial operation procedure. Then, the determination result data shown in FIG. 5A are created. Furthermore, given values are added to the calculated temperature change rates to obtain the thresholds. Then, the threshold data shown in FIG. 6A are eventually created from the determination result data.

[0044] Then, it is assumed that the "stabilized cooling" trigger is detected at 13:00 on August 1st, 2011. In such a case, the temperature change rates as wasteful operation determination data are calculated from the operation data at 13:05, 13:10, and 13:15, which are 5, 10, and 15 minutes after the trigger detection. The temperature change at 13:05, 13:10, and 13:15 since the trigger detection (13:00) is 0°C, -1°C, and 0°C, respectively. Furthermore, the difference between the set temperature and room temperature when the air conditioner 2 is started (at 12:00) is 10°C. Therefore, the temperature change rates at 13:05, 13:10, and 13:15 are "0 %," "-10 %," and "0 %," respectively. Furthermore, the absence of wasteful operation is always determined since this is the initial operation procedure. Then, the determination result data shown in FIG. 5B are created. Furthermore, given values are added to the calculated temperature changes rates to obtain the thresholds. Then, the threshold data shown in FIG. 6B are eventually created from the determination result data.

[0045] As described above, in the initial operation procedure, the determination data are created based on the operation data given times after detection of a trigger. Then, the temporary wasteful operation determination thresholds are set based on the determination data. From then on, the presence/absence of wasteful operation is determined based on the thresholds.

(Normal operation procedure)

[0046] The normal operation procedure executed after the above-described initial operation procedure is completed will be described hereafter with reference to the flowchart of FIG. 8.

[0047] In response to the initial operation procedure being completed, the trigger detector 102 monitors the operation data stored in the operation data storage 108 and determines whether any trigger to start the determination of wasteful operation is detected (Step S201).

[0048] If any trigger is detected (Step S201; Yes), the determination data creator 103 waits until the operation data for use in the determination are accumulated (stored) in the operation data storage 108 after the trigger is detected (Step Step S202). In this embodiment, the determination data creator 103 waits until the operation data 5, 10, and 15 minutes later are stored.

[0049] After the operation data for use in the determination have been stored, the determination data creator 103 creates wasteful operation determination data from the contents of the operation data (Step S203). More specifically, as in the above-described initial operation procedure, the determination data creator 103 calculates the temperature change rates 5, 10, and 15 minutes after the trigger detection as wasteful operation determination data.

[0050] Subsequently, the wasteful operation determiner 104 compares the wasteful operation determination data (the temperature change rates) created in the Step S203 with the threshold data stored in the thresholds storage 109 to determine whether any wasteful operation is taking place (Step S204).

[0051] For example, in the case of the "cooling operation start" trigger being detected, the wasteful operation determiner 104 acquires the threshold data corresponding to the trigger from the thresholds storage 109. Then, the wasteful operation determiner 104 determines whether the absolute value of the temperature change rate 5 minutes after the trigger detection is lower than the temperature change rate 5 minutes later indicated by the acquired threshold result data (namely the threshold for 5 minutes later). If the absolute value is lower than the threshold for 5 minutes later, the wasteful operation determiner 104 immediately determines "the presence of wasteful operation." On the other hand, if the absolute value of the temperature change rate 5 minutes after the trigger detection is not lower than the threshold for 5 minutes later, the wasteful operation determiner 104 further compares the absolute values of the temperature change rates 10 and 15 minutes after the trigger detection with the thresholds corresponding to these elapsed times. As the result of comparison, if the absolute values of the temperature change rates 10 and 15 minutes after the trigger detection are all lower than the corresponding thresholds, the wasteful operation determiner 104 determines "the presence of wasteful operation." On the other hand, if not so, the wasteful operation determiner 104 determines "the absence of wasteful operation."

[0052] On the other hand, in the case of the "stabilized cooling" trigger being detected, the wasteful operation determiner 104 acquires the threshold data corresponding to the trigger from the thresholds storage 109. Then, the wasteful operation determiner 104 determines whether the absolute value of the temperature change rate 5 minutes after the trigger detection is greater than the temperature change rate 5 minutes later indicated by the acquired threshold result data (namely the threshold for 5 minutes later). If the absolute value is greater than the threshold, the wasteful operation determiner 104 immediately determines "the presence of wasteful operation." On the other hand, if the absolute value of the temperature change rate 5 minutes after the trigger detection is equal to or lower than the threshold for 5 minutes later, the wasteful operation determiner 104 further compares the absolute values of the temperature change rates 10 and 15 minutes

after the trigger detection with the thresholds corresponding to these elapsed times. As the result of comparison, if the absolute values of the temperature change rates 10 and 15 minutes after the trigger detection are all greater than the corresponding thresholds, the wasteful operation determiner 104 determines "the presence of wasteful operation." On the other hand, if not so, the wasteful operation determiner 104 determines "the absence of wasteful operation."

[0053] Subsequently, the wasteful operation determiner 104 stores in the determination results storage 110 the determination result data in which information indicating the rigger detected in the Step S201, the wasteful operation determination data (the temperature change rates 5, 10, and 15 minutes after the trigger detection) created in the Step S203, and information indicating the presence/absence of wasteful operation determined in the Step S204 are associated with one another (Step S205).

[0054] If the absence of wasteful operation is determined in the Step S204 (Step S206; No), there is no need for notification of wasteful operation and the processing returns to the Step S201.

[0055] On the other hand, if the presence of wasteful operation is determined in the Step S204 (Step S206; Yes), the wasteful operation notifier 105 turns on the LED or the like to notify the user of occurrence of the wasteful operation (Step S207).

[0056] Notified of the wasteful operation, the user evaluates whether the wasteful operation is actually taking place and enters the evaluation result via the evaluation inputter 106. For example, if the air conditioner 2 is in operation for cooling the room with some door or window kept open, the user may find (determine) the presence of wasteful operation since the cooled air escapes through the door or window. On the other hand, if the doors and/or windows are closed, the user may assume that the determination of the air-conditioning management device 1 is wrong and find the absence of wasteful operation.

[0057] As the evaluation inputter 106 receives the evaluation result from the user (Step S208), the threshold adjuster 107 reflects the evaluation result on the determination result data (Step S209). More specifically, if the user evaluation result indicates the absence of wasteful operation, the threshold adjuster 107 updates the determination result data recorded in the Step S205 and indicating the presence of wasteful operation to data indicating the absence of wasteful operation.

[0058] Subsequently, the threshold adjuster 107 adjusts the thresholds in the threshold data based on the contents of the determination result data stored in the determination results storage 110 (Step S210).

[0059] For example, for the threshold data for use in the determination of wasteful operation upon detection of the " stabilized cooling" trigger, the threshold adjuster 107 acquires the determination result data corresponding to detection of the "stabilized cooling" trigger from the determination results storage 110. Then, the threshold adjuster 107 extracts the temperature change rate having the highest absolute value from which the absence of wasteful operation is determined and the temperature change rate having the lowest absolute value from which the presence of wasteful operation is determined among the temperature change rates at each elapsed time (5, 10, and 15 minutes) later in the acquired determination result data, and obtains the respective median values between those temperature change rates. Then, the threshold adjuster 107 sets the thresholds for each of the times later (the temperature change rates) in the threshold data corresponding to the "stabilized cooling" trigger to the respective median values obtained.

[0060] On the other hand, for the threshold data for use in the determination of wasteful operation upon detection of the "cooling operation start" trigger, the threshold adjuster 107 acquires the determination result data corresponding to detection of the "cooling operation start" trigger from the determination results storage 110. Then, the threshold adjuster 107 extracts the temperature change rate having the lowest absolute value from which the absence of wasteful operation is determined and the temperature change rate having the highest absolute value from which the presence of wasteful operation is determined among the temperature change rates each of the times later in the acquired determination result data, and obtains the respective median values between those temperature change rates. Then, the threshold adjuster 107 sets the thresholds for each of the times later in the threshold data corresponding to the "cooling operation start" trigger to the respective median values obtained.

[0061] The threshold adjustment procedure will be described hereafter with reference to FIG. 9. In FIG. 9, the temperature change rate " 5 minutes later" in the determination result data determined upon detection of the "stabilized cooling" trigger is plotted. It is assumed that determination result data A to C indicating the absence of wasteful operation and marked by open circles and determination result data D to F indicating the presence of wasteful operation and marked by filled circles are stored in the determination results storage 110 in the preceding normal operation procedure. Furthermore, determination result data G marked by a double circle are newly stored and evaluated by the user in the current normal operation procedure.

[0062] Here, the case in which the user determines (finds) the presence of wasteful operation from the data G is discussed. In such a case, the data having the lowest temperature change rate among the determination result data indicating the presence of wasteful operation are the data G. On the other hand, the data having the highest temperature change rate among the determination result data indicating the absence of wasteful operation are the data C. Therefore, the threshold adjuster 107 sets the threshold for "5 minutes later" to the median value between the temperature change rate in the data C and the temperature change rate in the data G. Here, the threshold adjuster 107 can set the threshold

for "5 minutes later" to the median value between the average value of the temperature change rates in the data A, B, and C indicating the absence of wasteful operation and the average value of the temperature change rates in the data G, D, E, and F indicating the presence of wasteful operation.

[0063] Furthermore, the case in which the user determines (finds) the absence of wasteful operation from the data G is discussed. In such a case, the data having the great temperature change rate among the determination result data indicating the absence of wasteful operation are the data G. On the other hand, the data having the lowest temperature change rate among the determination result data indicating the presence of wasteful operation are the data D. Therefore, the threshold adjuster 107 sets the threshold for "5 minutes later" to the median value between the temperature change rate in the data G and the temperature change rate in the data D. Here, the threshold adjuster 107 can set the threshold for "5 minutes later" to the median value between the average value of the temperature change rates in the data A, B, C, and G indicating the absence of wasteful operation and the average value of the temperature change rates in the data D, E, and F indicating the presence of wasteful operation.

[0064] As described above, the thresholds are adjusted to different values depending on the user evaluation result (whether the wasteful operation is actually taking place).

[0065] Returning to FIG. 8, as the threshold adjustment is completed, the processing returns to the Step S201. Then, a series is repeated of processing of determining the presence/absence of wasteful operation upon detection of a trigger, notifying if the presence of wasteful operation is determined, and adjusting the threshold according to the user evaluation.

[0066] As described above, in the case of the presence of wasteful operation being determined, the air-conditioning management device 1 according to Embodiment 1 notifies the user so and receives evaluation on the determination from the user. Then, taking the evaluation into account, the wasteful operation determination threshold is adjusted. Therefore, the wasteful operation can be determined with accuracy.

« Embodiment 2»

[0067] Embodiment 1 adjusts the wasteful operation determination thresholds based on the evaluation results on the determination of wasteful operation entered by the user. Embodiment 2 of the present invention is characterized by being able to take into account the user evaluation result to adjust the wasteful operation determination threshold even if there is no direct input of user evaluation result.

[0068] An air-conditioning management device 10 according to Embodiment 2 of the present invention is, as shown in FIG. 10, different from Embodiment 1 in that the evaluation inputter 106 is omitted and an improvement action determiner 111 is additionally provided.

[0069] The improvement action determiner 111 determines whether the user has taken any improvement action for preventing wasteful operation from the contents of the operation data stored in the operation data storage 108 and outputs the results to the threshold adjuster 107.

[0070] The procedures executed by the air-conditioning management device 10 will be described hereafter. The initial operation procedure executed by the air-conditioning management device 10 is substantially the same as the initial operation procedure executed by the air-conditioning management device 1 according to Embodiment 1.

[0071] The normal operation procedure executed by the air-conditioning management device 10 will be described with reference to the flowchart of FIG. 11. Explanation of the same steps as those of the normal operation procedure in Embodiment 1 will be simplified as appropriate.

[0072] As the normal operation starts and the trigger detector 102 detects a trigger (Step S301; Yes), the determination data creator 103 waits until the operation data for use in the determination are accumulated (stored) (Step S302), and creates wasteful operation determination data from the contents of the operation data given times later (Step S303). Subsequently, the wasteful operation determiner 104 compares the wasteful operation determination data with the threshold data stored in the thresholds storage 109 to determine the presence/absence of wasteful operation (Step S304), and stores determination result data created consequently in the determination results storage 110 (Step S305). Subsequently, if the presence of wasteful operation is determined in the Step S304 (Step S306; Yes), the wasteful operation notifier 105 notifies the user of occurrence of the wasteful operation (Step S307). Here, a series of processing steps from the Step S301 to Step 307 is the substantially the same as the processing steps of the normal operation procedure in Embodiment 1 (Steps S201 to 207 in FIG. 8).

[0073] Following the notification of wasteful operation in Step S307, the improvement action determiner 111 waits until the operation data given times after the notification of wasteful operation are stored in the operation data storage 108 (Step S308). Here, the improvement action determiner 111 waits until the operation data 5, 10, and 15 minutes after the notification of wasteful operation are stored in the operation data storage 108.

[0074] Subsequently, after the operation data given times after the notification of wasteful operation are stored, the improvement action determiner 111 determines whether the user has taken any improvement action for presenting the wasteful operation from the contents of the operation data (Step S309). For example, the improvement action taken by the user for presenting the wasteful operation can be the action of closing the window and/or door that is open so that

the cool air does not escape.

[0075] Here, in the case of the "cooling operation start" trigger being detected in the Step S301, whether any improvement action is taken can be determined as follows. First, the improvement action determiner 111 acquires the operation data 5, 10, and 15 minutes after the notification of wasteful operation. Subsequently, the improvement action determiner 111 calculates the temperature change rates 5, 10, and 15 minutes after the notification of wasteful operation from the acquired operation data. Subsequently, the improvement action determiner 111 compares the absolute values of the calculated temperature change rates with the thresholds for the times later (the temperature change rates) in the threshold data corresponding to the "cooling operation start" trigger stored in the thresholds storage 109. Then, the improvement action determiner 111 determines that some improvement action has been taken if the comparison results reveal that the temperature change rates 5, 10, and 15 minutes after the notification of wasteful operation are all equal to or higher than the corresponding thresholds, and otherwise determines that no improvement action has been taken.

[0076] Alternatively, the improvement action determiner 111 acquires multiple pieces of operation data at a given time before and after the notification of wasteful operation. Then, the improvement action determiner 111 determines whether the ratio of the drop in room temperature to the time after the notification of wasteful operation is greater than the ratio of the drop in room temperature to the time before the notification of wasteful operation by a given value or more from the multiple pieces of operation data acquired and if greater, determines that some improvement action has beenaken.

[0077] On the other hand, in the case of the "stabilized cooling" trigger is detected in the Step S301, whether any improvement action has been taken is determined as follows. First, the improvement action determiner 111 acquires the operation data 5, 10, and 15 minutes after the notification of wasteful operation. Subsequently, the improvement action determiner 111 calculates the temperature change rates 5, 10, and 15 minutes after the notification of wasteful operation from the acquired operation data. Subsequently, the improvement action determiner 111 compares the absolute values of the calculated temperature change rates with the thresholds for the times later in the threshold data corresponding to the "stabilized cooling" trigger stored in the thresholds storage 109. Then, the improvement action determiner 111 determines that some improvement action has been taken if the comparison results reveal that the temperature change rates 5, 10, and 15 minutes after the notification of wasteful operation are all equal to or lower than the corresponding thresholds, and otherwise determines that no improvement action has been taken.

[0078] Alternatively, the improvement action determiner 111 acquires multiple pieces of operation data a given time before and after the notification of wasteful operation. Then, the improvement action determiner 111 determines whether the difference between the set temperature and room temperature after the notification of wasteful operation is less than before the notification of wasteful operation from the multiple pieces of operation data acquired and if less, determines that some improvement action has been taken.

[0079] If some improvement action has been taken (Step S309; Yes), it is assumed that the user found that the notification of wasteful operation was correct and then took some improvement action. Therefore, it is correct that the presence of wasteful operation was determined in the Step S304 and the processing proceeds to Step S311.

[0080] On the other hand, if no improvement action has been taken (Step S309; No), it is assumed that the user found that the notification of wasteful operation was wrong and then took no improvement action. Therefore, the threshold adjuster 107 updates the determination result data stored in the Step S305 from data results indicating the presence of wasteful operation to data results indicating the absence of wasteful operation (Step S310), and proceeds to the Step S311.

[0081] In the Step S311, the threshold adjuster 107 adjusts the thresholds in the threshold data based on the contents of the determination result data stored in the determination results storage 110. This is substantially the same processing as in the normal operation (Step S210 in FIG. 8). After the threshold adjustment is completed, the processing returns to the Step S301. As described above, a series of processing of determining wasteful operation upon detection of a trigger and adjusting the threshold depending on whether the user took any improvement action is repeated.

[0082] As described above, the air-conditioning management device 10 determines whether any improvement action for presenting wasteful operation has been taken after notification of wasteful operation. Then, it is assumed that the user found that the wasteful operation was present if any improvement action has been taken, and that the user found that the wasteful operation was absent if no improvement action was taken. Such evaluation results are reflected to adjust the wasteful operation determination threshold. Therefore, the air-conditioning management device 10 can determine wasteful operation with accuracy like the air-conditioning management device 1 of Embodiment 1. Furthermore, the user does not need to directly enter the result of evaluation on the determination of wasteful operation, which is more convenient. Furthermore, the air-conditioning management device 10 does not need to comprise buttons or the like for receiving input of the evaluation from the user. The air-conditioning management device 10 can have a smaller number of parts mounted and is expected to be reduced in size and/or cost.

[0083] The present invention is not confined to the above embodiments and various modifications can be made without departing from the gist of the present invention.

[0084] For example, in the above-described embodiments, the wasteful operation determination data are three temperature change rates calculated 5, 10, and 15 minutes after detection of a trigger. This is not restrictive. A greater

number of temperature change rates or temperature change rates some other times later could be used in the determination of wasteful operation. Furthermore, only the temperature change rate calculated 5 minutes after detection of a trigger could be used in the determination of wasteful operation.

[0085] Furthermore, in the above-described embodiments, wasteful operation is determined upon detection of the "cooling operation start" trigger or the "stabilized cooling" trigger. However, the triggers to start the determination of wasteful operation are not restricted thereto. For example, triggers such as a specific time of a day and start of heating operation could be used to start the determination of wasteful operation. In such a case, the threshold data corresponding to these triggers should be stored in the thresholds storage 109.

[0086] Furthermore, in the above-described embodiments, the temperature change rates are used as the wasteful operation determination data. However, other data such as the difference between the room temperature and set temperature and the gradient of the room temperature to the time (the time rate of change of the room temperature) could be used to determine the presence/absence of wasteful operation.

[0087] Furthermore, it is possible to make an existing personal computer, information terminal device, or the like function as the air-conditioning management device according to the present invention by, for example, applying operation programs defining the operation of the air-conditioning management device according to the present invention to the personal computer or the like.

[0088] Such programs can be distributed by any method and, for example, stored and distributed on a computer readable recording medium such as a CD-ROM (compact disk read-only memory), DVD (digital versatile disk), MO (magnetooptical disk), and memory card, or distributed via a communication network such as the Internet.

Industrial Applicability

[0089] The present invention can preferably be used with air-conditioning systems installed in buildings and the like.

Reference Signs List

[0090]

1, 10	Air-conditioning management device
2	Air conditioner
3	Sensor
101	Operation data acquirer
102	Trigger detector
103	Determination data creator
104	Wasteful operation determiner
105	Wasteful operation notifier
106	Evaluation inputter
107	Threshold adjuster
108	Operation data storage
109	Thresholds storage
110	Determination results storage
111	Improvement action determiner

Claims

1. An air-conditioning management device, comprising:

operation data acquisition means acquiring operation data of an air conditioner;
wasteful operation determination means determining whether the air conditioner is conducting wasteful operation based on the acquired operation data and given criteria;
wasteful operation notification means giving notice of wasteful operation when the wasteful operation determination means determines the presence of wasteful operation; and
criteria adjustment means adjusting the given criteria based on the result of user evaluation on the determination of wasteful operation.

2. The air-conditioning management device according to Claim 1, further comprising:

evaluation input means receiving input of evaluation result on the determination of wasteful operation from the user, wherein
the criteria adjustment means adjusts the given criteria based on the evaluation result received by the evaluation input means.

3. The air-conditioning management device according to Claim 1, wherein the criteria adjustment means further comprises:

improvement action determination means determining whether any improvement action for preventing the wasteful operation is taken, based on the operation data acquired after a given period of time following the notice of the wasteful operation given by the wasteful operation notification means,
wherein
the criteria adjustment means adjusts the given criteria based on the result of determination by the improvement action determination means.

4. The air-conditioning management device according to any one of Claims 1 to 3, further comprising:

trigger detection means detecting a trigger for the wasteful operation determination means to start the determination of wasteful operation.

5. The air-conditioning management device according to Claim 4, wherein the wasteful operation determination means determines whether the air conditioner is conducting wasteful operation based on multiple pieces of operation data after different periods of time following the detection of a trigger and the given criteria.

6. An air-conditioning management method, comprising:

an operation data acquisition step of acquiring operation data of an air conditioner;
a wasteful operation determination step of determining whether the air conditioner is conducting wasteful operation based on the acquired operation data and given criteria;
a wasteful operation notification step of giving notice of wasteful operation when the presence of wasteful operation is determined in the wasteful operation determination step; and
a criteria adjustment step of adjusting the given criteria based on the result of user evaluation on the determination of wasteful operation.

7. A program allowing a computer to function as:

operation data acquisition means acquiring operation data of an air conditioner;
wasteful operation determination means determining whether the air conditioner is conducting wasteful operation based on the acquired operation data and given criteria;
wasteful operation notification means giving notice of wasteful operation when the wasteful operation determination means determines the presence of wasteful operation; and
criteria adjustment means adjusting the given criteria based on the result of user evaluation on the determination of wasteful operation.

FIG. 1

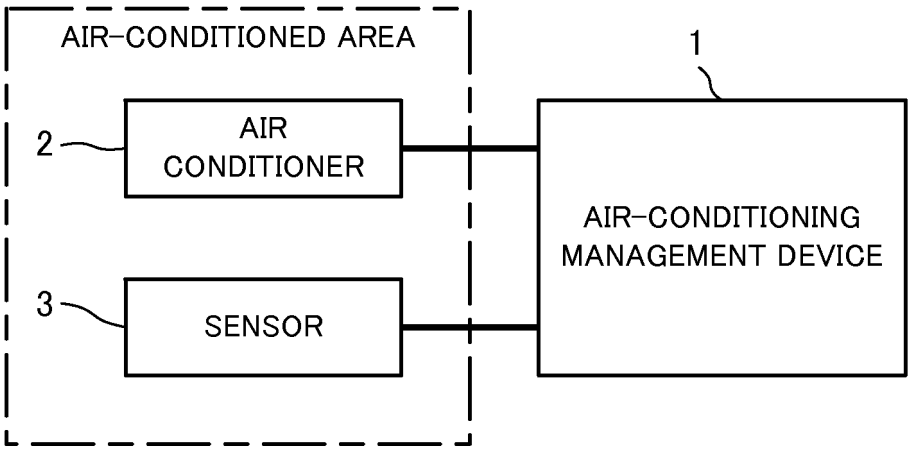

AIR-CONDITIONED AREA
1
2
AIR CONDITIONER
3
SENSOR
AIR-CONDITIONING MANAGEMENT DEVICE

FIG. 2

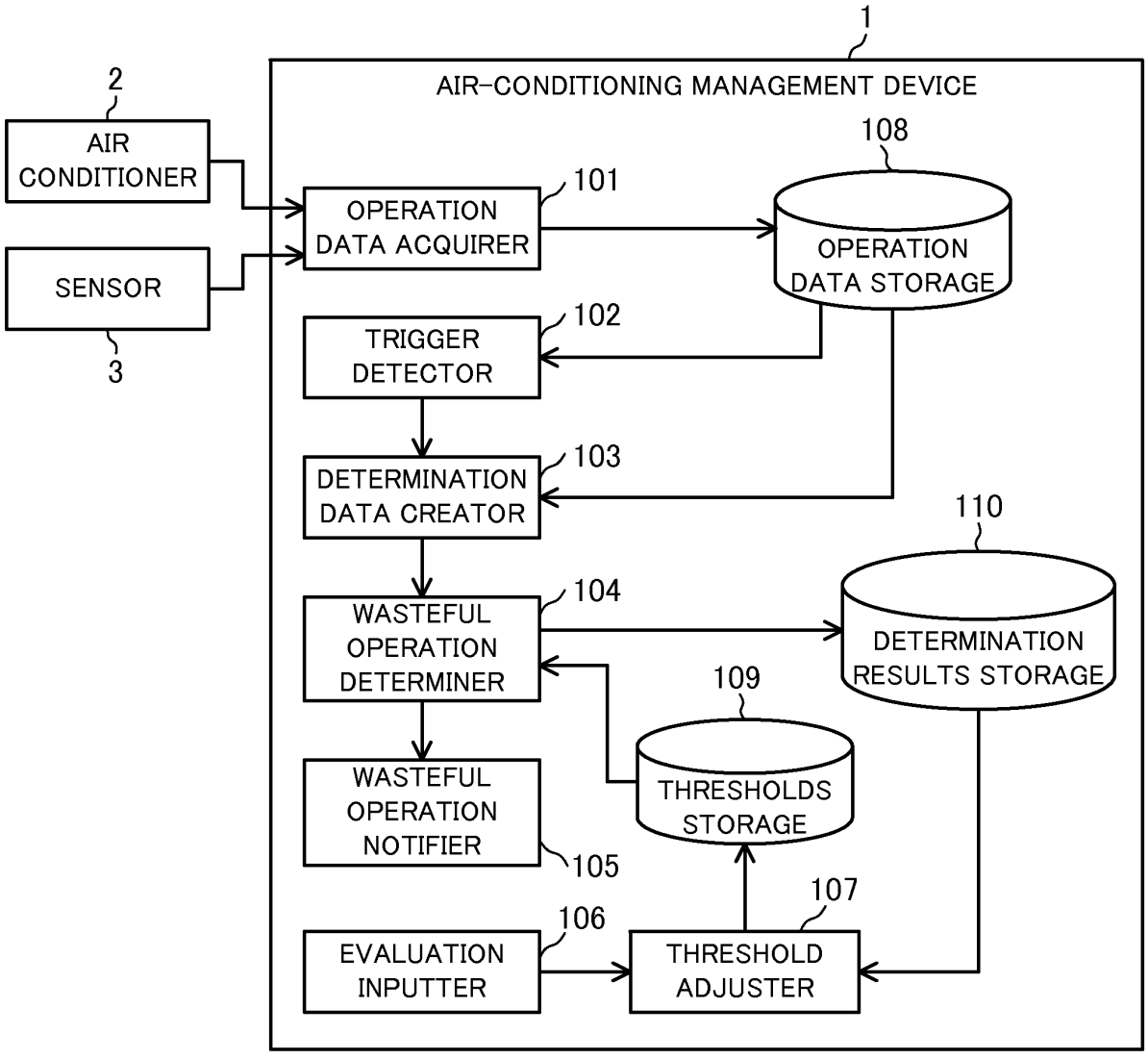

1
AIR-CONDITIONING MANAGEMENT DEVICE
2
AIR CONDITIONER
SENSOR
3
OPERATION DATA ACQUIRER
101
108
OPERATION DATA STORAGE
TRIGGER DETECTOR
102
DETERMINATION DATA CREATOR
103
110
WASTEFUL OPERATION DETERMINER
104
DETERMINATION RESULTS STORAGE
109
THRESHOLDS STORAGE
WASTEFUL OPERATION NOTIFIER
105
107
EVALUATION INPUTTER
106
THRESHOLD ADJUSTER

FIG. 3

DATE/TIME	OPERATION MODE	SET TEMPERATURE	ROOM TEMPERATURE
AUGUST 1, 2011 11:55	OFF	N/A	34°C
AUGUST 1, 2011 12:00	COOL	24°C	34°C
AUGUST 1, 2011 12:05	COOL	24°C	31°C
AUGUST 1, 2011 12:10	COOL	24°C	29°C
AUGUST 1, 2011 12:15	COOL	24°C	27°C
:	:	:	:
AUGUST 1, 2011 13:00	COOL	24°C	26°C
AUGUST 1, 2011 13:05	COOL	24°C	26°C
AUGUST 1, 2011 13:10	COOL	24°C	25°C
AUGUST 1, 2011 13:15	COOL	24°C	26°C
:	:	:	:

FIG. 4

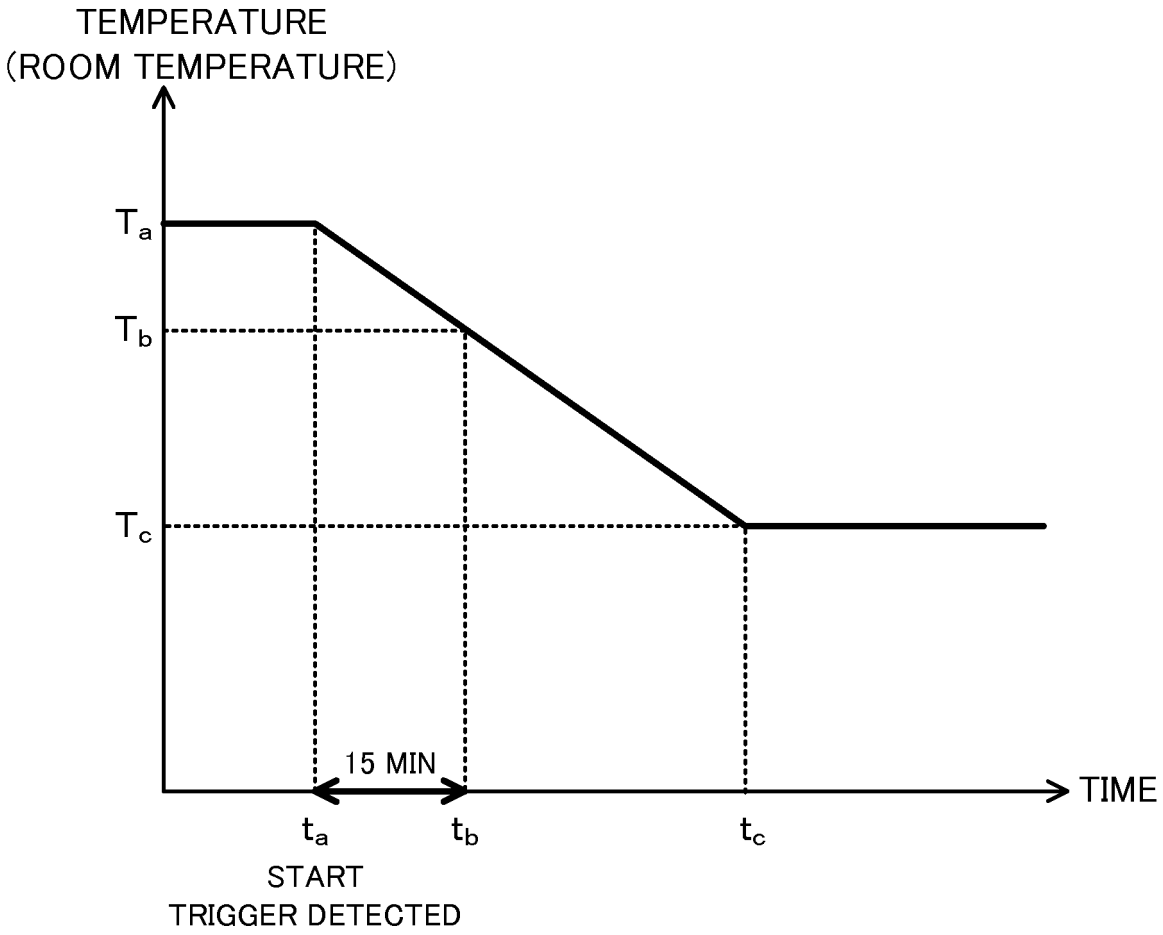

TEMPERATURE
(ROOM TEMPERATURE)
T_a
T_b
T_c
15 MIN
TIME
t_a
t_b
t_c
START
TRIGGER DETECTED

FIG. 5A

TRIGGER		COOLING OPERATION START
DETERMINATION DATA	TEMPERATURE CHANGE RATE (5 MIN. LATER)	−30%
	TEMPERATURE CHANGE RATE (10 MIN. LATER)	−50%
	TEMPERATURE CHANGE RATE (15 MIN. LATER)	−70%
DETERMINATION RESULT		ABSENCE OF WASTEFUL OPERATION

FIG. 5B

TRIGGER		STABILIZED COOLING
DETERMINATION DATA	TEMPERATURE CHANGE RATE (5 MIN. LATER)	0%
	TEMPERATURE CHANGE RATE (10 MIN. LATER)	−10%
	TEMPERATURE CHANGE RATE (15 MIN. LATER)	0%
DETERMINATION RESULT		ABSENCE OF WASTEFUL OPERATION

FIG. 6A

TRIGGER		COOLING OPERATION START
THRESHOLD	TEMPERATURE CHANGE RATE (5 MIN. LATER)	20% OR HIGHER
	TEMPERATURE CHANGE RATE (10 MIN. LATER)	30% OR HIGHER
	TEMPERATURE CHANGE RATE (15 MIN. LATER)	40% OR HIGHER

FIG. 6B

TRIGGER		STABILIZED COOLING
THRESHOLD	TEMPERATURE CHANGE RATE (5 MIN. LATER)	10% OR LOWER
	TEMPERATURE CHANGE RATE (10 MIN. LATER)	10% OR LOWER
	TEMPERATURE CHANGE RATE (15 MIN. LATER)	30% OR LOWER

FIG. 7

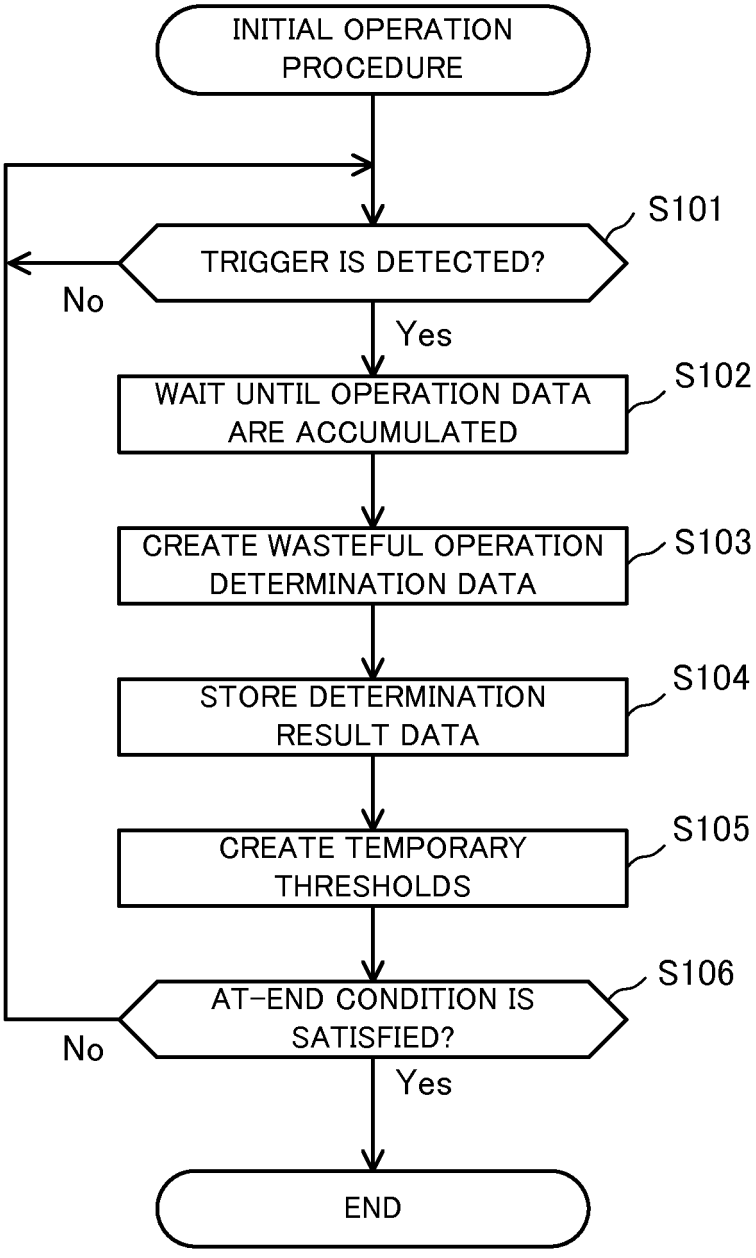

INITIAL OPERATION PROCEDURE
S101
TRIGGER IS DETECTED?
No
Yes
S102
WAIT UNTIL OPERATION DATA ARE ACCUMULATED
S103
CREATE WASTEFUL OPERATION DETERMINATION DATA
S104
STORE DETERMINATION RESULT DATA
S105
CREATE TEMPORARY THRESHOLDS
S106
AT-END CONDITION IS SATISFIED?
No
Yes
END

FIG. 8

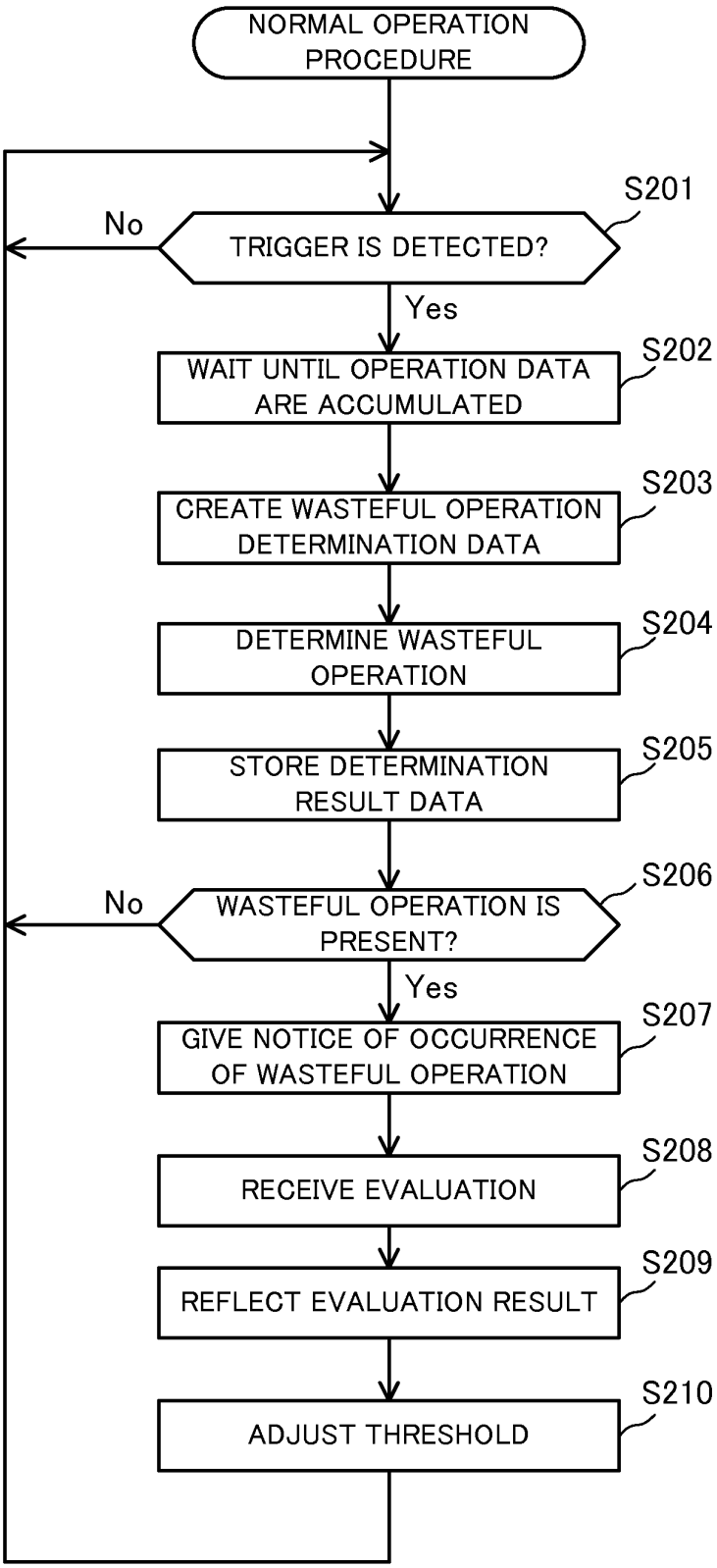

NORMAL OPERATION PROCEDURE
S201
No
TRIGGER IS DETECTED?
Yes
S202
WAIT UNTIL OPERATION DATA ARE ACCUMULATED
S203
CREATE WASTEFUL OPERATION DETERMINATION DATA
S204
DETERMINE WASTEFUL OPERATION
S205
STORE DETERMINATION RESULT DATA
S206
No
WASTEFUL OPERATION IS PRESENT?
Yes
S207
GIVE NOTICE OF OCCURRENCE OF WASTEFUL OPERATION
S208
RECEIVE EVALUATION
S209
REFLECT EVALUATION RESULT
S210
ADJUST THRESHOLD

FIG. 9

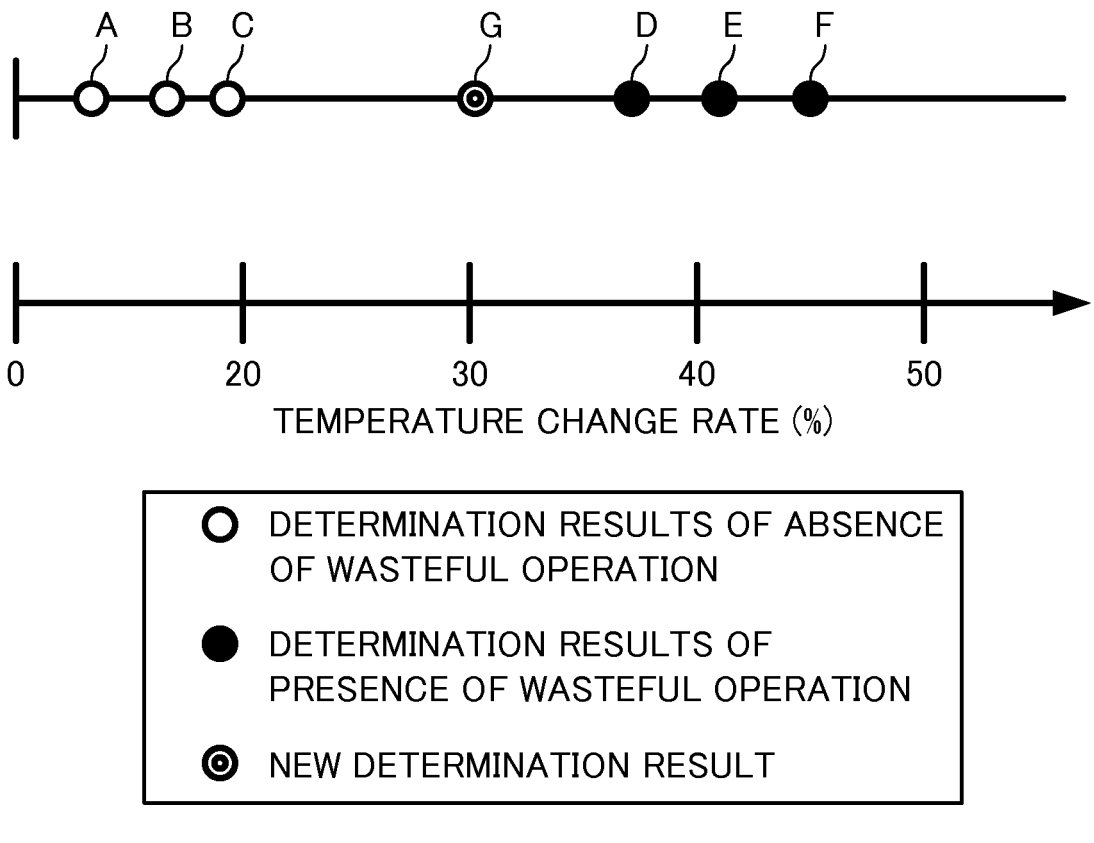

A
B
C
G
D
E
F
0
20
30
40
50
TEMPERATURE CHANGE RATE (%)
DETERMINATION RESULTS OF ABSENCE OF WASTEFUL OPERATION
DETERMINATION RESULTS OF PRESENCE OF WASTEFUL OPERATION
NEW DETERMINATION RESULT

FIG. 10

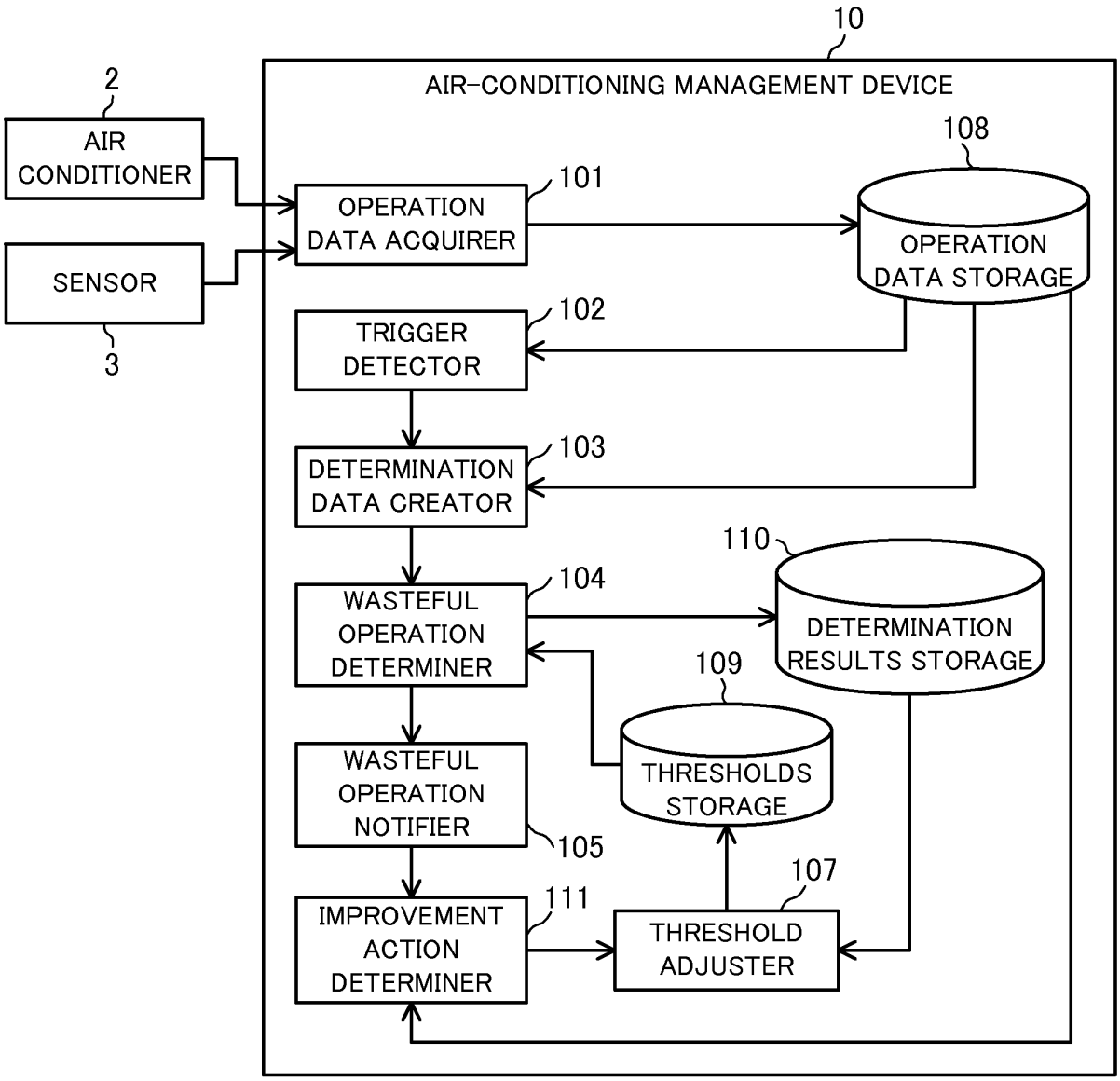
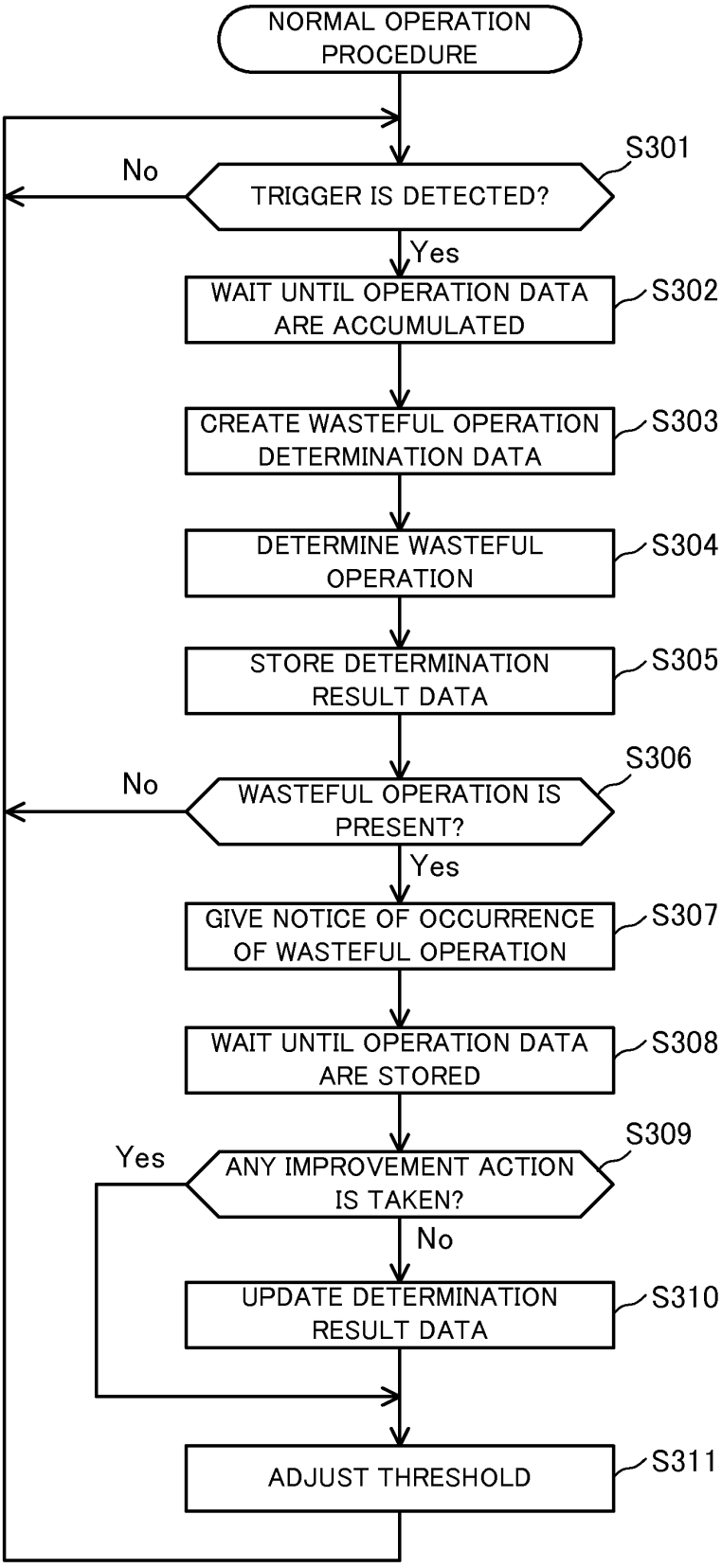

10
AIR-CONDITIONING MANAGEMENT DEVICE
2
AIR CONDITIONER
SENSOR
3
OPERATION DATA ACQUIRER
101
108
OPERATION DATA STORAGE
TRIGGER DETECTOR
102
DETERMINATION DATA CREATOR
103
110
WASTEFUL OPERATION DETERMINER
104
DETERMINATION RESULTS STORAGE
109
THRESHOLDS STORAGE
WASTEFUL OPERATION NOTIFIER
105
107
IMPROVEMENT ACTION DETERMINER
111
THRESHOLD ADJUSTER

FIG. 11


NORMAL OPERATION PROCEDURE
S301
No
TRIGGER IS DETECTED?
Yes
WAIT UNTIL OPERATION DATA ARE ACCUMULATED
S302
CREATE WASTEFUL OPERATION DETERMINATION DATA
S303
DETERMINE WASTEFUL OPERATION
S304
STORE DETERMINATION RESULT DATA
S305
S306
No
WASTEFUL OPERATION IS PRESENT?
Yes
GIVE NOTICE OF OCCURRENCE OF WASTEFUL OPERATION
S307
WAIT UNTIL OPERATION DATA ARE STORED
S308
S309
Yes
ANY IMPROVEMENT ACTION IS TAKEN?
No
UPDATE DETERMINATION RESULT DATA
S310
ADJUST THRESHOLD
S311

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/063971

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 1996-2011
Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

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 2006-336901 A (Mitsubishi Electric Building Techno-Service Co., Ltd.), 14 December 2006 (14.12.2006), entire text; all drawings (Family: none)	1-7
Y	JP 2010-44522 A (Panasonic Electric Works Co., Ltd.), 25 February 2010 (25.02.2010), paragraphs [0001] to [0085]; fig. 1 to 5 (Family: none)	1-7
Y	JP 2006-115977 A (Sanyo Electric Co., Ltd.), 11 May 2006 (11.05.2006), paragraphs [0001] to [0019]; fig. 4 (Family: none)	1-7

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

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"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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"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
08 September, 2011 (08.09.11)	20 September, 2011 (20.09.11)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/063971

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2011-38718 A (Bunpei MAGORI), 24 February 2011 (24.02.2011), entire text; all drawings & WO 2011/019011 A1	1-7
A	JP 2002-299077 A (Tempearl Industrial Co., Ltd.), 11 October 2002 (11.10.2002), entire text; all drawings (Family: none)	1-7
A	JP 2004-240828 A (Horiba, Ltd.), 26 August 2004 (26.08.2004), entire text; all drawings (Family: none)	1-7
A	JP 2005-273937 A (Matsushita Electric Industrial Co., Ltd.), 06 October 2005 (06.10.2005), entire text; all drawings (Family: none)	1-7

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006336901 A **[0005]**