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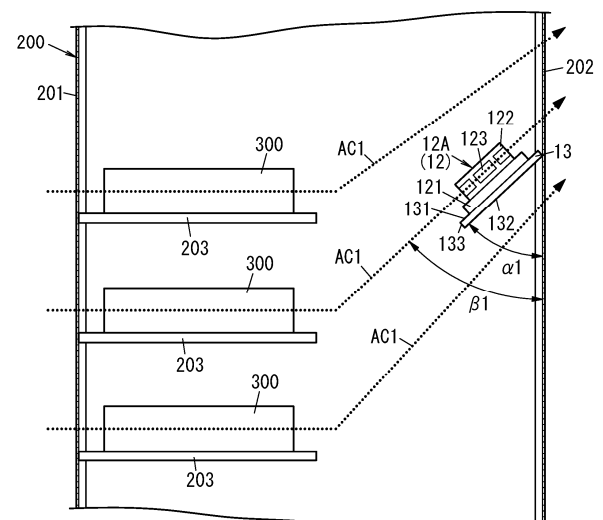
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(54) **FIRE SIGN DETECTION SYSTEM**

(57) An object of the present disclosure is to accurately detect a precursor prior to an outbreak of fire. A fire precursor detection system of the present disclosure includes a detector (12) and a holding member (13). The detector (12) is configured to detect a presence or absence of an abnormal gas. The holding member (13) holds the detector (12). A housing (200) in which a computer device (300) is housed has a first side wall (201) and a second side wall (202). The first side wall (201) is configured to allow cool air flowing from a blowout port to pass therethrough into the housing (200). The second side wall (202) is aligned with the first side wall (201) in one direction and is configured to allow hot air having passed through the computer device (300) to pass therethrough toward a suction port. The holding member (13) is in the housing (200) and is attached to the second side wall (202) in a state where the holding member (13) is inclined with respect to the second side wall (202).

FIG. 4



Description

Technical Field

[0001] The present disclosure generally relates to fire precursor detection systems and specifically relates to a fire precursor detection system for detecting a potential fire in a data center.

Background Art

[0002] Patent Literature 1 describes a monitoring system that monitors the environment of a target space. The monitoring system described in Patent Literature 1 is provided with a first acquiring unit, a second acquiring unit, and a determining unit. The first acquiring unit acquires environmental information relating to the environment in the target space. The second acquiring unit acquires electric power information relating to electric power of a device disposed in the target space. The determining unit determines the presence or absence of an abnormality (e.g., a fire) occurring in the target space, on the basis of the environmental information and the electric power information.

Citation List

Patent Literature

[0003] Patent Literature 1: WO 2022/004312 A1

Summary of Invention

[0004] The monitoring system described in Patent Literature 1 can detect a fire that has broken out in the target space, but the monitoring system described in Patent Literature 1 cannot detect any precursors prior to the outbreak of the fire.

[0005] Incidentally, systems have recently been provided that can detect precursors prior to an outbreak of fire. Such systems are required to accurately detect the precursors prior to the outbreak of fire.

[0006] It is an object of the present disclosure to provide a fire precursor detection system configured to accurately detect a precursor prior to an outbreak of fire.

[0007] A fire precursor detection system of an aspect of the present disclosure is a fire precursor detection system configured to detect a precursor of a potential fire in a data center. An air circulation cycle is formed for the data center. The air circulation cycle includes a blowout port provided in a floor surface of the data center and a suction port provided in a ceiling surface of the data center. The air circulation cycle is configured to: supply cool air from the blowout port to a computer device housed in a housing installed in the data center, from at least one of a lower side or a lateral side of the computer device; and guide hot air having

passed through the computer device toward the suction port. The fire precursor detection system includes a detector and a holding member. The detector is configured to detect a presence or absence of an abnormal gas resulting from at least one of melting or ignition of a covered wire connected to the computer device or an electronic component included in the computer device. The holding member holds the detector. The housing has a first side wall and a second side wall. The first side wall is configured to allow the cool air flowing from the blowout port to pass through the first side wall into the housing. The second side wall is in alignment with the first side wall in one direction and is configured to allow the hot air having passed through the computer device to pass through the second side wall toward the suction port. The holding member is in the housing and is attached to the second side wall in a state where the holding member is inclined with respect to the second side wall.

Brief Description of Drawings

[0008]

[FIG. 1] FIG. 1 is a block diagram of a fire precursor detection system according to a first embodiment;

[FIG. 2] FIG. 2 is a simplified schematic view of a data center to which the fire precursor detection system is applied;

[FIG. 3] FIG. 3 is a schematic diagram of an example of an analysis result by an analyzer of the fire precursor detection system;

[FIG. 4] FIG. 4 is a schematic diagram of an installation state of a detector of the fire precursor detection system;

[FIG. 5] FIG. 5 is a flowchart of a fire precursor detection method executed by the fire precursor detection system;

[FIG. 6] FIG. 6 is a schematic diagram of an installation state of a detector of a fire precursor detection system according to a second embodiment; and

[FIG. 7] FIG. 7 is a schematic diagram of an installation state of a detector of a fire precursor detection system according to the third embodiment.

Description of Embodiments

[0009] A fire precursor detection system according to first to third embodiments will be described below with reference to the drawings. Figures described in the following first to third embodiments are schematic views, and therefore, sizes and thicknesses of components in the figures do not necessarily reflect actual dimensions, and the ratio of the sizes and the ratio of the thicknesses of the components in the figures also do not necessarily reflect actual dimensional ratios.

(First Embodiment)

(1) Overview

[0010] First of all, the overview of a fire precursor detection system 1 according to the first embodiment will be described with reference to FIGS. 1 and 2.

[0011] The fire precursor detection system 1 according to the first embodiment is, for example, a system that detects a precursor of a potential fire in a data center 100. In the present disclosure, the data center 100 includes a server room in which a plurality of server computers, related apparatuses (e.g., hubs), and the like are installed. Moreover, in the present disclosure, the precursor of the potential fire in the data center 100 includes generation of an abnormal gas in the data center 100 due to at least one of melting or ignition of a covered wire FS (see FIG. 3) connected to a computer device 300 described later. That is, in the fire precursor detection system 1 according to the first embodiment, the abnormal gas generated in the data center 100 is detected by a first detector 12A (a detector 12) described later, and based on a detection result by the first detector 12A, the presence or absence of the precursor of the potential fire in the data center 100 is detected (determined).

[0012] In the present embodiment, a plurality of housings (racks) 200 are installed in the data center 100 as shown in FIG. 2. The plurality of housings 200 are in the data center 100 and are arranged in a matrix along a first direction (a left/right direction in FIG. 2) and a second direction (a normal direction of the paper surface of FIG. 2) orthogonal to the first direction. More specifically, the plurality of housings 200 are in the data center 100 and are arranged in two or more rows (in the example shown in the figure, two rows) in the first direction, and in each row, two or more of the plurality of housings 200 are aligned with each other in the second direction. Moreover, each housing 200 houses a plurality of (in the example shown in the figure, five) computer devices 300. The plurality of computer devices 300 are disposed in each housing 200 at equal intervals in a third direction (an up/down direction in FIG. 2) orthogonal to both the first direction and the second direction. The computer devices 300 include, for example, server computers and hubs which are apparatuses related to the server computers. To each computer device 300, the covered wire FS (see FIG. 3) for power supply and a covered wire FS for communication are connected.

[0013] In the fire precursor detection system 1 according to the first embodiment, an air circulation cycle C1 is formed for the data center 100 as shown in FIGS. 1 and 2. The air circulation cycle C1 includes a blowout port 101 provided on a floor surface F1 of the data center 100 and a suction port 102 provided on a ceiling surface W1 of the data center 100. The air circulation cycle C1 supplies cool air from the blowout port 101 to

the computer devices 300 housed in each housing 200 installed in the data center 100, from at least one of a lower side or a lateral side of the computer devices 300, and guides hot air having passed through the computer devices 300 toward the suction port 102.

[0014] The fire precursor detection system 1 includes the detector 12 and a holding member 13 (see FIG. 4). The detector 12 determines the presence or absence of an abnormal gas resulting from at least one of melting or ignition of at least one of: the covered wires FS (see FIG. 3) connected to the computer devices 300; or electronic components included in the computer devices 300. The holding member 13 holds the detector 12. Each housing 200 has a first side wall 201 (see FIG. 4) and a second side wall 202 (see FIG. 4). The first side wall 201 allows the cool air flowing from the blowout port 101 to pass therethrough into the housing 200. The second side wall 202 is aligned with the first side wall 201 in one direction (the left/right direction in FIG. 4) and allows the hot air having passed through the computer devices 300 to pass therethrough toward the suction port 102. The holding member 13 is in each housing 200 and is attached to the second side wall 202 in a state where the holding member 13 is inclined with respect to the second side wall 202 (see FIG. 4).

[0015] In the fire precursor detection system 1 according to the first embodiment, the holding member 13 is in each housing 200 and is attached to the second side wall 202 in the state where the holding member 13 is inclined with respect to the second side wall 202. This increases the amount of an air current AC1 flowing into the detector 12 as compared with the case where the holding member 13 is vertically attached to the second side wall 202, and as a result, the amount of the abnormal gas included in the air current AC1 also increases, which can enhance the detection accuracy of the detector 12. That is, the fire precursor detection system 1 according to the first embodiment can accurately detect a precursor prior to an outbreak of fire.

(2) Details

[0016] Next, the components of the fire precursor detection system 1 according to the first embodiment will be described with reference to FIGS. 1 and 2.

[0017] As shown in FIG. 1, the fire precursor detection system 1 according to the first embodiment is connected to a management system 2 and is configured to communication with the management system 2. Moreover, the management system 2 is connected to an external system 3 via a network NT such as the Internet and is configured to communicate with the external system 3. The management system 2 is a system for management and is disposed in, for example, a room for managing the data center 100. The external system 3 is a system owned by, for example, a telecommunications carrier that uses the data center 100. In the data center 100, the computer devices 300 owned by the

telecommunications carrier are installed, and the external system 3 is configured to communicate also with the computer devices 300 over a network NT.

[0018] As described above, the fire precursor detection system 1 according to the first embodiment is a system that detects the precursor of the potential fire in the data center 100. The air circulation cycle C1 is formed for the data center 100 as shown in FIG. 2. The air circulation cycle C1 includes two blowout ports 101 provided in the floor surface F1 of the data center 100 and one suction port 102 provided on the ceiling surface W1 of the data center 100. The air circulation cycle C1 supplies cool air from the blowout ports 101 to the computer devices 300 housed in each housing 200 installed in the data center 100, from at least one of the lower side or the lateral side of the computer devices 300, and guides hot air having passed through the computer devices 300 toward the suction port 102. The data center 100 is in the shape of a rectangular parallelepiped having a depth along the normal direction of the paper surface of FIG. 2. Moreover, the data center 100 is provided with an air conditioner unit 103 for generating the air circulation cycle C1. The air conditioner unit 103 converts the hot air sucked through the suction port 102 into cool air and supplies the cool air into the data center 100 through the blowout ports 101. Note that in FIG. 2, arrows shaded with dots represent the hot air having passed through the computer devices 300, and arrows without dots represent the cool air before passing through the computer devices 300.

[0019] Each housing 200 is in the shape of a rectangular parallelepiped having a size that allows the plurality of (in the example shown in the figure, five) computer devices 300 to be housed therein. As shown in FIG. 4, each housing 200 has the first side wall 201 and the second side wall 202. The first side wall 201 allows the cool air flowing from the blowout port 101 to pass therethrough into the housing 200. The second side wall 202 is aligned with the first side wall 201 in one direction (the left/right direction in FIG. 4) and allows the hot air having passed through the computer device 300 to pass therethrough toward the suction port 102. Each of the first side wall 201 and the second side wall 202 is formed of perforated metal having a plurality of holes. This can improve the flow of the air current AC1 in the air circulation cycle C1.

[0020] As shown in FIG. 1, the fire precursor detection system 1 includes a controller 11, the first detector 12A, a second detector 12B, an angle adjusting mechanism 130, an input 14, a communicator 15, and a storage 16. Note that the controller 11, the second detector 12B, the angle adjusting mechanism 130, the input 14, the communicator 15, and the storage 16 are not essential configurations for the fire precursor detection system 1. That is, all or some of the controller 11, the second detector 12B, the angle adjusting mechanism 130, the input 14, the communicator 15, and the

storage 16 do not have to be included in the components of the fire precursor detection system 1.

(2.1) Controller

[0021] The controller 11 can be implemented by, for example, a computer system including one or more processors and one or more memory elements. That is, the one or more processors execute a program stored in the one or more memory elements of the computer system, thereby implementing functions as the controller 11 (including an acquirer 111, an analyzer 112, an estimator 113, and a determiner 114 which will be described later). The program is stored in advance in the one or more memory elements of the computer system in this embodiment, but the program may be downloaded over a telecommunications network such as the Internet or may be distributed after having been stored in a non-transitory recording medium such as a memory card.

[0022] The controller 11 performs overall control of the fire precursor detection system 1. As shown in FIG. 1, the controller 11 is electrically connected to each of the first detector 12A, the second detector 12B, the angle adjusting mechanism 130, the input 14, the communicator 15, and the storage 16. The controller 11 acquires, from the first detector 12A, first detection information including the detection result by the first detector 12A. The controller 11 acquires, from the second detector 12B, second detection information including a detection result by the second detector 12B. The controller 11 controls the angle adjusting mechanism 130, thereby causing the angle adjusting mechanism 130 to adjust a first angle α_1 (see FIG. 4) of the holding member 13 (see FIG. 4) described later. The first angle α_1 is, as described later, an angle formed between the second side wall 202 of the housing 200 and the holding member 13 and is an attachment angle (hereinafter also referred to as an "attachment angle α_1 ") of the holding member 13 with respect to the second side wall 202.

[0023] Moreover, the controller 11 acquires input information received by the input 14. The controller 11 controls the communicator 15, thereby causing the communicator 15 to perform wired communication with the management system 2. The controller 11 controls the storage 16, thereby storing information in the storage 16, or reading information from the storage 16.

[0024] As shown in FIG. 1, the controller 11 includes the acquirer 111, the analyzer 112, the estimator 113, and the determiner 114.

[0025] The acquirer 111 acquires first information and second information. The first information is information regarding the structure of the data center 100 and the structure of the housing 200. The information regarding the structure of the data center 100 includes, for example, the shape and size (volume) of the data center 100. Moreover, the information regarding the structure

of the housing 200 includes, for example, the shape and size (inner capacity) of the housing 200. The first information is input via the input 14. That is, the acquirer 111 acquires the input information received by the input 14 as the first information.

[0026] The second information is information regarding the air current AC1 in the air circulation cycle C1. The second information includes, for example, a flow velocity and a temperature of the air current AC1 from the blowout port 101, a suction amount of the air current AC1 into the suction port 102, a flow velocity of the air current AC1 to the first side wall 201 of the housing 200, and a flow velocity of the air current AC1 from the second side wall 202 of the housing 200. The flow velocities of the air current AC1 are measured by, for example, the second detector 12B. Moreover, the temperature of the air current AC1 is measured by, for example, a temperature sensor. Moreover, a flow rate of the air current AC1 is measured by, for example, a flow rate sensor. The acquirer 111 acquires measurement results by the second detector 12B, the temperature sensor, and the flow rate sensor as the second information.

[0027] The analyzer 112 analyzes the flow of the air current AC1 on the basis of the first information and the second information acquired by the acquirer 111. The air current AC1 includes an abnormal gas resulting from at least one of melting or ignition of at least one of the covered wires FS (see FIG. 3) connected to the computer devices 300 housed in the housings 200. Here, the melting and the ignition of the covered wire FS can occur when the load of the computer device 300 increases and the amount of data passing through the covered wire FS increases. FIG. 3 is a schematic diagram of an example of an analysis result of the air current AC1 by the analyzer 112. The example in FIG. 3 shows that an abnormal gas is generated from a covered wire FS which is a simulated ignition source and which is connected to a lowermost computer device 300 of the five computer devices 300 housed in the housing 200 on the left side. Note that for computer devices 300 other than the lowermost computer device 300, analysis results of the air current AC1 can be obtained in a similar manner.

[0028] Incidentally, the air circulation cycle C1 changes depending on operating conditions of the air conditioner unit 103 disposed in the data center 100, the positions of the computer devices 300 in the housings 200, and the like. Therefore, the analyzer 112 preferably measures the flow of the air current AC1 of the air circulation cycle C1 over a certain time period (e.g., 1 hour).

[0029] The estimator 113 estimates, based on an analysis result (see FIG. 3) by the analyzer 112, at least one of a position Po1 or the number of instances of the first detector 12A (the detector 12) in the housing 200. In the present embodiment, the estimator 113 estimates both the position Po1 and the number of instances of the first detector 12A in the housing 200. In

the example shown in FIG. 3, the estimator 113 estimates a first position Po11 and a second position Po12 as the positions Po1 of the first detectors 12A in the housing 200. Moreover, the estimator 113 further estimates a third position Po13 as the position Po1 of the first detector 12A outside the housing 200. That is, the estimator 113 estimates the first position Po11 and the second position Po12 as the positions Po1 of the first detectors 12A in the housing 200 and estimates the number of instances of the first detector 12A (which is two in the example shown in FIG. 3) in the housing 200. Each of the first position Po11 and the second position Po12 is an attachment position of the first detector 12A on the second side wall 202 of the housing 200. Moreover, the third position Po13 is an attachment position of the first detector 12A on the ceiling surface W1 of the data center 100. That is, in the example shown in FIG. 3, two first detectors 12A have to be attached to the first position Po11 and the second position Po12 in the housing 200.

[0030] Moreover, the estimator 113 further estimates the attachment angle (the first angle) α_1 of the holding member 13 with respect to the second side wall 202 of the housing 200 in addition to the position Po1 and the number of instances of the first detector 12A. Here, the holding member 13 is a member for attaching the first detector 12A to the housing 200 and, as shown in FIG. 4, has a plate shape having a first surface 131 and a second surface 132 facing away from each other. Moreover, the holding member 13 further includes an end surface 133 positioned in a direction toward the first side wall 201 in one direction (the left/right direction in FIG. 4). The end surface 133 connects the first surface 131 and the second surface 132 to each other. As shown in FIG. 4, the first detector 12A is held on the first surface 131 of the holding member 13, and the holding member 13 is attached to the second side wall 202 of the housing 200, and thereby, the first detector 12A is attached to the second side wall 202 via the holding member 13. That is, the fire precursor detection system 1 according to the first embodiment includes the holding member 13 holding the first detector 12A (the detector 12).

[0031] Here, in the present embodiment, the fire precursor detection system 1 includes the second detector 12B. The second detector 12B is a sensor that detects the direction of the air current AC1 in the housing 200 as described later. Therefore, the estimator 113 may further estimate the attachment angle α_1 (see FIG. 4) of the holding member 13 with respect to the second side wall 202 of the housing 200 on the basis of the detection result by the second detector 12B, in addition to the analysis result by the analyzer 112.

[0032] The determiner 114 determines the presence or absence of the precursor of the potential fire in the data center 100 on the basis of the detection result by the first detector 12A. In the present embodiment, the fire precursor detection system 1 includes a plurality of

first detectors 12A. Therefore, the determiner 114 preferably determines the presence or absence of the precursor of the potential fire for every first detector 12A, but in that case, the process load of the determiner 114 increases. Therefore, the determiner 114 may determine the presence or absence of the precursor of the potential fire on the basis of a detection result by one first detector 12A of the plurality of first detectors 12A which has detected an abnormal gas having the highest concentration. This enables the presence or absence of the precursor of the potential fire to be determined while the process load of the determiner 114 is reduced.

[0033] Here, a case is assumed where the plurality of first detectors 12A correspond to the plurality of computer devices 300 on a one-to-one basis and one computer device 300 of the plurality of computer devices 300 is in a busy state. In that case, the amount of data passing through the covered wire FS (see FIG. 3) connected to the one computer device 300 is large, and the covered wire FS therefore generates heat, and as a result, at least one of the melting or ignition of the covered wire FS may occur. Therefore, in that case, the determiner 114 preferably determines the presence or absence of the precursor of the potential fire on the basis of the detection result by the one first detector 12A of the plurality of first detectors 12A which corresponds to the one computer device 300.

(2.2) First Detector

[0034] The first detector 12A is, for example, a gas sensor that converts the concentration of a gas thus detected into an electric signal. The first detector 12A detects the presence or absence of an abnormal gas resulting from at least one of melting or ignition of at least one of the covered wires FS connected to the computer devices 300. The abnormal gas includes, for example, at least one of a hydrogen chloride gas, an ammonia gas, a carbon monoxide gas, and a formaldehyde. In the present embodiment, the first detector 12A corresponds to the detector 12. Note that the first detector 12A may be an electrochemical gas sensor or an infrared gas sensor.

(2.3) Second Detector

[0035] Unlike the first detector 12A, the second detector 12B is an airflow direction sensor that detects the direction of the air current AC1 in the air circulation cycle C1. The second detector 12B detects, for example, a rising angle of the air current AC1 with respect to the second side wall 202 of the housing 200.

(2.4) Angle Adjusting Mechanism

[0036] The holding member 13 includes the angle adjusting mechanism 130. The angle adjusting me-

chanism 130 adjusts the first angle (the attachment angle) $\alpha 1$ of the holding member 13 in accordance with the input information externally provided. The input information is information input via the input 14 and includes, for example, angular information on the holding member 13 with respect to the second side wall 202 of the housing 200. The angle adjusting mechanism 130 can adjust the first angle $\alpha 1$ of the holding member 13, for example, in increments of 1 degree.

[0037] Moreover, the fire precursor detection system 1 according to the first embodiment includes the second detector 12B, which detects the direction of the air current AC1 in the air circulation cycle C1, as described above. Therefore, the angle adjusting mechanism 130 preferably further adjusts the first angle $\alpha 1$ on the basis of the detection result by the second detector 12B in addition to the input information.

[0038] Here, a case is assumed where the plurality of first detectors 12A correspond to the plurality of computer devices 300 on a one-to-one basis and one computer device 300 of the plurality of computer devices 300 is in a busy state. In that case, at least one of the melting or ignition of the covered wire FS (see FIG. 3) connected to the one computer device 300 may occur. Therefore, in that case, the angle adjusting mechanism 130 preferably readjusts the first angle (the attachment angle) $\alpha 1$ of the holding member 13 holding the one first detector 12A. Note that the input information in that case is information corresponding to the one first detector 12A of the plurality of first detectors 12A and includes, for example, the angular information on the holding member 13 holding the one first detector 12A with respect to the second side wall 202 of the housing 200.

(2.5) Input

[0039] The input 14 receives the input information externally provided. More specifically, the input 14 includes an input interface that receives the input information from, for example, an administrator of the data center 100. As described above, the input information includes at least one of the first information or the angular information on the holding member 13. The input 14 includes, for example, a plurality of push buttons and a numeric keyboard. Therefore, the administrator of the data center 100 uses the plurality of push buttons and the numeric keyboard to input the input information.

(2.6) Communicator

[0040] The communicator 15 includes a communication interface for communicating with the management system 2. The communicator 15 performs, for example, wired communication with the management system 2. The communicator 15 communicates with the management system 2 to transmit, to the management system

2, a communication signal including the first angle (the attachment angle) α_1 of each holding member 13, a communication signal including the detection result by each first detector 12A, and a communication signal including the detection result by each second detector 12B. Moreover, the communicator 15 communicates with the management system 2 to transmit, to the management system 2, a communication signal including the analysis result by the analyzer 112, a communication signal including an estimation result by the estimator 113, and a communication signal including a determination result by the determiner 114. Note that the communication between the communicator 15 and the management system 2 is not limited to the wired communication but may be wireless communication.

(2.7) Storage

[0041] The storage 16 is a memory element such as read only memory (ROM), random access memory (RAM), or electrically erasable programmable read only memory (EEPROM). The storage 16 stores, for example, the first angle (attachment angle) α_1 of each holding member 13, the detection result by each first detector 12A, and the detection result by each second detector 12B. Moreover, the storage 16 stores, for example, the analysis result by the analyzer 112, the estimation result by the estimator 113, and the determination result by the determiner 114.

(3) Installation State of First Detector

[0042] Next, the installation state of the first detector 12A will be described with reference to FIG. 4. As described above, FIG. 4 is a schematic diagram of the installation state of the first detector 12A. In the example in FIG. 4, three computer devices 300 of the five computer devices 300 housed in the housing 200 are shown. Moreover, in the example in FIG. 4, only the first detector 12A and the holding member 13 corresponding to a center computer device 300 of the three computer devices 300 aligned with each other in the up/down direction are shown. Each computer device 300 is placed on a support table 203 extending from the first side wall 201 toward the second side wall 202 of the housing 200 (see FIG. 4).

[0043] As shown in FIG. 4, the holding member 13 is in the housing 200 and is attached to the second side wall 202 of the housing 200. More specifically, the holding member 13 is in the housing 200 and is attached to the second side wall 202 in a state where the holding member 13 is inclined with respect to the second side wall 202.

[0044] As shown in FIG. 4, the first detector 12A includes a base part 121 and a head part 122. The base part 121 is a part of the first detector 12A and is attached to the holding member 13. The head part 122 is a part including a plurality of inflow ports 123 (only three

of which are shown in FIG. 4) and is attached to the base part 121. Each of the plurality of inflow ports 123 is a portion into which the air current AC1 flows. That is, the first detector 12A has the inflow ports 123 into which the air current AC1 in the air circulation cycle C1 flows. As shown in FIG. 4, the base part 121 is attached to the holding member 13, and thereby, the first detector 12A is held by the holding member 13.

[0045] Here, a case is assumed where the first angle which is the angle formed between the second side wall 202 of the housing 200 and the holding member 13 is α_1 and a second angle which is an angle formed between the second side wall 202 and the direction of the air current AC1 passing through the first detector 12A held by the holding member 13 is β_1 . In that case, the first angle α_1 and the second angle β_1 preferably satisfy the conditions $0 < \alpha_1$ and $\alpha_1 \leq \beta_1$. Further, the first angle α_1 and the second angle β_1 further satisfy the condition $\beta_1/2 \leq \alpha_1$. The first angle α_1 and the second angle β_1 satisfying the conditions as described above increases the amount of the air current AC1 flowing into the first detector 12A through the inflow ports 123 and consequently increases the amount of the abnormal gas flowing into the first detector 12A through the inflow port 123, which enables the detection accuracy of the first detector 12A to be enhanced. As a result, the precursor prior to the outbreak of fire can be accurately detected.

(4) Fire Precursor Detection Method

[0046] Next, a fire precursor detection method according to the first embodiment will be described with reference to FIG. 5. The fire precursor detection method according to the first embodiment is implemented by, for example, the fire precursor detection system 1 described above.

[0047] The fire precursor detection method according to the first embodiment is a fire precursor detection method of detecting the precursor of the potential fire in the data center 100. The air circulation cycle C1 is formed for the data center 100. The air circulation cycle C1 includes the blowout port 101 provided on the floor surface F1 of the data center 100 and the suction port 102 provided on the ceiling surface W1 of the data center 100. The air circulation cycle C1 supplies cool air from the blowout ports 101 to the computer devices 300 housed in each housing 200 installed in the data center 100, from at least one of the lower side or the lateral side of the computer devices 300, and guides hot air having passed through the computer devices 300 toward the suction port 102. The fire precursor detection method includes an acquisition step ST1, an analysis step ST2, and an estimation step ST3. The acquisition step ST1 includes acquiring the first information which is the information regarding the structure of the data center 100 and the structure of the housing 200 and the second information which is the informa-

tion regarding the air current AC1 in the air circulation cycle C1. The analysis step ST2 includes analyzing, based on the first information and the second information acquired in the acquisition step ST1, a flow (behavior) of the air current AC1 including an abnormal gas resulting from at least one of melting or ignition of at least one of: the covered wires FS (see FIG. 3) connected to the computer devices 300; or electronic components included in the computer devices 300. The estimation step ST3 includes estimating, based on an analysis result in the analysis step ST2, at least one of the position Po1 or the number of instances of the first detector 12A (the detector 12) configured to determine the presence or absence of the abnormal gas, in the housing 200.

[0048] In the fire precursor detection method according to the first embodiment, the estimation step ST3 includes estimating, based on the analysis result in the analysis step ST2, the position Po1 and the number of instances of the first detector 12A. Therefore, disposing the first detector 12A at the position Po1 estimated in the estimation step ST3 enables the detection accuracy of the first detector 12A to be enhanced, and as a result, the precursor prior to the outbreak of fire can be accurately detected.

[0049] FIG. 5 is a flowchart of the fire precursor detection method executed by the fire precursor detection system 1 according to the first embodiment. The fire precursor detection method includes the steps ST1 to ST3 shown in FIG. 5. Note that the flowchart shown in FIG. 5 is a mere example and may include one or more steps other than the steps ST1 to ST3 shown in FIG. 5.

[0050] The fire precursor detection method will be described in further detail below.

[0051] First of all, the fire precursor detection system 1 executes the acquisition step ST1. More specifically, the acquirer 111 of the fire precursor detection system 1 acquires the first information and the second information described above in the acquisition step ST1.

[0052] Then, the fire precursor detection system 1 executes the analysis step ST2. More specifically, the analyzer 112 of the fire precursor detection system 1 analyzes, based on the first information and the second information, the flow of the air current AC1 including the abnormal gas in the analysis step ST2 (see FIG. 3). As described above, the example in FIG. 3 shows the flow of the air current AC1 passing through the lowermost computer device 300 of the five computer devices 300 aligned with each other in the up/down direction in the housing 200.

[0053] Then, the fire precursor detection system 1 executes the estimation step ST3. More specifically, the estimator 113 of the fire precursor detection system 1 estimates, based on the analysis result by the analyzer 112 (the analysis result in the analysis step ST2), the position Po1 and the number of instances of the first detector 12A in the housing 200 in the estimation step ST3. In the example shown in FIG. 3, the estima-

tor 113 estimates the first position Po11 and the second position Po12 as the positions Po1 of the first detectors 12A in the housing 200.

[0054] Here, the position Po1 of the first detector 12A in the housing 200 is preferably a position that allows for cooling of the computer device 300 by the air current AC1. This enables the computer device 300 to be efficiently cooled.

(5) Effects

[0055] In the fire precursor detection system 1 according to the first embodiment, the holding member 13 is in the housing 200 and is attached to the second side wall 202 in the state where the holding member 13 is inclined with respect to the second side wall 202. This increases the amount of the air current AC1 flowing into the first detector 12A (the detector 12A) as compared with the case where the holding member 13 is vertically attached to the second side wall 202, and as a result, the amount of the abnormal gas included in the air current AC1 also increases, which enables the detection accuracy of the first detector 12A to be enhanced. That is, the fire precursor detection system 1 according to the first embodiment can accurately detect the precursor prior to the outbreak of fire.

[0056] Moreover, in the fire precursor detection system 1 according to the first embodiment, the first angle $\alpha 1$ and the second angle $\beta 1$ satisfy the conditions $0 < \alpha 1$ and $\alpha 1 \leq \beta 1$. This further increases the amount of the air current AC1 flowing into the first detector 12A, and consequently further increases the amount of the abnormal gas included in the air current AC1, which enables the detection accuracy of the first detector 12A to be further enhanced.

[0057] Moreover, in the fire precursor detection system 1 according to the first embodiment, the first angle $\alpha 1$ and the second angle $\beta 1$ satisfy the condition $\beta 1/2 \leq \alpha 1$. This further increases the amount of the air current AC1 flowing into the first detector 12A, and consequently further increases the amount of the abnormal gas included in the air current AC1, which enables the detection accuracy of the first detector 12A to be further enhanced.

[0058] Moreover, in the fire precursor detection system 1 according to the first embodiment, the holding member 13 includes the angle adjusting mechanism 130 which adjusts the first angle $\alpha 1$ of the holding member 13 in accordance with the input information externally received. This enables the first angle $\alpha 1$ of the holding member 13 to be adjusted by remote operation.

[0059] Moreover, in the fire precursor detection system 1 according to the first embodiment, the determiner 114 determines the presence or absence of the precursor of the potential fire on the basis of a detection result by one first detector 12A of the plurality of first detectors 12A. This enables the precursor of the potential fire

to be detected at an earlier stage, for example, when one computer device 300 corresponding to the one first detector 12A is in the busy state.

[0060] Moreover, in the fire precursor detection system 1 according to the first embodiment, the angle adjusting mechanism 130 further adjusts the first angle $\alpha 1$ of the holding member 13 on the basis of the detection result by the second detector 12B. This enables the detection accuracy of the first detector 12A to be enhanced.

[0061] Moreover, in the fire precursor detection system 1 according to the first embodiment, the abnormal gas detected by the first detector 12A includes at least one of hydrogen chloride gas, ammonia gas, carbon monoxide gas, or formaldehyde gas. This can enhance the detection accuracy of the precursor of the potential fire caused due to at least one of melting or ignition of the covered wire FS (see FIG. 3).

[0062] Moreover, in the fire precursor detection system 1 according to the first embodiment, the determiner 114 determines the presence or absence of the precursor of the potential fire on the basis of a detection result by one first detector 12A of the plurality of first detectors 12A which has detected an abnormal gas having the highest concentration. This enables the presence or absence of the precursor of the potential fire to be determined while the process load of the determiner 114 is reduced.

[0063] Moreover, in the fire precursor detection system 1 according to the first embodiment, each of the first side wall 201 and the second side wall 202 of the housing 200 is formed of perforated metal having a plurality of holes. This can improve the flow of the air current AC1 in the air circulation cycle C1.

[0064] Moreover, in fire precursor detection system 1 according to the first embodiment, the position Po1 of the first detector 12A in the housing 200 include the position that allows for cooling of the computer device 300 by the air current AC1. This enables the computer device 300 to be efficiently cooled.

(6) Variations

[0065] The first embodiment is a mere example of various embodiments of the present disclosure. The first embodiment may be modified variously depending on design or the like as long as the object of the present disclosure is achieved. Moreover, similar functions to the fire precursor detection system 1 according to the first embodiment may be implemented by the fire precursor detection method described above, a (computer) program, a non-transitory recording medium storing the program, or the like. The program according to an aspect is a program configured to cause one or more processors to execute the fire precursor detection method described above. Such a program enables the precursor prior to the outbreak of fire to be accurately detected.

[0066] Variations of the first embodiment will be enumerated below. Any of the variations to be described below may be combined as appropriate.

[0067] The fire precursor detection system 1 or an agent that carries out the fire precursor detection method in the present disclosure includes a computer system. The computer system may include a processor and a memory element as principal hardware components thereof. The processor executes a program stored in the memory element of the computer system, thereby implementing functions as the fire precursor detection system 1 or the agent that carries out the fire precursor detection method in the present disclosure. The program may be stored in advance in the memory element of the computer system. Alternatively, the program may also be downloaded over a telecommunications network or be distributed after having been recorded in some non-transitory storage medium such as a memory card, an optical disc, or a hard disk drive, any of which is readable for the computer system. The processor of the computer system may be made up of a single or a plurality of electronic circuits including a semiconductor integrated circuit (IC) or a large-scale integrated circuit (LSI). As used herein, the "integrated circuit" such as an IC or an LSI is called by a different name depending on the degree of integration thereof. Examples of the integrated circuits include a system LSI, a very-large-scale integrated circuit (VLSI), and an ultra-large-scale integrated circuit (ULSI). Optionally, a field-programmable gate array (FPGA) to be programmed after an LSI has been fabricated or a reconfigurable logic device allowing the connections or circuit sections inside of an LSI to be reconfigured may also be adopted as the processor. Those electronic circuits may be either integrated together on a single chip or distributed on multiple chips, whichever is appropriate. Those multiple chips may be integrated together in a single device or distributed in multiple devices without limitation. As used herein, the "computer system" includes a microcontroller including one or more processors and one or more memory elements. Thus, the microcontroller may also be implemented as a single or a plurality of electronic circuits including a semiconductor integrated circuit or a large-scale integrated circuit.

[0068] Moreover, in the description described above, the plurality of functions of the fire precursor detection system 1 are integrated together in a single housing. However, this is only an example and is not an essential configuration for the fire precursor detection system 1. Alternatively, these components of the fire precursor detection system 1 may be distributed in multiple different housings. Further, at least some of the functions of the fire precursor detection system 1, for example, some functions of the controller 11, may be implemented by, for example, cloud computing.

[0069] Conversely, in the first embodiment, at least some of the functions of the fire precursor detection

system 1 distributed in a plurality of devices may be integrated together in a single housing. For example, some of the functions of the fire precursor detection system 1 which are distributed in the first detector 12A and the second detector 12B may be integrated together in a single housing.

[0070] In the first embodiment, the estimator 113 estimates both the position Po1 and the number of instances of the first detector 12A in the housing 200. Alternatively, the estimator 113 may estimate only the number of instances of the first detector 12A in the housing 200.

[0071] In the first embodiment, the first detector 12A detects the presence or absence of an abnormal gas resulting from at least one of melting or ignition of at least one of the covered wires FS connected to the computer devices 300. Alternatively, the first detector 12A may detect the presence or absence of an abnormal gas resulting from at least one of melting or ignition of at least one electronic components included in the computer devices 300. Further, the first detector 12A may detect both the presence or absence of an abnormal gas resulting from at least one of melting or ignition of a covered wire FS and the presence or absence of an abnormal gas resulting from at least one of melting or ignition of the electronic component.

[0072] In the first embodiment, the determiner 114 determines the presence or absence of the precursor of the potential fire on the basis of a detection result by one first detector 12A of the plurality of first detectors 12A which has detected an abnormal gas having the highest concentration. Here, the concentration balance of abnormal gases generated tends to differ depending on materials being heated. Therefore, the determiner 114 may determine the presence or absence of the precursor of the potential fire on the basis of, for example, at least one of a combination of a plurality of abnormal gases generated upon burning of the covered wire FS or a combination of a plurality of abnormal gases generated upon burning of the electronic component. Alternatively, the determiner 114 may determine the presence or absence of the precursor of the potential fire on the basis of the concentration proportions of the plurality of abnormal gases.

(Second Embodiment)

[0073] A fire precursor detection system 1 according to the second embodiment will be described with reference to FIG. 6. In the fire precursor detection system 1 according to the second embodiment, components similar to those in the fire precursor detection system 1 according to the first embodiment (see FIGS. 1, 2, and 4) are denoted by the same reference signs as those in the first embodiment, and the description thereof is omitted.

[0074] The fire precursor detection system 1 according to the second embodiment is different from the fire

precursor detection system 1 according to the first embodiment in that a first detector 12A is movable with respect to a holding member 13.

[0075] In the fire precursor detection system 1 according to the second embodiment, the first detector 12A has only a head part 122 as shown in FIG. 6. The head part 122 is provided with a plurality of inflow ports 123. The head part 122 is movable along a first surface 131 of the holding member 13. In the example shown in FIG. 6, the head part 122 of the first detector 12A is held by the holding member 13 such that a leftmost inflow port 123 of the plurality of inflow ports 123 is positioned to the left of an end surface 133 of the holding member 13. That is, in the fire precursor detection system 1 according to the second embodiment, the first detector 12A is held by the holding member 13 such that the leftmost inflow port 123 is positioned between the end surface 133 of the holding member 13 and a first side wall 201 (on the left side) in one direction (the left/right direction in FIG. 6). This can reduce the influence of turbulence of the air current AC1. Note that the one direction is a direction in which the first side wall 201 and a second side wall 202 of a housing 200 are aligned with each other.

[0076] In a similar manner to the fire precursor detection system 1 according to the first embodiment, the fire precursor detection system 1 according to the second embodiment can also accurately detect a precursor prior to an outbreak of fire.

[0077] Note that the first detector 12A may be held by the holding member 13 such that the leftmost inflow port 123 of the plurality of inflow ports 123 is flush with the end surface 133 of the holding member 13.

[0078] Moreover, various configurations described in the second embodiment may be employed accordingly in combination with the various configurations (including the variations) described in the first embodiment.

(Third Embodiment)

[0079] A fire precursor detection system 1 according to the third embodiment will be described with reference to FIG. 7. In the fire precursor detection system 1 according to the third embodiment, components similar to those in the fire precursor detection system 1 according to the first embodiment (see FIGS. 1, 2, and 4) are denoted by the same reference signs, and the description thereof is omitted.

[0080] The fire precursor detection system 1 according to the third embodiment is different from the fire precursor detection system 1 according to the first embodiment in that a first detector 12A has first inflow ports 123A and a second inflow port 123B.

[0081] In the fire precursor detection system 1 according to the third embodiment, the first detector 12A includes only a head part 122 as shown in FIG. 7. The head part 122 is provided with the plurality of inflow ports 123A and 123B. The first inflow ports 123A of the

plurality of inflow ports 123A and 123B are provided in a first portion which is part of the head part 122 and which is disposed on a first surface 131 of a holding member 13. Moreover, the second inflow port 123B of the plurality of inflow ports 123A and 123B is provided in a second portion which is part of the head part 122 and which is disposed on a second surface 132 of the holding member 13. That is, the first detector 12A has the first inflow ports 123A and the second inflow port 123B into each of which an air current AC1 flows. The first inflow port 123A is disposed on a side to which the first surface 131 is directed in a thickness direction defined with respect to the holding member 13, and the second inflow port 123B is disposed on a side to which the second surface 132 is directed in the thickness direction defined with respect to the holding member 13. In this case, the first detector 12A preferably detects the presence or absence of an abnormal gas on the basis of both the air current AC1 flowing therein through the first inflow ports 123A and the air current AC1 flowing therein through the second inflow port 123B. This enables the detection accuracy of the first detector 12A to be enhanced as compared with the case where the first detector 12A detects the presence or absence of the abnormal gas on the basis of the air current AC1 flowing therein through the first inflow ports 123A or the air current AC1 flowing therein through the second inflow port 123B.

[0082] As described above, disposing the first inflow ports 123A on the side to which the first surface 131 of the holding member 13 is directed and disposing the second inflow port 123B on the side to which the second surface 132 of the holding member 13 is directed enable a reduction in influence of turbulence of the air current AC1.

[0083] Moreover, in a similar manner to the fire precursor detection system 1 according to the first embodiment, the fire precursor detection system 1 according to the third embodiment can also accurately detect a precursor prior to an outbreak of fire.

[0084] Note that various configurations described in the third embodiment may be employed accordingly in combination with the various configurations (including the variations) described in the first and second embodiments.

(Aspects)

[0085] The present specification discloses the following aspects.

(Aspect 1)

[0086] A fire precursor detection system (1) of a first aspect is a fire precursor detection system (1) configured to detect a precursor of a potential fire in a data center (100). An air circulation cycle (C1) is formed for the data center (100). The air circulation cycle (C1) in-

cludes a blowout port (101) provided on a floor surface (F1) of the data center (100) and a suction port (102) provided on a ceiling surface (W1) of the data center (100). The air circulation cycle (C1) is configured to: supply cool air from the blowout port (101) to a computer device (300) housed in a housing (200) installed in the data center (100), from at least one of a lower side or a lateral side of the computer device (300); and guide hot air having passed through the computer device (300) toward the suction port (102). The fire precursor detection system (1) includes a detector (12) and a holding member (13). The detector (12) is configured to detect a presence or absence of an abnormal gas resulting from at least one of melting or ignition of at least one of a covered wire (FS) connected to the computer device (300) or an electronic component included in the computer device (300). The holding member (13) holds the detector (12). The housing (200) has a first side wall (201) and a second side wall (202). The first side wall (201) is configured to allow the cool air flowing from the blowout port (101) to pass through the first side wall (201) into the housing (200). The second side wall (202) is in alignment with the first side wall (201) in one direction and is configured to allow the hot air having passed through the computer device (300) to pass through the second side wall (202) toward the suction port (102). The holding member (13) is in the housing (200) and is attached to the second side wall (202) in a state where the holding member (13) is inclined with respect to the second side wall (202).

[0087] This aspect enables accurate detection of a precursor prior to an outbreak of fire.

[0088] In a fire precursor detection system (1) of a second aspect referring to the first aspect, a first angle formed between the holding member (13) and the second side wall (202) is defined as α_1 , a second angle formed between the second side wall (202) and a direction of an air current (AC1) passing through the detector (12) held by the holding member (13) is defined as β_1 , and the first angle (α_1) and the second angle (β_1) satisfy conditions $0 < \alpha_1$ and $\alpha_1 \leq \beta_1$.

[0089] This aspect increases the air current (AC1) flowing into the detector (12) as compared with the case where the first angle (α_1) and the second angle (β_1) fail to satisfy the conditions, thereby enabling accurate detection of a precursor prior to an outbreak of fire.

[0090] In a fire precursor detection system (1) of a third aspect referring to the second aspect, the first angle (α_1) and the second angle (β_1) further satisfy a condition $\beta_1/2 \leq \alpha_1$.

[0091] This aspect further increases the air current (AC1) flowing into the detector (12), thereby enabling further accurate detection of a precursor prior to an outbreak of fire.

[0092] In a fire precursor detection system (1) of a fourth aspect referring to the second or third aspect, the holding member (13) includes an angle adjusting

mechanism (130) configured to adjust the first angle (α_1) in accordance with input information externally provided.

[0093] This aspect enables the first angle (α_1) to be externally adjusted by remote operation.

[0094] In a fire precursor detection system (1) of a fifth aspect referring to the fourth aspect, the fire precursor detection system (1) includes a plurality of the detectors (12). The detectors (12) correspond to a plurality of the computer devices (300) on a one-to-one basis. The input information includes information corresponding to one detector (12) of the detectors (12). The angle adjusting mechanism (130) is configured to readjust the first angle (α_1) of the holding member (13) holding the one detector (12) in accordance with the input information. The fire precursor detection system (1) further includes a determiner (114). The determiner (114) is configured to determine a presence or absence of the precursor of a potential fire on a basis of a detection result by the one detector (12).

[0095] This aspect enables the presence or absence of the precursor of the potential fire to be determined on the basis of the detection result by the one detector (12).

[0096] The fire precursor detection system (1) of a sixth aspect referring to the fourth aspect further includes a first detector (12A) which is the detector (12) and a second detector (12B). The second detector (12B) is different from the first detector (12A) and is configured to detect the direction of the air current (AC1) in the air circulation cycle (C1). The angle adjusting mechanism (130) is configured to further adjust the first angle (α_1) on a basis of a detection result by the second detector (12B).

[0097] This aspect adjusts the first angle (α_1) on the basis of the detection result by the second detector (12B), thereby enhancing the detection accuracy of the detector (12).

[0098] In a fire precursor detection system (1) of a seventh aspect referring to any one of the first to sixth aspects, the detector (12) has an inflow port (123) into which an air current (AC1) in the air circulation cycle (C1) flows. The holding member (13) has a plate shape having a first surface (131) and a second surface (132) facing away from each other. The holding member (13) further has an end surface (133) positioned in a direction toward the first side wall (201) in the one direction. The end surface (133) connects the first surface (131) and the second surface (132) to each other. The detector (12) is held by the holding member (13) such that the inflow port (123) is flush with the end surface (133) of the holding member (13) or is located between the end surface (133) and the first side wall (201).

[0099] This aspect enables a reduction in influence of turbulence of an air current (AC1).

[0100] In a fire precursor detection system (1) of an eighth aspect referring to any one of the first to sixth aspects, the detector (12) has a first inflow port (123A)

and a second inflow port (123B) into which an air current (AC1) in the air circulation cycle (C1) flows. The holding member (13) has a plate shape having a first surface (131) and a second surface (132) facing away from each other. The first inflow port (123A) is disposed on a side to which the first surface (131) is directed in a thickness direction defined with respect to the holding member (13). The second inflow port (123B) is disposed on a side to which the second surface (132) is directed in the thickness direction defined with respect to the holding member (13).

[0101] This aspect enables a reduction in influence of turbulence of an air current (AC1).

[0102] In a fire precursor detection system (1) of a ninth aspect referring to the eighth aspect, the detector (12) is configured to detect the presence or absence of the abnormal gas on a basis of both the air current (AC1) flowing into the detector (12) from the first inflow port (123A) and the air current (AC1) flowing into the detector (12) from the second inflow port (123B).

[0103] This aspect can enhance the detection accuracy of the detector (12) as compared with the case where the detector (12) detects the presence or absence of the abnormal gas on the basis of the air current (AC1) flowing thereinto from the first inflow port (123A) or the air current (AC1) flowing thereinto from the second inflow port (123B).

[0104] In a fire precursor detection system (1) of a tenth aspect referring to any one of the first to ninth aspects, the abnormal gas includes at least one of hydrogen chloride gas, ammonia gas, carbon monoxide gas, or formaldehyde gas.

[0105] This aspect enables enhancing the detection accuracy of the precursor of the potential fire resulting from the melting or ignition of the covered wire (FS).

[0106] In a fire precursor detection system (1) of an eleventh aspect referring to any one of the first to tenth aspects, the fire precursor detection system (1) includes a plurality of the detectors (12). The fire precursor detection system (1) further includes a determiner (114). The determiner (114) is configured to determine a presence or absence of the precursor of the potential fire on a basis of at least one of a detection result by one detector (12) of the detectors (12) which detects an abnormal gas of a highest concentration, or detection results of a plurality of abnormal gases by the detectors (12).

[0107] This aspect enables the presence or absence of the precursor of the potential fire to be determined while reducing the process load of the determiner (114).

[0108] In a fire precursor detection system (1) of a twelfth aspect referring to any one of the first to eleventh aspects, each of the first side wall (201) and the second side wall (202) is formed from perforated metal having a plurality of holes.

[0109] This configuration enables improving the flow of the air current (AC1) in the air circulation cycle (C1).

[0110] In a fire precursor detection system (1) of a thirteenth aspect referring to any one of the first to twelfth aspects, a position of the detector (12) in the housing (200) includes a position that allows for cooling of the computer device (300) by an air current (AC1) in the air circulation cycle (C1).

[0111] This configuration enables the computer device (300) to be efficiently cooled.

[0112] A fire precursor detection system (1) of a fourteenth aspect referring to any one of the first to thirteenth aspects further includes an acquirer (111), an analyzer (112), and an estimator (113). The acquirer (111) is configured to acquire first information which is information regarding a structure of the data center (100) and a structure of the housing (200) and second information which is information regarding an air current (AC1) in the air circulation cycle (C1). The analyzer (112) is configured to analyze, based on the first information and the second information acquired by the acquirer (111), a flow of the air current (AC1) including the abnormal gas resulting from at least one of the melting or the ignition of at least one of the covered wire (FS) connected to the computer device (300) or an electronic component included in the computer device (300). The estimator (113) is configured to estimate, based on an analysis result by the analyzer (112), at least one of a position (Po1) or a number of instances of the detector (12) in the housing (200).

[0113] This aspect enables accurate detection of a precursor prior to an outbreak of fire.

[0114] In a fire precursor detection system (1) of a fifteenth aspect referring to the fourteenth aspect, the estimator (113) is configured to further estimate a first angle (α_1) which is an angle formed between the holding member (13) and the second side wall (202).

[0115] This aspect increases the amount of the air current (AC1) flowing into the detector (12), thereby enhancing the detection accuracy of the detector (12).

[0116] A fire precursor detection system (1) of a sixteenth aspect referring to the fifteenth aspect further includes a second detector (12B). The second detector (12B) is different from a first detector (12A) which is the detector (12). The second detector (12B) is configured to detect a direction of the air current (AC1). The estimator (113) is configured to estimate the first angle (α_1) on a basis of a detection result by the second detector (12B).

[0117] In this aspect, the first angle (α_1) is estimated based on the detection result by the second detector (12B), thereby further enhancing the detection accuracy of the detector (12).

[0118] The configurations according to the second to sixteenth aspects are not essential configurations for the fire precursor detection system (1) and may be accordingly omitted.

(Aspect 2)

[0119] A fire precursor detection system (1) of a first aspect is a fire precursor detection system (1) configured to detect a precursor of a potential fire in a data center (100). An air circulation cycle (C1) is formed for the data center (100). The air circulation cycle (C1) includes a blowout port (101) provided on a floor surface (F1) of the data center (100) and a suction port (102) provided on a ceiling surface (W1) of the data center (100). The air circulation cycle (C1) is configured to: supply cool air from the blowout port (101) to a computer device (300) housed in a housing (200) installed in the data center (100), from at least one of a lower side or a lateral side of the computer device (300); and guide hot air having passed through the computer device (300) toward the suction port (102). The fire precursor detection system (1) includes an acquirer (111), an analyzer (112), and an estimator (113). The acquirer (111) is configured to acquire first information which is information regarding a structure of the data center (100) and a structure of the housing (200) and second information which is information regarding an air current (AC1) in the air circulation cycle (C1). The analyzer (112) is configured to analyze, based on the first information and the second information acquired by the acquirer (111), a flow of the air current (AC1) including an abnormal gas resulting from at least one of melting or ignition of at least one of a covered wire (FS) connected to the computer device (300) or an electronic component included in the computer device (300). The estimator (113) is configured to estimate, based on an analysis result by the analyzer (112), at least one of a position (Po1) or a number of instances of a detector (12) in the housing (200), the detectors (12) being configured to detect a presence or absence of the abnormal gas.

[0120] This aspect enables accurate detection of a precursor prior to an outbreak of fire.

[0121] In a fire precursor detection system (1) of a second aspect referring to the first aspect, the position (Po1) of the detector (12) in the housing (200) includes a position that allows for cooling of the computer device (300) by the air current (AC1).

[0122] This aspect enables the computer device (300) to be efficiently cooled.

[0123] In a fire precursor detection system (1) of a third aspect referring to the second aspect further includes the detector (12) and a holding member (13) holding the detector (12). The housing (200) has a first side wall (201) and a second side wall (202). The first side wall (201) is configured to allow the cool air flowing from the blowout port (101) to pass through the first side wall (201) into the housing (200). The second side wall (202) is in alignment with the first side wall (201) in one direction and is configured to allow the hot air having passed through the computer device (300) to pass through the second side wall (202) toward the suction

port (102). The holding member (13) is in the housing (200) and is attached to the second side wall (202). The estimator (113) is configured to further estimate an attachment angle (α_1) of the holding member (13) with respect to the second side wall (202).

[0124] This aspect increases the amount of the air current (AC1) flowing into the detector (12), thereby enhancing the detection accuracy of the detector (12).

[0125] In a fire precursor detection system (1) of a fourth aspect referring to the third aspect, the holding member (13) includes an angle adjusting mechanism (130) configured to adjust the attachment angle (α_1) on a basis of input information externally provided.

[0126] This aspect enables the attachment angle (α_1) of the holding member (13) to be externally adjusted by remote operation.

[0127] In a fire precursor detection system (1) of a fifth aspect referring to the fourth aspect, the fire precursor detection system (1) includes a plurality of the detectors (12). The detectors (12) correspond to a plurality of the computer devices (300) on a one-to-one basis. The input information includes information corresponding to one detector (12) of the detectors (12). The angle adjusting mechanism (130) is configured to readjust, based on the input information, the attachment angle (α_1) of the holding member (13) which holds the one detector (12). The fire precursor detection system (1) further includes a determiner (114). The determiner (114) is configured to determine a presence or absence of the precursor of the potential fire on a basis of a detection result by the one detector (12).

[0128] This aspect enables the presence or absence of the precursor of the potential fire to be determined on the basis of the detection result by the one detector (12).

[0129] The fire precursor detection system (1) of a sixth aspect referring to any one of the third to fifth aspects further includes a second detector (12B). The second detector (12B) is different from a first detector (12A) which is the detector (12). The second detector (12B) is configured to detect a direction of the air current (AC1). The estimator (113) is configured to estimate the attachment angle (α_1) on a basis of a detection result by the second detector (12B).

[0130] In this aspect, the attachment angle (α_1) is estimated based on the detection result by the second detector (12B), thereby further enhancing the detection accuracy of the detector (12).

[0131] In a fire precursor detection system (1) of a seventh aspect referring to any one of the third to sixth aspects, the detector (12) has an inflow port (123) into which the air current (AC1) flows. The holding member (13) has a plate shape having a first surface (131) and a second surface (132) facing away from each other. The holding member (13) further has an end surface (133) positioned in a direction toward the first side wall (201) in the one direction. The end surface (133) connects the first surface (131) and the second surface

(132) to each other. The detector (12) is held by the holding member (13) such that the inflow port (123) is flush with the end surface (133) of the holding member (13) or is located between the end surface (133) and the first side wall (201).

[0132] This aspect enables a reduction in influence of turbulence of an air current (AC1).

[0133] In the fire precursor detection system (1) of an eighth aspect referring to any one of the third to sixth aspects, the detector (12) includes a first inflow port (123A) and a second inflow port (123B) into which the air current (AC1) flows. The holding member (13) has a plate shape having a first surface (131) and a second surface (132) facing away from each other. The first inflow port (123A) is disposed on a side to which the first surface (131) is directed in a thickness direction defined with respect to the holding member (13). The second inflow port (123B) is disposed on a side to which the second surface (132) is directed in the thickness direction defined with respect to the holding member (13).

[0134] This aspect enables a reduction in influence of turbulence of an air current (AC1).

[0135] In a fire precursor detection system (1) of a ninth aspect referring to the eighth aspect, the detector (12) is configured to detect the presence or absence of the abnormal gas on a basis of both the air current (AC1) flowing into the detector (12) from the first inflow port (123A) and the air current (AC1) flowing into the detector (12) from the second inflow port (123B).

[0136] This aspect can enhance the detection accuracy of the detector (12) as compared with the case where the detector (12) detects the presence or absence of the abnormal gas on the basis of the air current (AC1) flowing thereinto from the first inflow port (123A) or the air current (AC1) flowing thereinto from the second inflow port (123B).

[0137] In a fire precursor detection system (1) of a tenth aspect referring to any one of the first to ninth aspects, the abnormal gas includes at least one of hydrogen chloride gas, ammonia gas, carbon monoxide gas, or formaldehyde gas.

[0138] This aspect enables enhancing the detection accuracy of the precursor of the potential fire resulting from the melting or ignition of the covered wire (FS).

[0139] In a fire precursor detection system (1) of an eleventh aspect referring to any one of the first to tenth aspects, the fire precursor detection system (1) includes a plurality of the detectors (12). The fire precursor detection system (1) further includes a determiner (114). The determiner (114) is configured to determine a presence or absence of the precursor of the potential fire on a basis of at least one of: a detection result by one detector (12) of the detectors (12) which detects an abnormal gas of a highest concentration; or detection results of plurality of abnormal gases by the detectors (12).

[0140] This aspect enables the presence or absence

of the precursor of the potential fire to be determined while reducing the process load of the determiner (114).

[0141] In a fire precursor detection system (1) of a twelfth aspect referring to any one of the third to eleventh aspects, each of the first side wall (201) and the second side wall (202) is formed from perforated metal having a plurality of holes.

[0142] This aspect enables improving the flow of the air current (AC1) in the air circulation cycle (C1).

[0143] A fire precursor detection method of a thirteenth aspect is a fire precursor detection method of detecting the precursor of the potential fire in the data center (100) having an air circulation cycle (C1) including a blowout port (101) in a floor surface (F1) of the data center

[0144] (100) and a suction port (102) in a ceiling surface (W1) of the data center (100). The air circulation cycle (C1) supplies cool air from the blowout ports (101) to a computer device (300) housed in a housing (200) installed in the data center (100), from at least one of a lower side or a lateral side of the computer devices (300), and guides hot air having passed through the computer device (300) toward the suction port (102). The fire precursor detection method includes an acquisition step (ST1), an analysis step (ST2), and an estimation step (ST3). The acquisition step (ST1) includes acquiring first information which is information regarding a structure of the data center (100) and a structure of the housing (200) and second information which is information regarding an air current (AC1) in the air circulation cycle (C1). The analysis step (ST2) includes analyzing, based on the first information and the second information acquired in the acquisition step (ST1), a flow of the air current (AC1) including an abnormal gas resulting from at least one of melting or ignition of at least one of a covered wires (FS) connected to the computer device (300) or an electronic component included in the computer device (300). The estimation step (ST3) includes estimating, based on an analysis result in the analysis step (ST2), at least one of a position (Po1) or a number of instances of a detector (12) in the housing (200), the detector (12) being configured to determine a presence or absence of an abnormal gas.

[0145] This aspect enables accurate detection of a precursor prior to an outbreak of fire.

[0146] A program of a fourteenth aspect is a program for causing one or more processors to execute the fire precursor detection method of the thirteenth aspect.

[0147] This aspect enables accurate detection of a precursor prior to an outbreak of fire.

[0148] The configurations of the second to twelfth aspects are not essential configurations for the fire precursor detection system (1) and may be omitted accordingly.

Reference Signs List

[0149]

5	1	Fire Precursor Detection System
	12	Detector
	12A	First Detector (Detector)
	12B	Second Detector
	13	Holding Member
10	100	Data Center
	101	Blowout Port
	102	Suction Port
	114	Determiner
	123	Inflow Port
15	123A	First Inflow Port
	123B	Second Inflow Port
	130	Angle Adjusting Mechanism
	131	First Surface
	132	Second Surface
20	133	End Surface
	200	Housing
	201	First Side Wall
	202	Second Side Wall
	300	Computer Device
25	AC1	Air Current
	C1	Air Circulation Cycle
	F1	Floor Surface
	FS	Covered Wire
	W1	Ceiling Surface
30	A1	First Angle
	B1	Second Angle

Claims

- 35 1. A fire precursor detection system configured to detect a precursor of a potential fire in a data center for which an air circulation cycle is formed, the air circulation cycle including a blowout port provided in a floor surface of the data center and a suction port provided in a ceiling surface of the data center, the air circulation cycle being configured to: supply cool air from the blowout port to a computer device housed in a housing installed in the data center, from at least one of a lower side or a lateral side of the computer device; and guide hot air having passed through the computer device toward the suction port, the fire precursor detection system comprising:
 - 40
 - 45
 - 50 a detector configured to detect a presence or absence of an abnormal gas resulting from at least one of melting or ignition of at least one of a covered wire connected to the computer device or an electronic component included in the computer device; and
 - 55 a holding member holding the detector, the housing having

a first side wall configured to allow the cool air flowing from the blowout port to pass through the first side wall into the housing, and
 a second side wall in alignment with the first side wall in one direction and configured to allow the hot air having passed through the computer device to pass through the second side wall toward the suction port,

the holding member being in the housing and being attached to the second side wall in a state where the holding member is inclined with respect to the second side wall.

2. The fire precursor detection system of claim 1, wherein

a first angle formed between the holding member and the second side wall is defined as α_1 ,
 a second angle formed between the second side wall and a direction of an air current passing through the detector held by the holding member is defined as β_1 , and
 the first angle and the second angle satisfy conditions $0 < \alpha_1$ and $\alpha_1 \leq \beta_1$.

3. The fire precursor detection system of claim 2, wherein the first angle and the second angle further satisfy a condition $\beta_1/2 \leq \alpha_1$.

4. The fire precursor detection system of claim 2 or 3, wherein the holding member includes an angle adjusting mechanism configured to adjust the first angle in accordance with input information externally provided.

5. The fire precursor detection system of claim 4, wherein

the fire precursor detection system includes a plurality of the detectors,
 the detectors correspond to a plurality of computer devices on a one-to-one basis,
 the input information includes information corresponding to one detector of the detectors,
 the angle adjusting mechanism is configured to readjust the first angle of the holding member holding the one detector in accordance with the input information, and
 the fire precursor detection system further includes a determiner configured to determine a presence or absence of the precursor of a potential fire on a basis of a detection result by the one detector.

6. The fire precursor detection system of claim 4,

further comprising:

a first detector which is the detector; and
 a second detector different from the first detector and configured to detect the direction of the air current in the air circulation cycle, wherein the angle adjusting mechanism is configured to further adjust the first angle on a basis of a detection result by the second detector.

7. The fire precursor detection system of any one of claims 1 to 6, wherein

the detector has an inflow port into which an air current in the air circulation cycle flows, the holding member

has a plate shape having a first surface and a second surface facing away from each other, and
 further has an end surface positioned in a direction toward the first side wall in the one direction, the end surface connecting the first surface and the second surface to each other, and

the detector is held by the holding member such that the inflow port is flush with the end surface of the holding member or is located between the end surface and the first side wall.

8. The fire precursor detection system of any one of claims 1 to 6, wherein

the detector has a first inflow port and a second inflow port into which an air current in the air circulation cycle flows,
 the holding member has a plate shape having a first surface and a second surface facing away from each other,
 the first inflow port is disposed on a side to which the first surface is directed in a thickness direction defined with respect to the holding member, and
 the second inflow port is disposed on a side to which the second surface is directed in the thickness direction defined with respect to the holding member.

9. The fire precursor detection system of claim 8, wherein

the detector is configured to detect the presence or absence of the abnormal gas on a basis of both the air current flowing into the detector from the first inflow port and the air current flowing into the detector from the second inflow port.

10. The fire precursor detection system of any one of

claims 1 to 9, wherein
the abnormal gas includes at least one of hydrogen
chloride gas, ammonia gas, carbon monoxide gas,
or formaldehyde gas.

11. The fire precursor detection system of any one of
claims 1 to 10, wherein

the fire precursor detection system includes a
plurality of the detectors, and
the fire precursor detection system further in-
cludes a determiner configured to determine a
presence or absence of the precursor of the
potential fire on a basis of at least one of a
detection result by one detector of the detec-
tors which detects an abnormal gas of a high-
est concentration, or detection results of a
plurality of abnormal gases by the detectors.

12. The fire precursor detection system of any one of
claims 1 to 11, wherein
each of the first side wall and the second side wall
is formed from perforated metal having a plurality
of holes.

13. The fire precursor detection system of any one of
claims 1 to 12, wherein
a position of the detector in the housing include a
position that allows for cooling of the computer de-
vice by an air current in the air circulation cycle.

14. The fire precursor detection system of any one of
claims 1 to 13, further comprising:

an acquirer configured to acquire

first information which is information re-
garding a structure of the data center and
a structure of the housing and
second information which is information
regarding an air current in the air circula-
tion cycle;

an analyzer configured to analyze, based on
the first information and the second informa-
tion acquired by the acquirer, a flow of the air
current including the abnormal gas resulting
from at least one of the melting or the ignition
of at least one of the covered wire connected
to the computer device or an electronic com-
ponent included in the computer device; and
an estimator configured to estimate, based on
an analysis result by the analyzer, at least one
of a position or a number of instances of the
detector in the housing.

15. The fire precursor detection system of claim 14,
wherein

the estimator is configured to further estimate a
first angle which is an angle formed between the
holding member and the second side wall.

16. The fire precursor detection system of claim 15,
further comprising a second detector different from
a first detector which is the detector, the second
detector being configured to detect a direction of
the air current, wherein
the estimator is configured to estimate the first an-
gle on a basis of a detection result by the second
detector.

FIG. 1

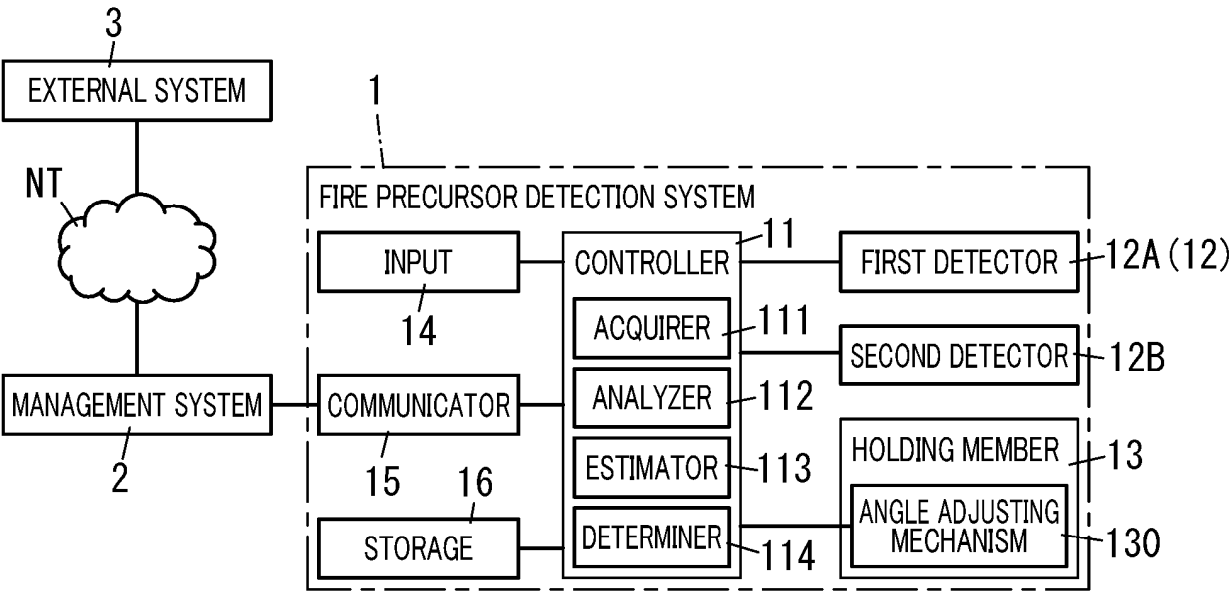


FIG. 2

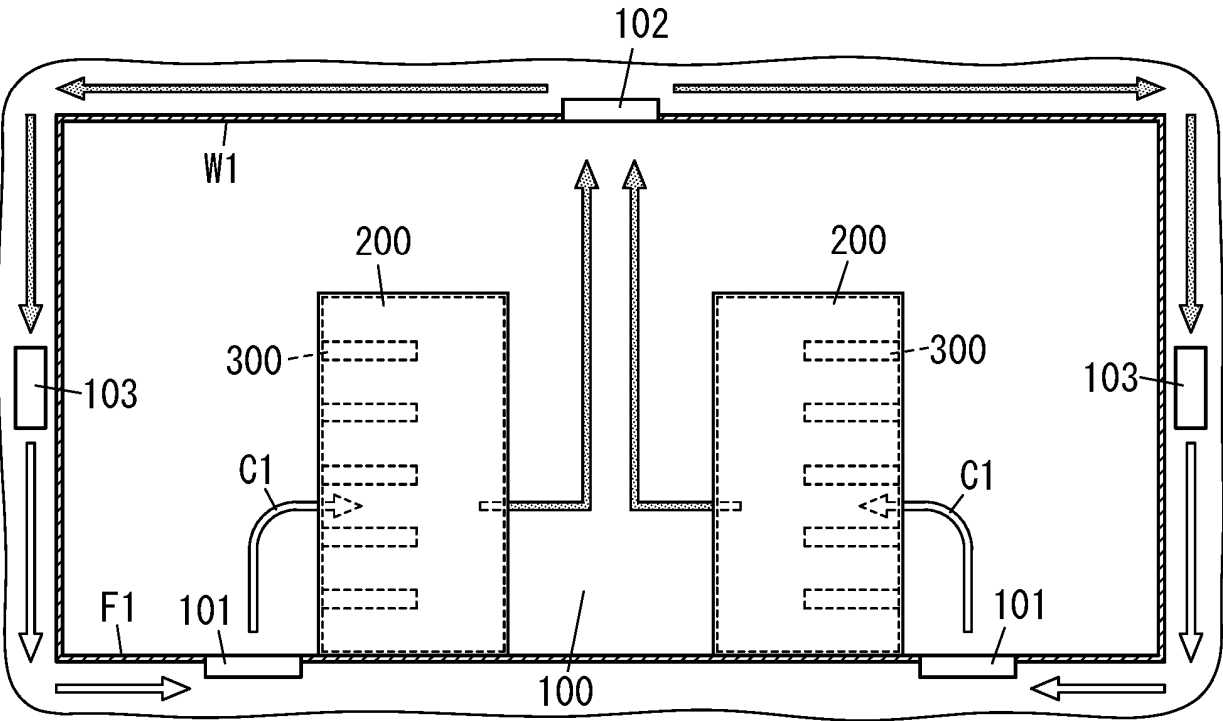


FIG. 3

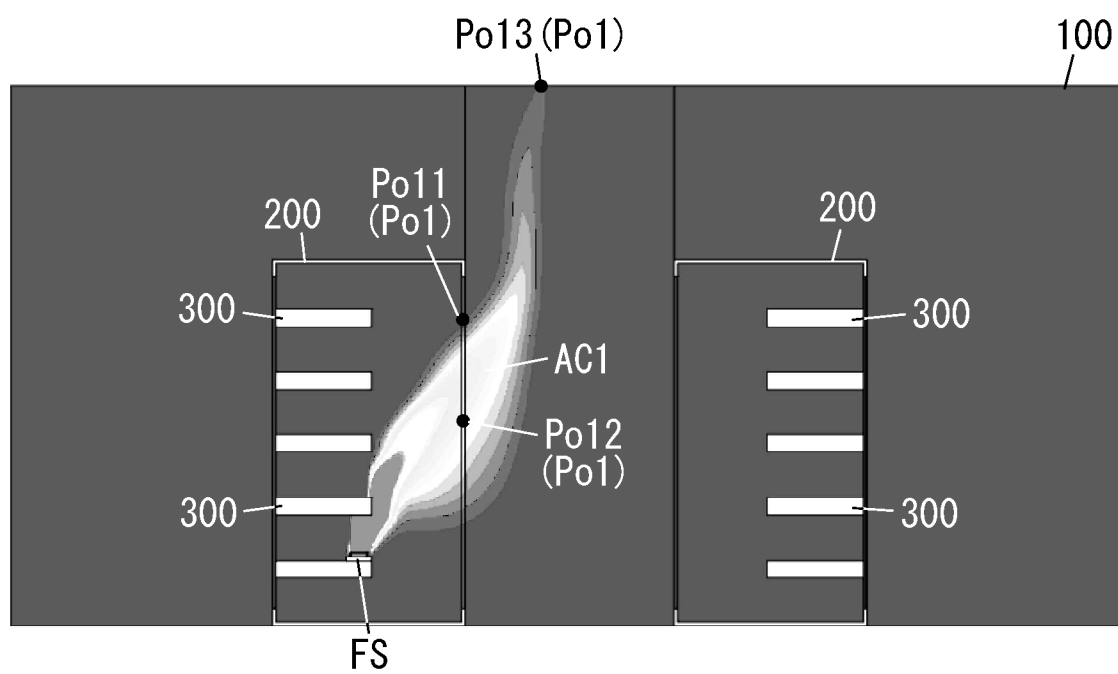


FIG. 4

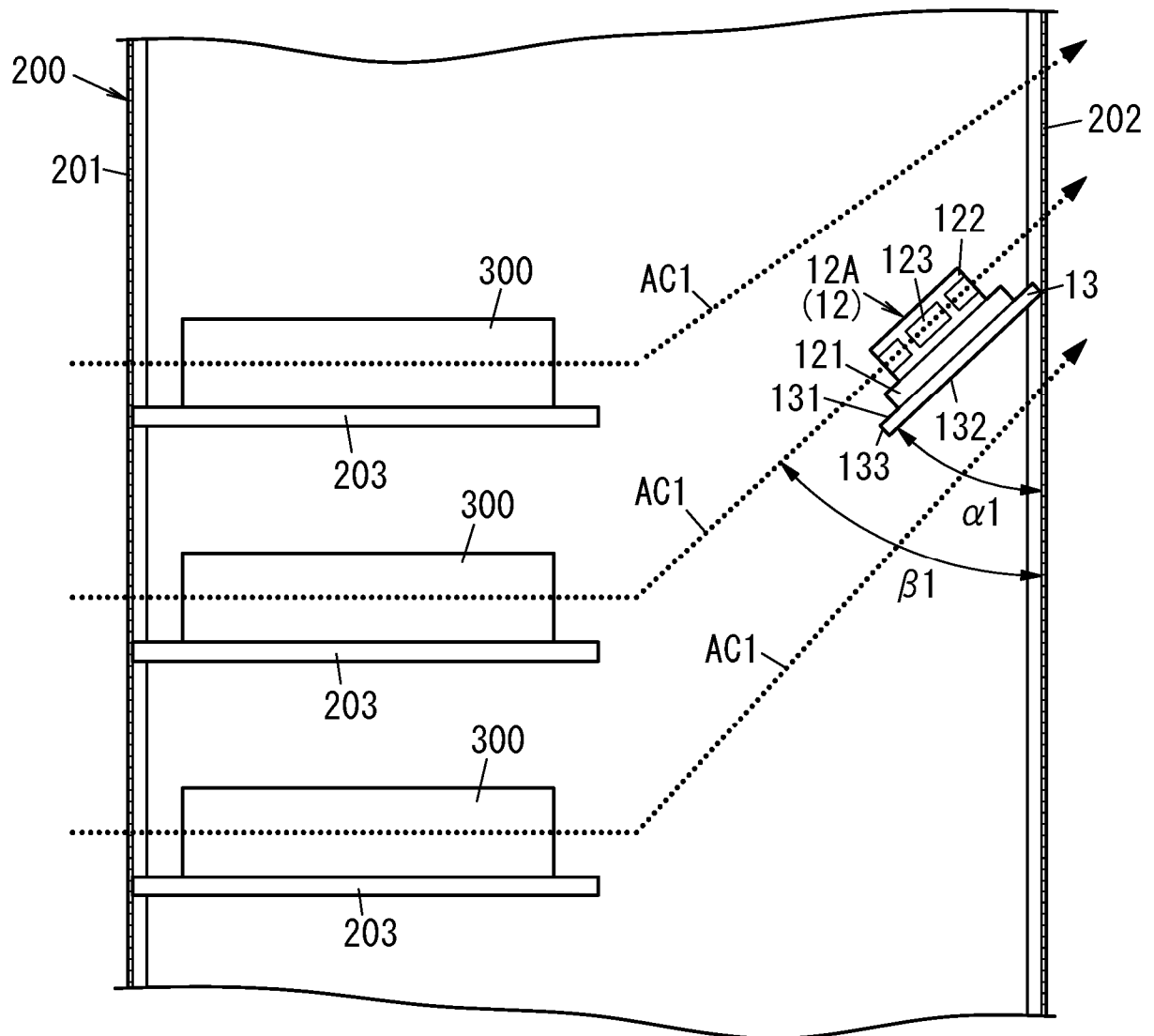


FIG. 5

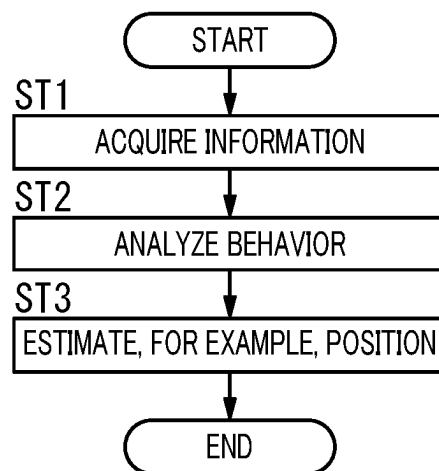


FIG. 6

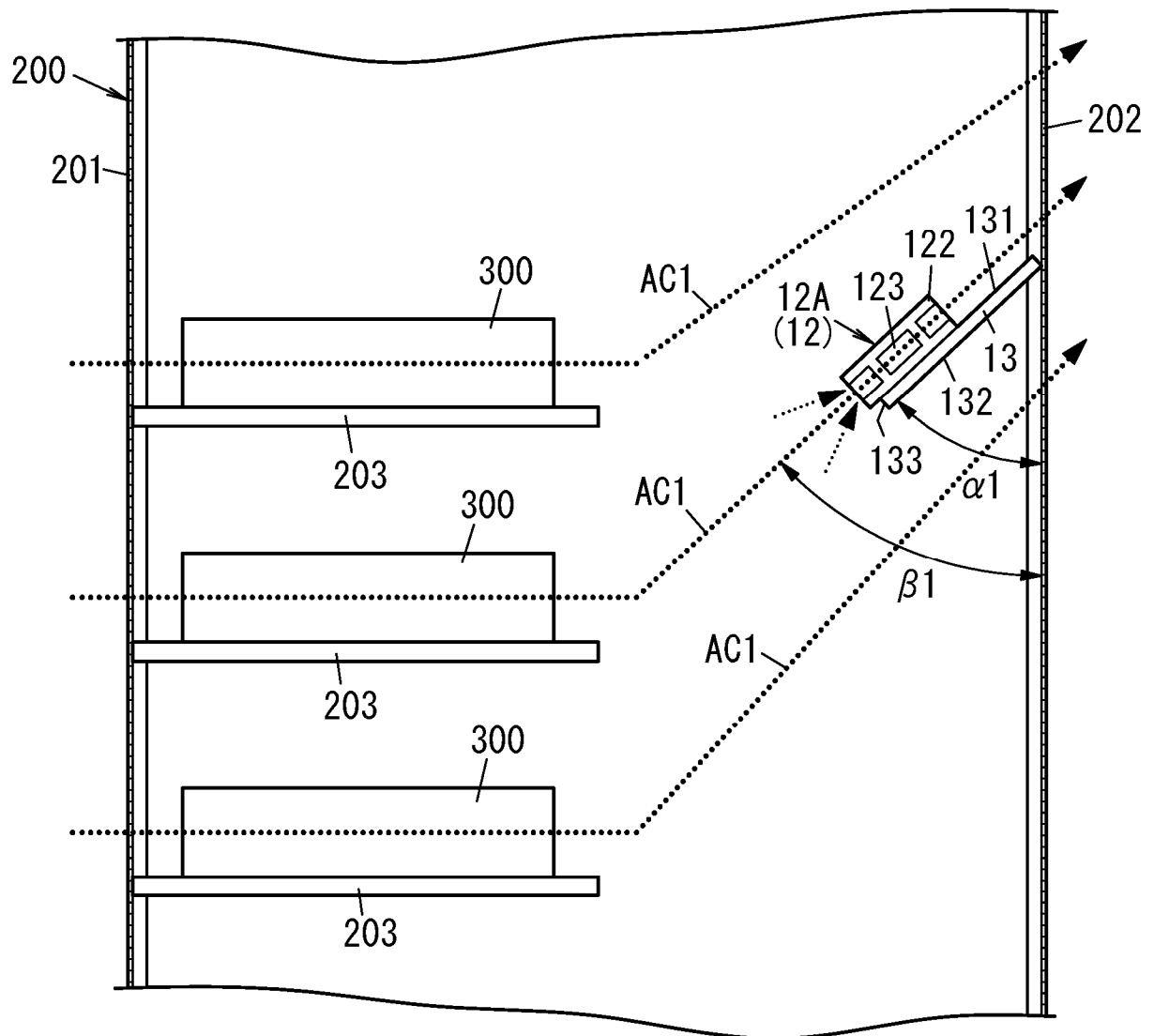
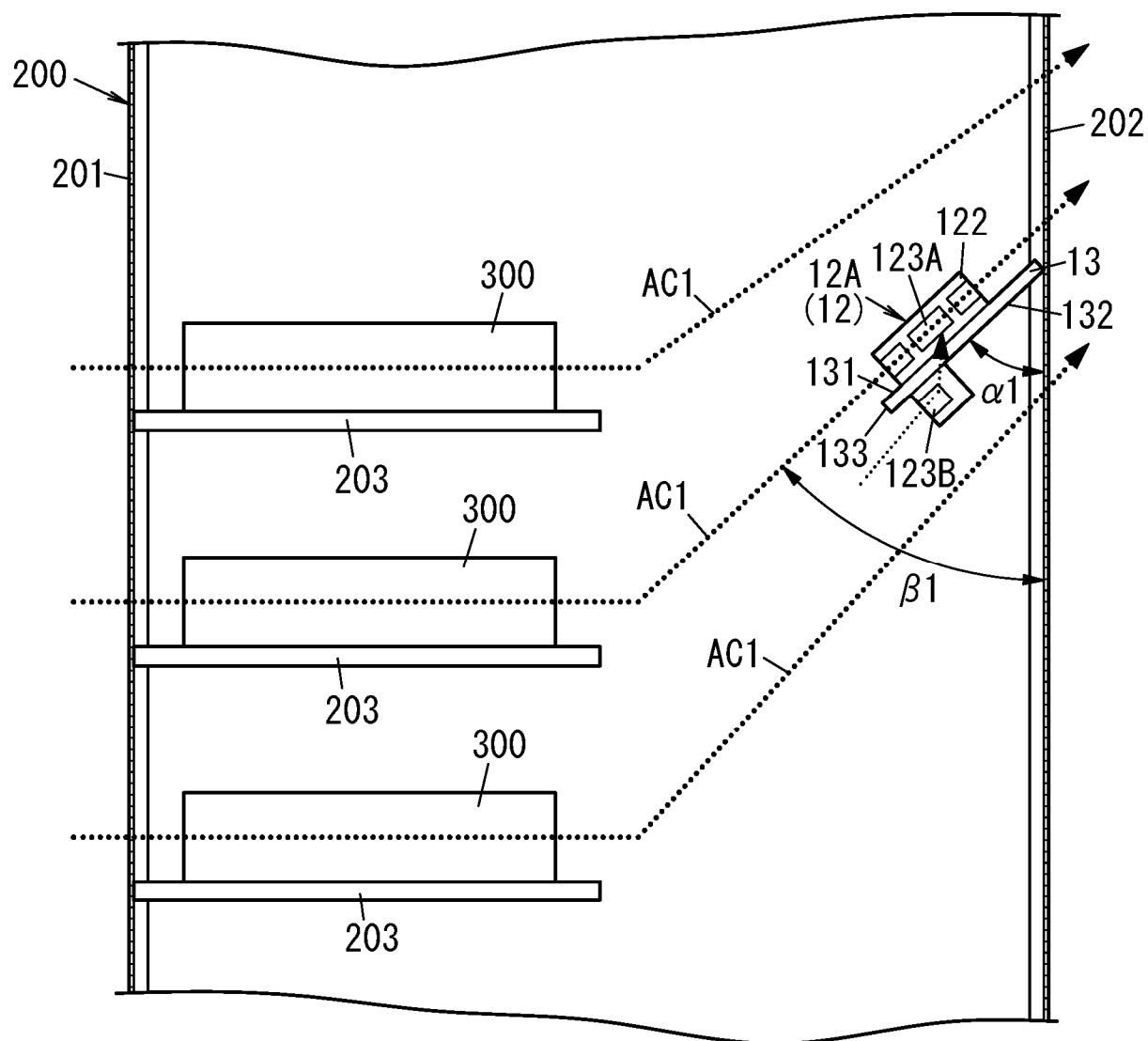


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/043198

A. CLASSIFICATION OF SUBJECT MATTER

G08B 17/117(2006.01)i; **G08B 17/00**(2006.01)i

FI: G08B17/117; G08B17/00 G; G08B17/00 C; G08B17/00 M

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)

G08B17/117; G08B17/00

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 1971-2025
 Registered utility model specifications of Japan 1996-2025
 Published registered utility model applications of Japan 1994-2025

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2023-148046 A (NIPPON DRY CHEM CO., LTD.) 13 October 2023 (2023-10-13) paragraphs [0004]-[0005], [0019]-[0020], [0035], fig. 2, etc.	1, 10-13 2-9, 14-16
Y A	JP 2006-215773 A (HOCHIKI CORP.) 17 August 2006 (2006-08-17) paragraphs [0018]-[0024], fig. 3, etc.	1, 10-13 2-9, 14-16
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 060631/1989 (Laid-open No. 003091/1991) (MATSUSHITA ELECTRIC WORKS, LTD.) 14 January 1991 (1991-01-14), entire text, all drawings	1-16
A	JP 2019-211860 A (PANASONIC INTELLECTUAL PROPERTY MANAGEMENT CO., LTD.) 12 December 2019 (2019-12-12) entire text, all drawings	1-16

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

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“&” document member of the same patent family

Date of the actual completion of the international search

30 January 2025

Date of mailing of the international search report

10 February 2025

Name and mailing address of the ISA/JP

Japan Patent Office (ISA/JP)
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 Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/JP2024/043198

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP	2023-148046	A	13 October 2023	(Family: none)	
JP	2006-215773	A	17 August 2006	(Family: none)	
JP	03-003091	U1	14 January 1991	(Family: none)	
JP	2019-211860	A	12 December 2019	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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