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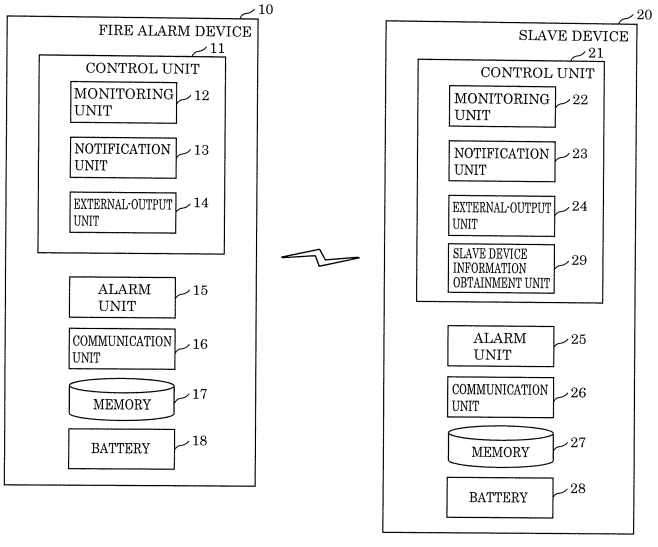
(54) FIRE ALARM DEVICE, FIRE ALARM SYSTEM, ABNORMALITY DETERMINATION METHOD, AND PROGRAM

(57) A fire alarm device (10), which wirelessly communicates with at least one slave device (20) and operates as a master device of the at least one slave device(20), includes: a monitoring unit (12) that monitors the at least one slave device (20) at regular or irregular time intervals to determine whether the at least one slave device (20) is in an abnormal condition; and an alarm unit (15) that issues an alarm indicating that the at least one slave device (20) is in an abnormal condition when the monitoring unit (12) determines that such slave device (20) is in an abnormal condition, wherein after a signal indicating battery exhaustion is received from any slave device (20), the monitoring unit (12) does not determine, in the monitoring, that such slave device (20) is in an abnormal condition even when radio waves cannot be received from such slave device (20).

FIG. 2



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Description

TECHNICAL FIELD

[0001] The present invention relates to a fire alarm device, a fire alarm system, an abnormality determination method of determining an abnormal condition in communication performed in the fire alarm system, and a program.

BACKGROUND ART

[0002] A fire alarm system is known that includes a master device and a plurality of slave devices. In such conventional fire alarm system, the master device and the slave devices wirelessly communicate with one another. Each of the master device and slave devices includes a fire detection sensor. A system is disclosed in which such a master device and a plurality of slave devices installed in different rooms wirelessly communicate with one another to notify about the detection results of their respective sensors. Through this, the master device and slave devices operate in conjunction with one another to issue a fire alarm (for example, patent literature (PTL) 1). With this structure, the system is capable of notifying a person in a room different from the one in which a fire is breaking out about the fire.

Citation List

Patent Literature

[0003] PTL 1: Japanese Unexamined Patent Application Publication No. 2012-4826

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0004] When the battery charge is exhausted (when the remaining battery has reached a predetermined level or below), the slave devices in the above fire alarm system output a voice message from their speakers indicating battery exhaustion. Assume, for example, that the battery charge of one of the slave devices is exhausted. Such slave device outputs a voice message indicating battery exhaustion. When a resident in a facility to which the fire alarm system is applied is away from the facility for a long period, for example, such slave device keeps outputting the voice message to exhaust its battery. Consequently, the slave device will go into an inactive state.

[0005] The master device monitors the slave devices at regular time intervals. More specifically, the master device sends, to each of the slave devices, a monitoring signal including a command that causes the slave device to send back a response indicating the own state of the slave device. In response to the monitoring signal, each of the slave devices sends back its own state. When failing to receive a response from a slave device to which the master device has sent the monitoring signal, for example, the master device outputs a voice message from its speaker indicating that such slave device is in an abnormal condition. Since the above one of the slave devices in an inactive state due to battery exhaustion cannot respond to the monitoring signal, the master device outputs a voice message indicating that such slave device is in an abnormal condition. When the resident is away from the facility for a long period, the master device also keeps outputting the voice message to exhaust its battery. Consequently, the master device will also go into an inactive state.

[0006] The slave devices recognize that the master device sends a monitoring signal at regular time intervals. As such, when failing to receive a monitoring signal from the master device, the slave devices output a voice message indicating that the master device is in an abnormal condition. Since the master device cannot send a monitoring signal when in an inactive state due to battery exhaustion as described above, the slave devices excluding the above one of the slave devices keep outputting the voice message indicating that the master device is in an abnormal condition. These slave devices also keep outputting the voice message, when the resident is away from the facility for a long period, to exhaust their batteries and consequently go into an inactive state.

[0007] As described above, the above fire alarm system has a problem that battery exhaustion of the master device and the slave devices occurs in a chained manner.

[0008] In view of the above, the present invention aims to provide a fire alarm device and so forth capable of preventing battery exhaustion that occurs in a chained manner.

SOLUTIONS TO PROBLEM

[0009] The fire alarm device according to an aspect of the present invention is a fire alarm device that wirelessly communicates with at least one slave device and operates as a master device of the at least one slave device. Such fire alarm device includes: a first monitoring unit that performs monitoring of the at least one slave device at regular or irregular time intervals to determine whether the at least one slave device is in an abnormal condition; and a first alarm unit that issues an alarm indicating that the at least one slave device is in an abnormal condition when the first monitoring unit determines that the at least one slave device is in an abnormal condition. In this fire alarm device, after a signal indicating battery exhaustion is received from any one of the at least one slave device, the first monitoring unit does not to determine, in the monitoring, that the slave device is in an abnormal condition even when radio waves cannot be received from the slave device.

[0010] The fire alarm system according to an aspect of the present invention includes the above fire alarm device and the at least one slave device.

[0011] The abnormality determination method according to an aspect of the present invention is an abnormality determination method of determining an abnormal condition in communication performed by a fire alarm device that wirelessly communicates with at least one slave device and operates as a master device of the at least one slave device. Such abnormality determination method includes: performing monitoring of the at least one slave device at regular or irregular time intervals to determine whether the at least one slave device is in an abnormal condition; and issuing an alarm indicating that the at least one slave device is in an abnormal condition when the at least one slave device is determined, in the performing of the monitoring, as being in an abnormal condition. In this abnormality determination method, after a signal indicating battery exhaustion is received from any one of the at least one slave device, the slave device is not determined, in the performing of the monitoring, as being in an abnormal condition even when radio waves cannot be received from the slave device.

[0012] The program according to an aspect of the present invention is a program that causes a computer to execute the above abnormality determination method.

ADVANTAGEOUS EFFECT OF INVENTION

[0013] The fire alarm device, etc. according to an aspect of the present invention prevents battery exhaustion that occurs in a chained manner.

BRIEF DESCRIPTION OF DRAWINGS

[0014]

FIG. 1 is a diagram showing an exemplary configuration of the fire alarm system according to the embodiment.

FIG. 2 is a diagram showing exemplary structures of a fire alarm device and a slave device according to the embodiment.

FIG. 3 is a flowchart of an exemplary basic operation performed by the fire alarm device according to the embodiment.

FIG. 4 is a flowchart of an exemplary abnormality determination operation performed by the fire alarm device according to the embodiment.

FIG. 5 is a flowchart of an exemplary basic operation performed by each slave device according to the embodiment.

FIG. 6 is a flowchart of an exemplary abnormality determination operation performed by each slave device according to the embodiment.

DESCRIPTION OF EXEMPLARY EMBODIMENT

[0015] The following describes in detail the embodiment according to the present invention with reference to the drawings. Note that the following embodiment shows a preferred specific example of the present invention. The numerical values, shapes, structural components, the arrangement and connection of the structural components, steps, the processing order of the steps, etc. shown in the following embodiment are mere examples, and thus are not intended to limit the present invention. Of the structural components described in the following embodiment, structural components not recited in any one of the independent claims that indicate the broadest concepts of the present invention will be described as optional structural components.

[0016] Also note that the drawings are schematic diagrams, and thus they are not necessarily precise illustrations. Also, the same structural components are assigned the same reference marks throughout the drawings.

EMBODIMENT

[0017] With reference to FIG. 1 through FIG. 6, the following describes the embodiment.

[0018] FIG. 1 is a diagram showing an exemplary configuration of fire alarm system 1 according to the embodiment.

[0019] Fire alarm system 1, which is applied to a facility such as a residence, is a system that detects a fire and issues an alarm about the outbreak of the fire. Fire alarm system 1 may also be applied to a facility such as an office and a commercial facility. Fire alarm system 1 includes fire alarm device 10 and at least one slave device 20, each having a fire detection sensor. Fire alarm device 10 and the at least one slave device 20 are installed, for example, on the ceilings, etc. of the facility, but may be installed on walls, etc. In the present embodiment, the at least one slave device 20 is a plurality of slave devices 20. Fire alarm device 10 operates as a master device of the at least one slave device 20. Note that to operate as the master device of the at least one slave device 20 refers to, for example, that the master device has the central role and performs the control, etc. of the at least one slave device 20. For example, fire alarm device 10 operates as the master device of the at least one slave device 20 by broadcasting a beacon signal and the at least one slave device 20 operates in accordance with the received beacon signal. Alternatively, fire alarm device 10 operates as the master device of the at least one slave device 20 by sending in unicast a control signal to each of the at least one slave device 20. Note that fire alarm device 10 differs from the at least one slave device 20 in that fire alarm device 10 serves as the master device. Other than this point, fire alarm device 10 and the at least one slave device 20 basically have the same functions (fire detection function, fire alarming function, etc.). For example, fire alarm device 10 and slave device 20 are different products (i.e., products with different product numbers), but they may be the same products. In this case, a user may select, from a plurality of products of the same specification, a product that will serve as fire alarm device 10 to function as the master device and a

product that will serve as slave device 20.

[0020] Fire alarm device 10 and the at least one slave device 20 wirelessly communicate with one another. For example, fire alarm device 10 and the at least one slave device 20 have undergone pairing to be capable of wirelessly communicating with one another. Fire alarm system 1 has a star network topology, for example, in which fire alarm device 10 is located at the center. This topology enables detection information indicating the outbreak of a fire to be shared among fire alarm device 10 and the at least one slave device 20, when any one of the fire detection sensors included in fire alarm device 10 and the at least one slave device 20 has detected the outbreak of the fire. As such, fire alarm device 10 and the at least one slave device 20 can issue a fire alarm in conjunction with one another. This also enables, for example, to notify a person in a room different from the one in which the fire is breaking out about an abnormal condition. Note that the network topology is not limited to having a star shape. For example, a plurality of slave devices 20 are not required to perform communication among one another via fire alarm device 10, and thus may perform communication directly among one another via slave device information obtainment unit 29 to be described later.

[0021] A frequency band to be used for wireless communication in fire alarm system 1 needs to be a band for security uses that ensures highly reliable communication with least interference waves. For example, wireless communication for fire alarms in Japan uses the frequency band between 426.25 MHz and 426.8375 MHz, inclusive, which is used by a radio station of a low power security system.

[0022] With reference to FIG. 2, the following describes the structures of fire alarm device 10 and slave device 20 included in fire alarm system 1.

[0023] FIG. 2 is a diagram showing exemplary structures of fire alarm device 10 and slave device 20 according to the embodiment. FIG. 2 omits the illustration of a fire detection sensor included in each of fire alarm device 10 and slave device 20. The sensor may detect a fire in any methods. The sensor may be, for example, an optical smoke detection sensor that detects a fire by detecting smoke generated by the fire, using scattered reflection of light. The sensor may also be, for example, a heat detection sensor that detects a fire by detecting heat generated by the fire. The sensor may also be, for example, a carbon monoxide detection sensor that detects a fire by detecting the concentration of carbon monoxide generated by the burning of the fire. The sensor may also be, for example, an infrared ray detection sensor that detects a fire by detecting an infrared ray radiated by the burning of the fire.

[0024] Fire alarm device 10 includes control unit 11, alarm unit 15, communication unit 16, memory 17, and battery 18. Fire alarm device 10 and slave device 20 have basically the same functions of detecting a fire and issuing an alarm about the outbreak of the fire as described above. As such, similar to fire alarm device 10, slave device 20 also includes control unit 21, alarm unit 25, communication unit 26, memory 27, and battery 28. The structural components of fire alarm device 10 and the structural components of slave device 20 have basically the same functions and thus these structural components will be described below in parallel.

[0025] Communication units 16 and 26 are communication interfaces for wireless communication between fire alarm device 10 and each of the at least one slave device 20, and each include an antenna, a transmitter-receiver circuit for a wireless signal, and so forth. Communication unit 16 wirelessly communicates with the at least one slave device 20 in response to an instruction from control unit 11, and communication unit 26 wirelessly communicates with fire alarm device 10 in response to an instruction from control unit 21.

[0026] Control unit 11 is a processing unit that controls alarm unit 15, communication unit 16, and memory 17. Control unit 21 is a processing unit that controls alarm unit 25, communication unit 26, and memory 27. Control units 11 and 21 are each implemented as, for example, a microcomputer. Control units 11 and 21 (microcomputers) are each an LSI, for example, that includes a ROM for holding a program, a RAM as a temporary storage region, a processor for executing a program, input and output circuits such as an A-D converter and a D-A converter, a counter timer, and so forth. Times in control units 11 and 21 are, for example, synchronized. Control unit 11 includes monitoring unit 12, notification unit 13, and external-output unit 14 as its functional structural components. These functional structural components are implemented by control unit 11 executing a program. Control unit 21 includes slave device information obtainment unit 29, in addition to monitoring unit 22, notification unit 23, and external-output unit 24 as its functional structural components. These functional structural components are implemented by control unit 21 executing a program.

[0027] Monitoring unit 12 is the first monitoring unit that monitors the at least one slave device 20 at regular or irregular time intervals to determine whether the at least one slave device 20 is in an abnormal condition. More specifically, at regular time intervals (e.g., every 24 hours, etc.), monitoring unit 12 sends (causes communication unit 16 to send), to each of the at least one slave device 20, a monitoring signal including a command that causes slave device 20 to send back the state of slave device 20. The state of slave device 20 refers to, for example, the states of the above-described sensor and alarm unit 25 included in slave device 20 (normal or abnormal), the remaining battery level of slave device 20, and so forth. Monitoring unit 12 determines, for example, that slave device 20 which has sent back a response indicating that these states are abnormal is in an abnormal condition. Monitoring unit 12 also determines that slave device 20 which has not responded to the monitoring signal (i.e., from which radio waves cannot be received) is in an abnormal condition.

[0028] Monitoring unit 22 is the second monitoring unit that monitors fire alarm device 10 at regular or irregular time intervals to determine whether fire alarm device 10 is in an abnormal condition. More specifically, monitoring unit 22 recognizes that fire alarm device 10 sends a monitoring signal at regular time intervals (e.g., every 24 hours, etc.). Here, to monitor fire alarm device 10 refers to monitoring whether fire alarm device 10 sends a monitoring signal at regular or irregular time intervals. When a monitoring signal is not sent from fire alarm device 10 at regular timings, for example, monitoring unit 22 determines that fire alarm device 10 is in an abnormal condition. Monitoring unit 22 may immediately determine that fire alarm device 10 is in an abnormal condition when, for example, a monitoring signal is not sent from fire alarm device 10 at regular timings. Alternatively, monitoring unit 22 may determine that fire alarm device 10 is in an abnormal condition when, for example, a monitoring signal is not sent from fire alarm device 10 at regular timings, and even after waiting for a predetermined period (e.g., an hour, etc.) thereafter. Monitoring unit 22 may also determine that fire alarm device 10 is in an abnormal condition when, for example, the failure of receiving a monitoring signal from fire alarm device 10 at regular timings has been repeated for a predetermined number of times.

[0029] Notification unit 13 sends (causes communication unit 16 to send) a signal indicating battery exhaustion to each of the at least one slave device 20 when the battery charge of fire alarm device 10 is exhausted. Similarly, notification unit 23 sends (causes communication unit 26 to send) a signal indicating battery exhaustion to fire alarm device 10 when the battery charge of slave device 20 is exhausted. Battery exhaustion refers to a state in which the remaining battery has reached a predetermined level or below. The measurement of the remaining battery level is possible, for example, by use of the A-D converter included in each of control units 11 and 21 (microcomputers). Control units 11 and 21 each measure the remaining battery level every predetermined time (e.g., every hour, etc.). Control units 11 and 21 each determine that the battery charge is exhausted when, for example, the remaining battery level of a 3.0 V battery has reached 2.8 V or below. Note, however, that the voltage to be determined as battery exhaustion is higher than the voltage at which fire alarm device 10 and slave device 20 go into an inactive state. For this reason, each of fire alarm device 10 and slave device 20 is capable of operating normally for a predetermined period (e.g., one month, etc.) after the battery charge is exhausted. The state of fire alarm device 10 and slave device 20 being inactive is also referred to as that the battery charge is completely exhausted.

[0030] External-output unit 14 is the first external-output unit that outputs (causes communication unit 16 to send), to an external device, information indicating that the at least one slave device is in an abnormal condition. Similarly, external-output unit 24 is the second external-output unit that outputs (causes communication unit 26 to send), to the external device, information indicating that fire alarm device 10 is in an abnormal condition. The external device is, for example, a mobile terminal such as a smartphone and a tablet. Note that the external device is not limited to a mobile terminal, and thus may be any Internet of Things (IoT) device. Communication units 16 and 26 are connected to the external device, for example, via a gateway to be capable of communication. For the case where the network between fire alarm device 10 and slave device 20 and the network between fire alarm device 10 and the gateway are compliant with different protocols, communication unit 16 may include an antenna and a transmitter-receiver circuit for communication with the gateway, in addition to the antenna and the transmitter-receiver circuit for communication with slave device 20. Similarly, communication unit 26 may include an antenna and a transmitter-receiver circuit for communication with the gateway, in addition to the antenna and the transmitter-receiver circuit for communication with fire alarm device 10. This structure enables the resident of the facility to see that fire alarm device 10 or the at least one slave device 20 is in an abnormal condition by use of the external device (mobile terminal, etc.) when, for example, the resident is away from the facility.

[0031] Slave device information obtainment unit 29 included in control unit 21 of slave device 20 will be described later.

[0032] Alarm unit 15 is the first alarm unit that issues an alarm indicating that the at least one slave device 20 is in an abnormal condition when monitoring unit 12 determines that the at least one slave device 20 is in an abnormal condition. Similarly, alarm unit 25 is the second alarm unit that issues an alarm indicating that fire alarm device 10 is in an abnormal condition when monitoring unit 22 determines that fire alarm device 10 is in an abnormal condition. Note that alarm units 15 and 25 are units that issue an alarm about a fire in the event of the fire. Alarm units 15 and 25 may issue an alarm about an abnormal condition or the outbreak of a fire in any methods. For example, alarm units 15 and 25 may be speakers or buzzers to issue an alarm about an abnormal condition or the outbreak of a fire by voice or buzzer sound. For example, alarm units 15 and 25 issue an alarm about a fire in the event of the fire. Alarm unit 15 issues an alarm about the details of an abnormal condition of slave device 20 when slave device 20 is in an abnormal condition. When communication unit 16 fails to receive radio waves from slave device 20, for example, alarm unit 15 issues an alarm (outputs a voice message) indicating that an abnormality is present in communication with slave device 20. Alarm unit 25 issues an alarm about the details of an abnormal condition of fire alarm device 10 when fire alarm device 10 is in an abnormal condition. When communication unit 26 fails to receive radio waves from fire alarm device 10, for example, alarm unit 25 issues an alarm (outputs a voice message) indicating that an abnormality is present in communication with fire alarm

device 10. In many cases, a voice message indicating an abnormal condition in communication, etc., is outputted every several tens of seconds, which consumes a large amount of battery.

[0033] Memories 17 and 27 are each, for example, a ROM and a RAM, and may store a program executed by control units 11 and 21. Memory 17 is the storage unit that stores information that includes the following pieces of information in association with each other: address information of slave device 20 which has sent a signal indicating battery exhaustion among the at least one slave device 20; and information indicating battery exhaustion. A signal indicating battery exhaustion to be sent from notification unit 23 to fire alarm device 10 when the battery charge of slave device 20 is exhausted includes the address information (e.g., media access control (MAC) address or logical address, etc.) of such battery-exhausted slave device. Control unit 11 stores the address information and the information indicating battery exhaustion into memory 17 in association with each other when communication unit 16 receives the signal indicating battery exhaustion. When communication unit 26 receives a signal indicating battery exhaustion from fire alarm device 10, memory 27 stores information indicating that the battery charge of fire alarm device 10 is exhausted. Since one master device (fire alarm device 10) is present for the at least one slave device, memory 27 does not need to store the address information of fire alarm device 10. Note that similar to memory 17, memory 27 may store information that includes the address information of fire alarm device 10 which has sent a signal indicating battery exhaustion and the information indicating battery exhaustion in association with each other.

[0034] Batteries 18 and 28 are power sources for driving fire alarm device 10 and slave device 20, respectively. Examples of batteries 18 and 28 include, but not limited to, a lithium battery.

[0035] With reference to FIG. 3 and FIG. 4, the following describes an operation performed by fire alarm device 10.

[0036] FIG. 3 is a flowchart of an exemplary basic operation performed by fire alarm device 10 according to the embodiment.

[0037] Monitoring unit 12 monitors the at least one slave device 20 (step S11) to determine whether the at least one slave device 20 is in an abnormal condition (step S12). When monitoring unit 12 determines that the at least one slave device 20 is in an abnormal condition (Yes in step S 12), alarm unit 15 issues an alarm indicating that the at least one slave device 20 is in an abnormal condition (step S13). Here, after communication unit 16 receives a signal indicating battery exhaustion from any one of the at least one slave device 20, monitoring unit 12 does not determine that such slave device 20 is in an abnormal condition even when radio waves cannot be received from such slave device 20 in the monitoring of slave device 20 which has sent the signal indicating battery exhaustion. This will be described below with reference to FIG. 4.

[0038] FIG. 4 is a flowchart of an exemplary abnormality determination operation performed by fire alarm device 10 according to the embodiment.

[0039] First, monitoring unit 12 (communication unit 16) receives a signal indicating battery exhaustion from any one of the at least one slave device 20 (step S21). As described above, since notification unit 23 included in slave device 20, the battery charge of which is exhausted, sends a signal indicating battery exhaustion to fire alarm device 10, monitoring unit 12 can receive the signal indicating battery exhaustion.

[0040] When this is done, information that includes the following pieces of information is stored into memory 17 in association with each other: the address information of slave device 20 which has sent the signal indicating battery exhaustion; and the information indicating battery exhaustion.

[0041] When the signal indicating battery exhaustion is received from any one of the at least one slave device 20, external-output unit 14 outputs, to an external device, information indicating that the battery charge of such slave device 20 is exhausted. This enables the resident of the facility to see that the battery charge of slave device 20 is exhausted by use of the external device (mobile terminal, etc.), when, for example, the resident is away from the facility.

[0042] Monitoring unit 12 keeps monitoring slave device 20 at regular time intervals even after the signal indicating battery exhaustion is received from such slave device 20 to determine whether a response to the monitoring signal can be received from such slave device 20 (stated differently, whether radio waves can be received from slave device 20) (step S22). As described above, slave devices 20 are capable of normally operating for a predetermined period (e.g., one month) even after the battery charge is exhausted. As such, a determination can be made of an abnormal condition in communication that is not attributable to battery exhaustion within such predetermined period after the battery charge of slave device 20 is exhausted.

[0043] When radio waves can be received from such slave device 20 (Yes in step S22), monitoring unit 12 does not determine that slave device 20 is in an abnormal condition (step S23). Stated differently, alarm unit 15 does not issue an alarm about an abnormal condition of slave device 20. Note, however, that monitoring unit 12 may determine that slave device 20 is in an abnormal condition when the radio waves carry information indicating that such slave device 20 is in an abnormal condition, and alarm unit 15 may issue an alarm indicating that slave device 20 is in an abnormal condition.

[0044] When radio waves cannot be received from such slave device 20 (No in step S22), monitoring unit 12 determines whether the current time is within the predetermined period from the point in time when the signal indicating battery exhaustion is received (step S24). The process of step S24 is achieved by use of the function

of the counter timer, etc., included in control unit 11 (microcomputer).

[0045] When radio waves cannot be received from the at least one of slave device 20 within the predetermined period after the point in time when the signal indicating battery exhaustion is received from such slave device 20, even after the signal indicating battery exhaustion is received from such slave device 20 (Yes in step S24), monitoring unit 12 determines that such slave device 20 is in an abnormal condition (step S25). Stated differently, alarm unit 15 issues an alarm about the abnormal condition of such slave device 20. Such slave device 20 is supposed to be capable of operating normally within the predetermined period even after the battery charge is exhausted. As such, the failure of receiving radio waves from slave device 20 within the predetermined period suggests that such slave device 20 is likely to be in an abnormal condition that does not allow slave device 20 to respond to the monitoring signal due to a cause different from battery exhaustion. Note that in the monitoring of the at least one slave device at regular time intervals, monitoring unit 12 compares the address information of slave device 20 from which radio waves cannot be received with the address information stored in memory 17 to determine whether the at least one slave device 20 (slave device 20 from which radio waves cannot be received) is in an abnormal condition. Through this, monitoring unit 12 can determine whether slave device 20 from which radio waves cannot be received is slave device 20 which has sent the signal indicating battery exhaustion.

[0046] Meanwhile, when radio waves cannot be received from slave device 20 after the predetermined time from the point in time when the signal indicating battery exhaustion is received from such slave device 20 (No in step S24), monitoring unit 12 determines that such slave device 20 is not in an abnormal condition (step S23). Stated differently, alarm unit 15 does not issue an alarm about an abnormal condition of slave device 20. The failure of receiving radio waves from slave device 20 after the predetermined time suggests that the battery charge of such slave device 20 is completely exhausted and slave device 20 is in an inactive state.

[0047] This structure enables monitoring unit 12 not to determine that slave device 20 is in an abnormal condition in communication due to battery exhaustion, thus preventing alarm unit 15 from issuing an alarm indicating that slave device 20 is in an abnormal condition. The prevention of alarm unit 15 from issuing an alarm indicating that slave device 20 is in an abnormal condition prevents battery exhaustion of fire alarm device 10. This structure thus prevents battery exhaustion that occurs in a chained manner. More specifically, this structure prevents the battery charge of fire alarm device 10 from being exhausted in a chained manner, following slave device 20, the battery charge of which is exhausted.

[0048] When radio waves cannot be received from any one of the at least one slave device 20 after the signal indicating battery exhaustion is received from such slave device 20, external-output unit 14 outputs to the external device information indicating that such slave device 20 is in an inactive state. This enables the resident of the facility to see that the battery charge of such slave device 20 is completely exhausted by use of the external device (mobile terminal, etc.), when, for example, the resident is away from the facility.

[0049] With reference to FIG. 5 and FIG. 6, the following describes the operation performed by slave device 20.

[0050] FIG. 5 is a flowchart of an exemplary basic operation performed by each slave device 20 according to the embodiment.

[0051] Monitoring unit 22 monitors fire alarm device 10 (step S31) to determine whether fire alarm device 10 is in an abnormal condition (step S32). When monitoring unit 22 determines that fire alarm device 10 is in an abnormal condition (Yes in S32), alarm unit 25 issues an alarm indicating that fire alarm device 10 is in an abnormal condition (step S33). Here, after communication unit 26 receives a signal indicating battery exhaustion from fire alarm device 10, monitoring unit 22 does not determine that fire alarm device 10 is in an abnormal condition even when radio waves cannot be received from fire alarm device 10 in the monitoring of fire alarm device 10. This will be described below with reference to FIG. 6.

[0052] FIG. 6 is a flowchart of an exemplary abnormality determination operation performed by each slave device 20 according to the embodiment.

[0053] First, monitoring unit 22 (communication unit 26) receives a signal indicating battery exhaustion from fire alarm device 10 (step S41). As described above, since notification unit 13 included in fire alarm device 10, the battery charge of which is exhausted, sends a signal indicating battery exhaustion to the at least one slave device 20, monitoring unit 22 can receive the signal indicating battery exhaustion.

[0054] When this is done, information indicating that the battery charge of fire alarm device 10 is exhausted is stored into memory 17.

[0055] When a signal indicating battery exhaustion is received from fire alarm device 10, external-output unit 24 outputs to the external device information indicating that the battery charge of fire alarm device 10 is exhausted. This enables the resident of the facility to see that the battery charge of fire alarm device 10 is exhausted by use of the external device (mobile terminal, etc.), when, for example, the resident is away from the facility.

[0056] Monitoring unit 22 keeps monitoring fire alarm device 10 at regular time intervals even after the signal indicating battery exhaustion is received from fire alarm device 10 to determine whether a monitoring signal is sent from fire alarm device 10 (stated differently, whether radio waves can be received from fire alarm device 10) (step S42). As described above, fire alarm device 10 is supposed to be capable of normally operating for a predetermined period (e.g., one month) even after the bat-

tery charge is exhausted. As such, a determination can be made of an abnormal condition in communication that is not attributable to battery exhaustion within such predetermined period after the battery charge of fire alarm device 10 is exhausted.

[0057] When radio waves can be received from fire alarm device 10 (Yes in step S42), monitoring unit 22 does not determine that fire alarm device 10 is in an abnormal condition (step S43). Stated differently, alarm unit 25 does not issue an alarm about an abnormal condition of fire alarm device 10. Note, however, that monitoring unit 22 may determine that fire alarm device 10 is in an abnormal condition when the radio waves carry information indicating that fire alarm slave device 10 is in an abnormal condition.

[0058] When radio waves cannot be received from fire alarm device 10 (No in step S42), monitoring unit 22 determines whether the current time is within a predetermined period from the point in time when the signal indicating battery exhaustion is received (step S44). The process of step S44 is achieved by use of the function of the counter timer, etc., included in controller 21 (microcomputer).

[0059] When radio waves cannot be received from fire alarm device 10 within the predetermined period after the point in time when the signal indicating battery exhaustion is received from fire alarm device 10, (Yes in step S44), monitoring unit 22 determines that fire alarm device 10 is in an abnormal condition (step S45). Stated differently, alarm unit 25 issues an alarm about the abnormal condition of fire alarm device 10. Fire alarm device 10 is supposed to be capable of operating normally within the predetermined period even after the battery charge is exhausted. As such, the failure of receiving radio waves from fire alarm device 10 within the predetermined period suggests that fire alarm device 10 is likely to be in an abnormal condition that does not allow fire alarm device 10 to send a monitoring signal due to a cause different from battery exhaustion.

[0060] Meanwhile, when radio waves cannot be received from fire alarm device 10 after the predetermined time from the point in time when the signal indicating battery exhaustion is received from fire alarm device 10 (No in step S44), monitoring unit 22 does not determine that fire alarm device 10 is in an abnormal condition, i.e., determines that such slave device 20 is not in an abnormal condition (step S43). Stated differently, alarm unit 25 does not issue an alarm about an abnormal condition of fire alarm device 10. The failure of receiving radio waves from fire alarm device 10 after the predetermined time suggests that the battery charge of fire alarm device 10 is completely exhausted and fire alarm device 10 is in an inactive state.

[0061] This structure enables monitoring unit 22 not to determine that fire alarm device 10 is in an abnormal condition in communication due to battery exhaustion, thus preventing alarm unit 25 from issuing an alarm indicating that fire alarm device 10 is an abnormal condition. The prevention of alarm unit 25 from issuing an alarm indicating that fire alarm device 10 is in an abnormal condition prevents battery exhaustion of slave device 20. This structure thus prevents battery exhaustion that occurs in a chained manner. More specifically, this structure prevents the battery charge of slave device 20 from being exhausted in a chained manner, following fire alarm device 10, the battery charge of which is exhausted.

[0062] When radio waves cannot be received from fire alarm device 10 after the signal indicating battery exhaustion is received from fire alarm device 10, external-output unit 24 outputs to the external device information indicating that fire alarm device 10 is in an inactive state. This enables the resident of the facility to see that the battery charge of fire alarm device 10 is completely exhausted by use of the external device (mobile terminal, etc.), when, for example, the resident is away from the facility.

[0063] The at least one slave device 20 according to the present embodiment is a plurality of slave devices 20, each of which includes slave device information obtainment unit 29 that obtains information from another slave device 20 when radio waves cannot be received from fire alarm device 10. Fire alarm system 1 has a star network topology in which fire alarm device 10 is located at the center of the network. For this reason, when the battery charge of fire alarm device 10 is completely exhausted, slave devices 20 cannot possibly operate in conjunction with each other to issue a fire alarm.

[0064] In view of this, slave device information obtainment unit 29 directly obtains (causes communication unit 26 to receive), from another slave device 20, a detection result of the fire detection sensor included in such another slave device 20. This enables slave devices 20 to share detection information indicating the outbreak of a fire and operate in conjunction with each other to issue a fire alarm, even when fire alarm device 10 is in an inactive state. Note that slave device information obtainment unit 29 may obtain information from another slave device 20 when radio waves can be received from fire alarm device 10.

[0065] As described above, fire alarm device 10 according to the present embodiment is a fire alarm device that wirelessly communicates with at least one slave device 20 and operates as a master device of the at least one slave device 20. Fire alarm device 10 includes: monitoring unit 12 that performs monitoring of the at least one slave device 20 at regular time intervals to determine whether the at least one slave device 20 is in an abnormal condition; and alarm unit 15 that issues an alarm indicating that the at least one slave device 20 is in an abnormal condition when monitoring unit 12 determines that the at least one slave device 20 is in an abnormal condition. After a signal indicating battery exhaustion is received from any one of the at least one slave device 20, monitoring unit 12 does not to determine, in the monitoring, that slave device 20 is in an abnormal condition even

when radio waves cannot be received from such slave device 20.

[0066] This structure enables monitoring unit 12 not to determine that slave device 20 is in an abnormal condition in communication due to battery exhaustion, thus preventing alarm unit 15 from issuing an alarm indicating that slave device 20 is in an abnormal condition. The prevention of alarm unit 15 from issuing an alarm indicating that slave device 20 is in an abnormal condition prevents battery exhaustion of fire alarm device 10. This structure thus prevents battery exhaustion that occurs in a chained manner. More specifically, this structure prevents the battery charge of fire alarm device 10 from being exhausted in a chained manner, following slave device 20, the battery charge of which is exhausted.

[0067] Also, when the radio waves cannot be received from slave device 20 within a predetermined period after a point in time when the signal indicating battery exhaustion is received from such slave device 20, monitoring unit 12 may determine that slave device 20 is in an abnormal condition.

[0068] With this structure, slave device 20 normally operates for a predetermined period (e.g., one month), for example, even after the battery charge is exhausted. As such, a determination can be made of an abnormal condition in communication that is not attributable to battery exhaustion within such predetermined period after the battery charge of slave device 20 is exhausted.

[0069] Also, fire alarm device 10 may further include memory 17 storing information that includes address information of slave device 20 and information indicating battery exhaustion in association with each other. Here, such slave device 20 is one of the at least one slave device 20 that has sent the signal indicating battery exhaustion. In performing the monitoring at regular time intervals, monitoring unit 12 may compare the address information of slave device 20 from which the radio waves cannot be received with address information stored in memory 17 to determine whether the at least one slave device 20 is in an abnormal condition.

[0070] This structure enables monitoring unit 12 to determine whether slave device 20 from which the radio waves cannot be received is slave device 20 which has sent the signal indicating battery exhaustion.

[0071] Also, fire alarm device 10 may further include external-output unit 14 that outputs, to an external device, information indicating that the at least one slave device 20 is in an abnormal condition.

[0072] This structure enables the resident of the facility to which fire alarm system 1 is applied to see that the at least one slave device 20 is in an abnormal condition by use of the external device (mobile terminal, etc.), when, for example, the resident is away from the facility.

[0073] Also, when the signal indicating battery exhaustion is received from any one of the at least one slave device 20, external-output unit 14 may output, to the external device, information indicating that a battery charge of the slave device 20 is exhausted.

[0074] This structure enables the resident of the facility to see that the battery charge of slave device 20 is exhausted by use of the external device (mobile terminal, etc.), when, for example, the resident is away from the facility.

[0075] Also, when the signal indicating battery exhaustion is received from any one of the at least one slave device 20 and the radio waves cannot be received from such slave device 20 thereafter, external-output unit 14 may output, to the external device, information indicating that such slave device 20 is in an inactive state.

[0076] This structure enables the resident of the facility to see that the battery charge of slave device 20 is completely exhausted by use of the external device (mobile terminal, etc.), when, for example, the resident is away from the facility.

[0077] Also, fire alarm device 10 may further include notification unit 13 that sends a signal indicating battery exhaustion to the at least one slave device 20 when a battery charge of fire alarm device 10 is exhausted. Further, the at least one slave device 20 may include: monitoring unit 22 that monitors fire alarm device 10 at regular time intervals to determine whether fire alarm device 10 is in an abnormal condition; and alarm unit 25 that issues an alarm indicating that fire alarm device 10 is in an abnormal condition when monitoring unit 22 determines that fire alarm device 10 is in an abnormal condition. Here, monitoring unit 22 may not determine, in the monitoring, that fire alarm device 10 is in an abnormal condition, even when radio waves cannot be received from fire alarm device 10, after the signal indicating battery exhaustion is received from fire alarm device 10.

[0078] This structure enables monitoring unit 22 not to determine that fire alarm device 10 is in an abnormal condition in communication due to battery exhaustion, thus preventing alarm unit 25 from issuing an alarm indicating that fire alarm device 10 is in an abnormal condition. The prevention of alarm unit 25 from issuing an alarm indicating that fire alarm device 10 is in an abnormal condition prevents battery exhaustion of slave device 20. This structure thus prevents battery exhaustion that occurs in a chained manner. More specifically, this structure prevents the battery charge of slave device 20 from being exhausted in a chained manner, following fire alarm device 10, the battery charge of which is exhausted.

[0079] Also, monitoring unit 22 may determine that fire alarm device 10 is in an abnormal condition when the radio waves cannot be received from fire alarm device 10 within a predetermined period after a point in time when the signal indicating battery exhaustion is received from fire alarm device 10.

[0080] With this structure, fire alarm device 10 normally operates for a predetermined period (e.g., one month), for example, even after the battery charge is exhausted. As such, a determination can be made of an abnormal condition in communication that is not attributable to battery exhaustion within such predetermined period after

the battery charge of fire alarm device 10 is exhausted.

[0081] Also, the at least one slave device 20 may further include external-output unit 24 that outputs, to an external device, information indicating that fire alarm device 10 is in an abnormal condition.

[0082] This structure enables the resident of the facility to which fire alarm system 1 is applied to see that fire alarm device 10 is in an abnormal condition by use of the external device (mobile terminal, etc.), when, for example, the resident is away from the facility.

[0083] Also, external-output unit 24 may output, to the external device, information indicating that the battery charge of fire alarm device 10 is exhausted when the signal indicating battery exhaustion is received from fire alarm device 10.

[0084] This structure enables the resident of the facility to see that the battery charge of fire alarm device 10 is exhausted by use of the external device (mobile terminal, etc.), when, for example, the resident is away from the facility.

[0085] Also, external-output unit 24 may output, to the external device, information indicating that fire alarm device 10 is in an inactive state when the radio waves cannot be received from fire alarm device 10 after the signal indicating battery exhaustion is received from fire alarm device 10.

[0086] This structure enables the resident of the facility to see that the battery charge of fire alarm device 10 is completely exhausted by use of the external device (mobile terminal, etc.), when, for example, the resident is away from the facility.

[0087] Also, the at least one slave device 20 may comprise a plurality of slave devices 20, and each of the plurality of slave devices 20 may further include slave device information obtainment unit 29 that obtains information from another one of the plurality of slave devices 20 when the radio waves cannot be received from fire alarm device 10.

[0088] This structure enables slave devices 20 to share detection information indicating the outbreak of a fire and operate in conjunction with each other, even when fire alarm device 10 is in an inactive state.

[0089] Also, fire alarm system 1 according to the present embodiment includes fire alarm device 10 and at least one slave device 20.

[0090] This structure provides fire alarm system 1 capable of preventing battery exhaustion that occurs in a chained manner.

OTHER EMBODIMENTS

[0091] Fire alarm device 10 according to the embodiment has been described above, but the present invention is not limited to the above embodiment.

[0092] For example, monitoring unit 12 according to the embodiment monitors the at least one slave device 20 at regular time intervals (e.g., every 24 hours, etc.), but may monitor the at least one slave device 20 at irregular time intervals (e.g., at random timings). Also, monitoring unit 22 monitors fire alarm device 10 at regular time intervals, but may monitor fire alarm device 10 at irregular time intervals.

[0093] Also, for example, when radio waves cannot be received from slave device 20 within the predetermined period after the point in time when a signal indicating battery exhaustion is received from such slave device 20, monitoring unit 12 according to the embodiment determines that such slave device 20 is in an abnormal condition, but such process may not be performed. Stated differently, monitoring unit 12 may determine that slave device 20 is not in an abnormal condition when radio waves cannot be received from such slave device 20 within the predetermined period after the point in time when the signal indicating battery exhaustion is received form such slave device 20.

[0094] Also, for example, memory 17 according to the embodiment stores information that includes the address information of slave device 20, among the at least one slave device 20, which has sent the signal indicating battery exhaustion and the information indicating battery exhaustion in association with each other, but may not store such information.

[0095] Also, for example, fire alarm device 10 according to the embodiment includes external-output unit 14, but may not include it.

[0096] Also, for example, fire alarm device 10 according to the embodiment includes notification unit 13, but may not include it. Stated differently, slave device 20 may not receive a signal indicating battery exhaustion from fire alarm device 10, and may not have the function of preventing battery exhaustion that occurs in a chained manner.

[0097] Also, for example, the at least one slave device 20 according to the embodiment includes external-output unit 24, but may not include it.

[0098] Also, for example, each of the at least one slave device 20 according to the embodiment includes slave device information obtainment unit 29, but may not include it.

[0099] Also, for example, the at least one slave device 20 according to the embodiment is a plurality of slave devices 20, but may be one slave device 20.

[0100] Also, for example, fire alarm device 10 in fire alarm system 1 may serve as slave device 20, and any one of the at least one slave device 20 may serve as fire alarm device 10.

[0101] Also, the present invention is embodied not only as fire alarm device 10, but also as an abnormality determination method that includes steps (processes) to be performed by the structural components included in fire alarm device 10.

[0102] More specifically, such abnormality determination method is a method of determining an abnormal condition in communication performed by fire alarm device 10 that wirelessly communicates with at least one slave device 20 and operates as a master device of the at least

one slave device 20. Such abnormality determination method includes, as shown in FIG. 3, performing monitoring of the at least one slave device 20 at regular time intervals to determine whether the at least one slave device 20 is in an abnormal condition (step S11 and step S12); and issuing an alarm indicating that the at least one slave device 20 is in an abnormal condition when the at least one slave device 20 is determined, in the performing of the monitoring, as being in an abnormal condition (Yes in step S12) (step S13). As shown in FIG, 4, after a signal indicating battery exhaustion is received from any one of the at least one slave device 20 (step S21), such slave device 20 is not determined, in the performing of the monitoring, as being in an abnormal condition (step S23) even when radio waves cannot be received from such slave device 20 (No in step S22).

[0103] Also, the present invention is embodied not only as fire alarm system 1, but also as a method that includes steps (processes) to be performed by the structural components included in fire alarm system 1.

[0104] These steps may be executed, for example, by a computer (computer system). The present invention is embodied as a program that causes the computer to execute the steps included in such method. The present invention is further embodied as a non-transitory, computer-readable recording medium, such as a CD-ROM, storing such program.

[0105] When the present invention is embodied as a program (software), its steps are executed by executing the program using hardware resources of a computer such as a CPU, a memory, and input/output circuits. Stated differently, the steps are executed by the CPU obtaining data from the memory or the input/output circuits, etc. to perform arithmetic operations, and outputting the results of the arithmetic operations to the memory or the input/output circuits, etc.

[0106] Also, the structural components included in fire alarm device 10 and fire alarm system 1 according to the embodiment may be implemented as dedicated or general-purpose circuits.

[0107] Also, the structural components included in fire alarm device 10 and fire alarm system 1 according to the embodiment may be embodied as a large scale integration (LSI), which is an integrated circuit (IC).

[0108] The IC is not limited to an LSI, and thus may be a dedicated circuit or a general-purpose processor. A field programmable gate array (FPGA) that allows for programming or a reconfigurable processor that allows for reconfiguration of the connection and the settings of circuit cells inside an LSI may be employed.

[0109] Furthermore, when the progress in a semiconductor technology or another derivative technology results an IC technology that replaces LSI, such new technology may of course be employed to integrate the structural components included in fire alarm device 10 and fire alarm system 1 onto a circuit.

[0110] In addition, the present invention includes variations achieved by making various modifications to the embodiment that can be conceived by those skilled in the art, and embodiments achieved by combining any structural components and functions in each embodiment without departing from the essence of the present invention.

REFERENCE MARKS IN THE DRAWINGS

[0111]

1	fire alarm system
10	fire alarm device
12	monitoring unit (first monitoring unit)
13, 23	notification unit
14	external-output unit (first external-output unit)
15	alarm unit (first alarm unit)
17	memory (storage unit)
20	slave device
22	monitoring unit (second monitoring unit)
24	external-output unit (second external-output unit)
25	alarm unit (second alarm unit)
29	slave device information obtainment unit

Claims

1. A fire alarm device that wirelessly communicates with at least one slave device and operates as a master device of the at least one slave device, the fire alarm device comprising:

a first monitoring unit configured to perform monitoring of the at least one slave device at regular or irregular time intervals to determine whether the at least one slave device is in an abnormal condition; and

a first alarm unit configured to issue an alarm indicating that the at least one slave device is in an abnormal condition when the first monitoring unit determines that the at least one slave device is in an abnormal condition,

wherein after a signal indicating battery exhaustion is received from any one of the at least one slave device, the first monitoring unit is configured not to determine, in the monitoring, that the slave device is in an abnormal condition even when radio waves cannot be received from the slave device.

2. The fire alarm device according to claim 1,

wherein when the radio waves cannot be received from the slave device within a predetermined period after a point in time when the signal indicating battery exhaustion is received from the slave device, the first monitoring unit is configured to determine that the slave device is in an abnormal condition.

3. The fire alarm device according to claim 1 or 2, further comprising:

a storage unit configured to store information that includes address information of the slave device and information indicating battery exhaustion in association with each other, the slave device being a slave device, among the at least one slave device, that has sent the signal indicating battery exhaustion,
wherein in the monitoring, the first monitoring unit is configured to compare the address information of the slave device from which the radio waves cannot be received with address information stored in the storage unit to determine whether the at least one slave device is in an abnormal condition.

4. The fire alarm device according to any one of claims 1 through 3, further comprising:
a first external-output unit configured to output, to an external device, information indicating that the at least one slave device is in an abnormal condition.

5. The fire alarm device according to claim 4,
wherein when the signal indicating battery exhaustion is received from any one of the at least one slave device, the first external-output unit is configured to output, to the external device, information indicating that a battery charge of the slave device is exhausted.

6. The fire alarm device according to claim 4 or 5,
wherein when the signal indicating battery exhaustion is received from any one of the at least one slave device and the radio waves cannot be received from the slave device thereafter, the first external-output unit is configured to output, to the external device, information indicating that the slave device is in an inactive state.

7. The fire alarm device according to any one of claims 1 through 6, further comprising:
a notification unit configured to send a signal indicating battery exhaustion to the at least one slave device when a battery charge of the fire alarm device is exhausted.

8. The fire alarm device according to claim 7,
wherein the at least one slave device includes:

a second monitoring unit configured to monitor the fire alarm device at regular or irregular time intervals to determine whether the fire alarm device is in an abnormal condition; and
a second alarm unit configured to issue an alarm indicating that the fire alarm device is in an abnormal condition when the second monitoring unit determines that the fire alarm device is in an abnormal condition,
wherein the second monitoring unit is configured not to determine, in the monitoring, that the fire alarm device is in an abnormal condition, even when radio waves cannot be received from the fire alarm device, after the signal indicating battery exhaustion is received from the fire alarm device.

9. The fire alarm device according to claim 8,
wherein the second monitoring unit is configured to determine that the fire alarm device is in an abnormal condition when the radio waves cannot be received from the fire alarm device within a predetermined period after a point in time when the signal indicating battery exhaustion is received from the fire alarm device.

10. The fire alarm device according to claim 8 or 9,
wherein the at least one slave device further includes a second external-output unit configured to output, to an external device, information indicating that the fire alarm device is in an abnormal condition.

11. The fire alarm device according to claim 10,
wherein the second external-output unit is configured to output, to the external device, information indicating that the battery charge of the fire alarm device is exhausted when the signal indicating battery exhaustion is received from the fire alarm device.

12. The fire alarm device according to claim 10 or 11,
wherein the second external-output unit is configured to output, to the external device, information indicating that the fire alarm device is in an inactive state when the radio waves cannot be received from the fire alarm device after the signal indicating battery exhaustion is received from the fire alarm device.

13. The fire alarm device according to any one of claims 8 through 12, wherein the at least one slave device comprises a plurality of slave devices, and
each of the plurality of slave devices further includes a slave device information obtainment unit configured to obtain information from another one of the plurality of slave devices when the radio waves cannot be received from the fire alarm device.

14. A fire alarm system, comprising:

the fire alarm device according to any one of claims 1 through 13; and
the at least one slave device.

15. An abnormality determination method of determining

an abnormal condition in communication performed by a fire alarm device that wirelessly communicates with at least one slave device and operates as a master device of the at least one slave device, the abnormality determination method comprising:

performing monitoring of the at least one slave device at regular or irregular time intervals to determine whether the at least one slave device is in an abnormal condition; and
issuing an alarm indicating that the at least one slave device is in an abnormal condition when the at least one slave device is determined, in the performing of the monitoring, as being in an abnormal condition,
wherein after a signal indicating battery exhaustion is received from any one of the at least one slave device, the slave device is not determined, in the performing of the monitoring, as being in an abnormal condition even when radio waves cannot be received from the slave device.

16. A program that causes a computer to execute the abnormality determination method according to claim 15.

FIG. 1

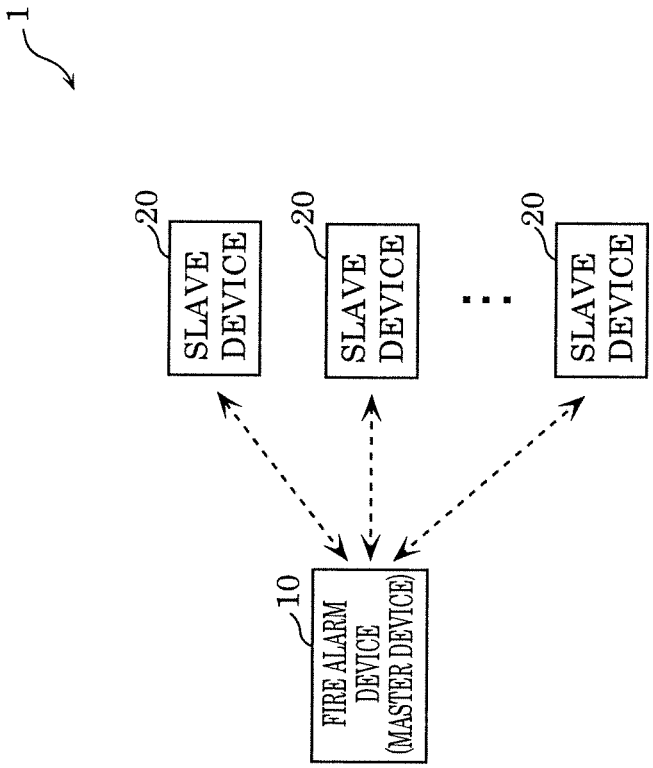

1
20
SLAVE DEVICE
20
SLAVE DEVICE
20
SLAVE DEVICE
10
FIRE ALARM DEVICE (MASTER DEVICE)

FIG. 2

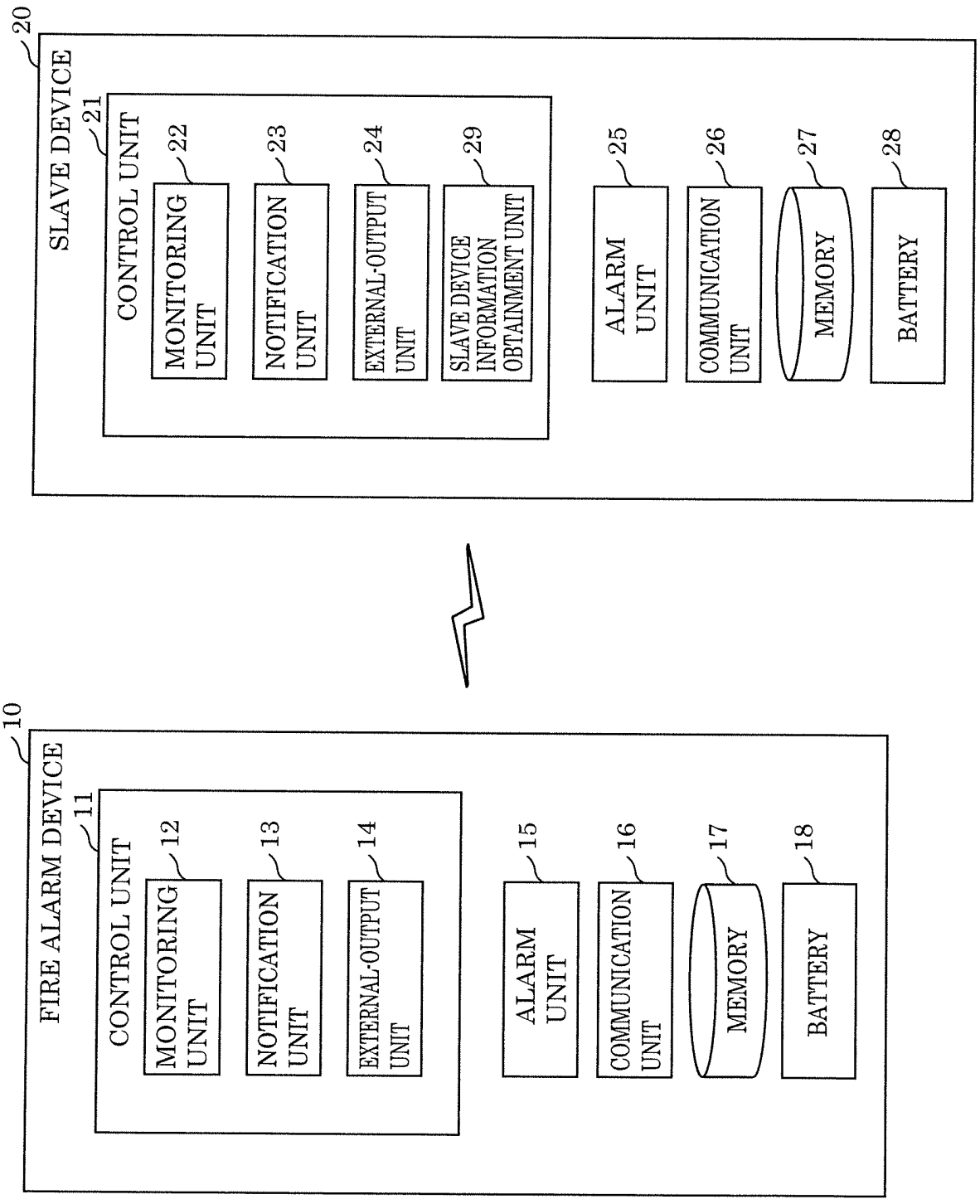

20
SLAVE DEVICE
21
CONTROL UNIT
22
MONITORING UNIT
23
NOTIFICATION UNIT
24
EXTERNAL-OUTPUT UNIT
29
SLAVE DEVICE INFORMATION OBTAINMENT UNIT
25
ALARM UNIT
26
COMMUNICATION UNIT
27
MEMORY
28
BATTERY
10
FIRE ALARM DEVICE
11
CONTROL UNIT
12
MONITORING UNIT
13
NOTIFICATION UNIT
14
EXTERNAL-OUTPUT UNIT
15
ALARM UNIT
16
COMMUNICATION UNIT
17
MEMORY
18
BATTERY

FIG. 3

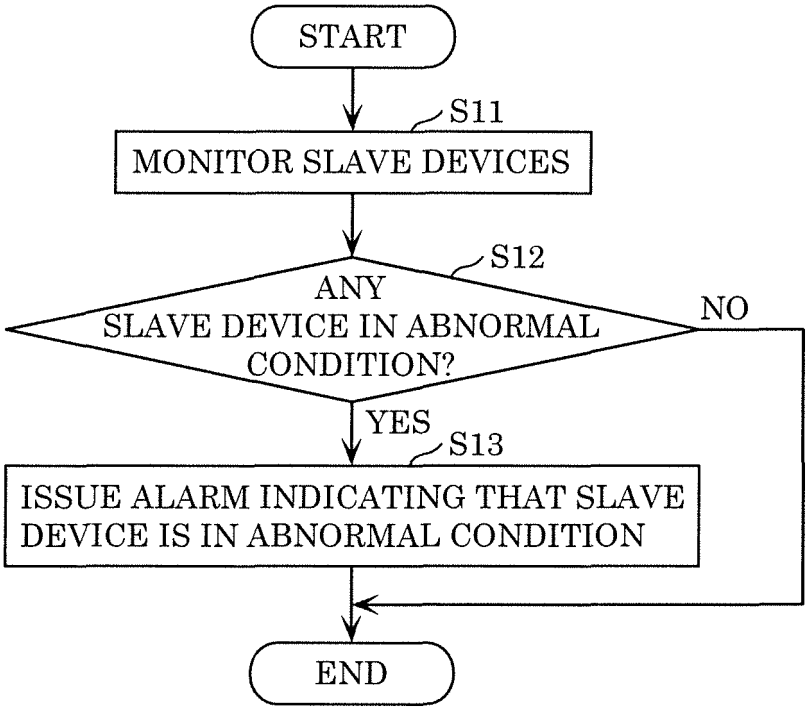

START
S11
MONITOR SLAVE DEVICES
S12
ANY SLAVE DEVICE IN ABNORMAL CONDITION?
NO
YES
S13
ISSUE ALARM INDICATING THAT SLAVE DEVICE IS IN ABNORMAL CONDITION
END

FIG. 4

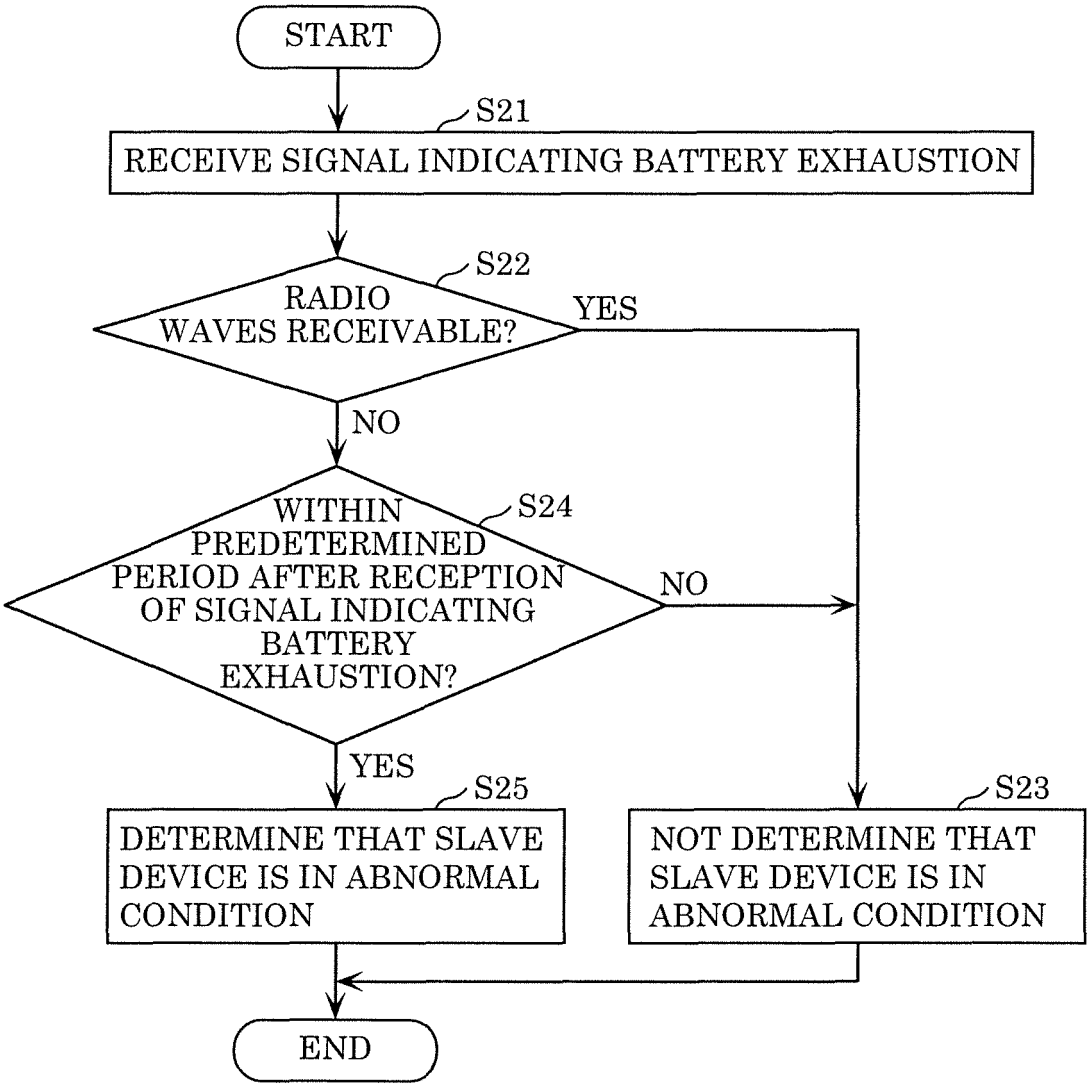

START
S21
RECEIVE SIGNAL INDICATING BATTERY EXHAUSTION
S22
RADIO WAVES RECEIVABLE?
YES
NO
S24
WITHIN PREDETERMINED PERIOD AFTER RECEPTION OF SIGNAL INDICATING BATTERY EXHAUSTION?
NO
YES
S25
DETERMINE THAT SLAVE DEVICE IS IN ABNORMAL CONDITION
S23
NOT DETERMINE THAT SLAVE DEVICE IS IN ABNORMAL CONDITION
END

FIG. 5

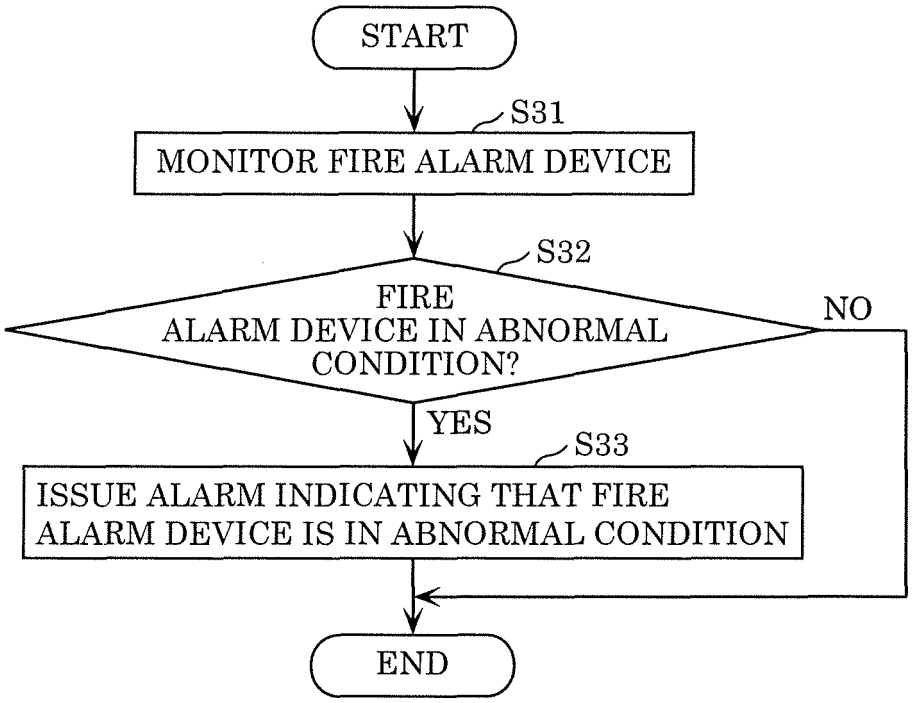
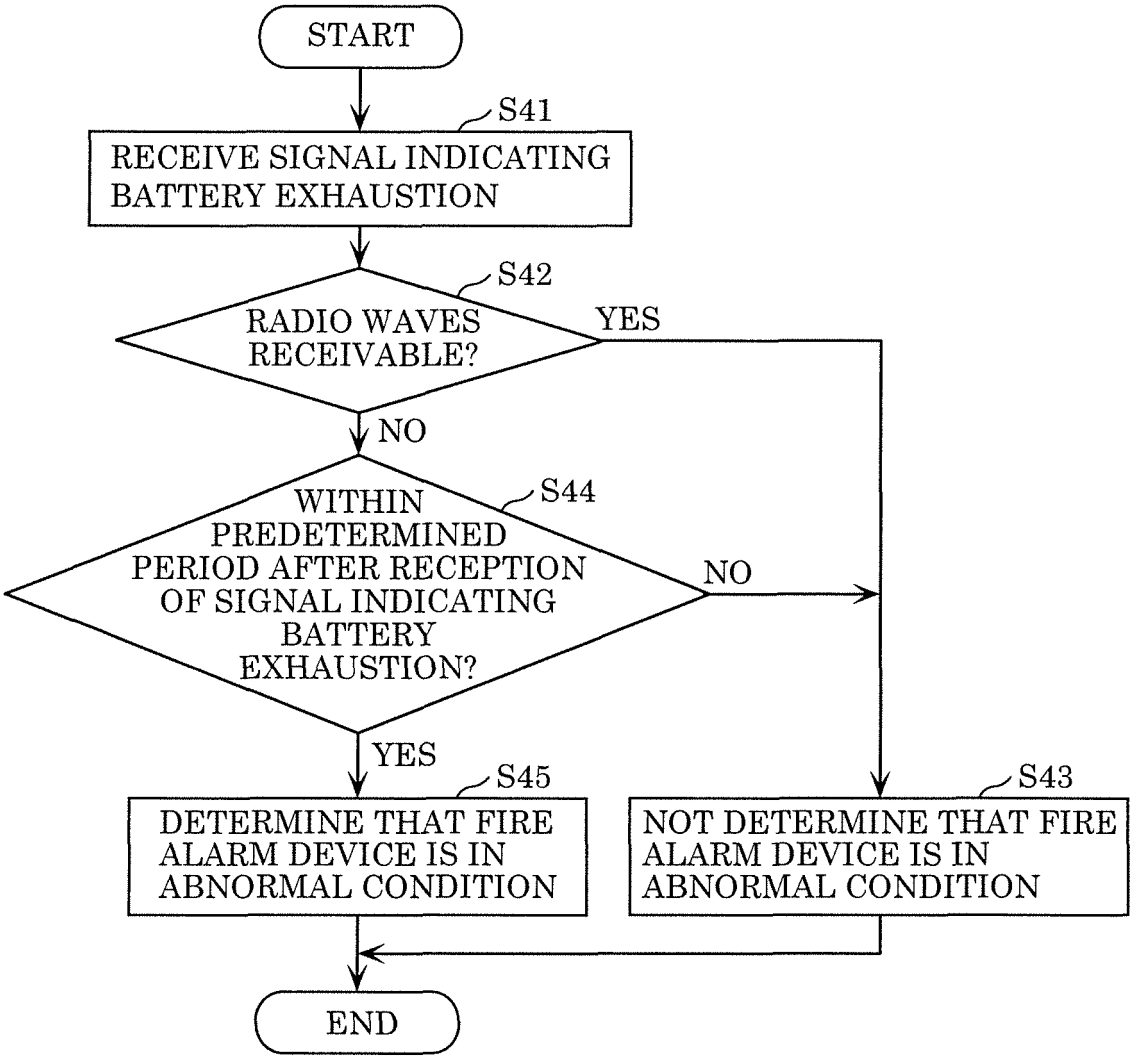

START
S31
MONITOR FIRE ALARM DEVICE
S32
FIRE ALARM DEVICE IN ABNORMAL CONDITION?
NO
YES
S33
ISSUE ALARM INDICATING THAT FIRE ALARM DEVICE IS IN ABNORMAL CONDITION
END

FIG. 6


START
S41
RECEIVE SIGNAL INDICATING BATTERY EXHAUSTION
S42
RADIO WAVES RECEIVABLE?
YES
NO
S44
WITHIN PREDETERMINED PERIOD AFTER RECEPTION OF SIGNAL INDICATING BATTERY EXHAUSTION?
NO
YES
S45
DETERMINE THAT FIRE ALARM DEVICE IS IN ABNORMAL CONDITION
S43
NOT DETERMINE THAT FIRE ALARM DEVICE IS IN ABNORMAL CONDITION
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/011400

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. G08B17/00(2006.01)i, G08B25/10(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)
Int. Cl. G08B17/00, G08B25/10

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 1971-2019
Registered utility model specifications of Japan 1996-2019
Published registered utility model applications of Japan 1994-2019

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.
A	JP 2011-034372 A (HOCHIKI CORP.) 17 February 2011, paragraphs [0025], [0045], [0076]-[0079] (Family: none)	1-16
A	JP 2013-009149 A (HOCHIKI CORP.) 10 January 2013, paragraphs [0051], [0055], [0056], [0064], [0087], [0091] (Family: none)	1-16
A	JP 2014-056419 A (PANASONIC CORP.) 27 March 2014, paragraphs [0039], [0040] (Family: none)	1-16
A	JP 2005-327034 A (SHARP CORP.) 24 November 2005, paragraphs [0023], [0024], [0032], [0044] (Family: none)	1-16

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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
05.04.2019	16.04.2019

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

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2012004826 A **[0003]**