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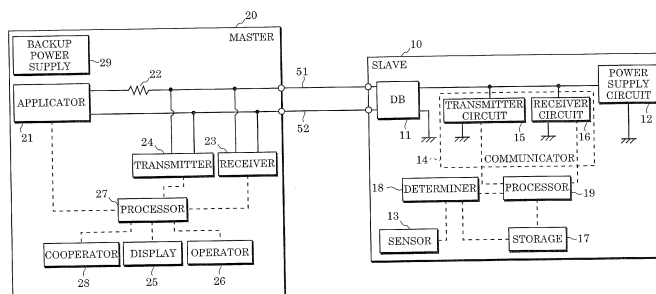
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(54) **SLAVE UNIT FOR AUTOMATIC FIRE ALARM SYSTEM, AND AUTOMATIC FIRE ALARM SYSTEM IN WHICH SAME IS USED**

(57) A slave (10) for an automatic fire alarm system (A1) electrically connected to a pair of electric wires to which a voltage is applied includes a storage (17), a communicator (14) and a processor (19). The storage (17) stores identification information unique to the slave. The communicator (14) receives a synchronization signal transmitted from a master (20) in order to synchronize with another slave (10), the synchronization signal being

a signal indicated by a change in the voltage applied to the pair of electric wires. The processor (19) performs a fire detection operation by using a consumption current supplied from the master (20) in an operation time slot allocated according to the identification information stored in the storage (17) when the communicator (14) receives the synchronization signal.

FIG. 1



A1

Description

TECHNICAL FIELD

[0001] The present invention generally relates to a slave for an automatic fire alarm system, and an automatic fire alarm system using the same, and more particularly to, for example, a slave for an automatic fire alarm system that is electrically connected to a master via a pair of electric wires, and an automatic fire alarm system using the same.

BACKGROUND ART

[0002] As a conventional automatic fire alarm system (auto fire alarm system), there is a proprietary-type (P-type) automatic fire alarm system. The P-type automatic fire alarm system is configured to detect the occurrence of a fire by using a slave that is a heat sensor, a smoke sensor, a flame sensor or the like, and issue a notification of the occurrence of a fire from the slave to a master that is a receiving apparatus.

[0003] The P-type automatic fire alarm system issues a notification of the occurrence of a fire to the master that is a receiving apparatus as a result of the pair of electric wires being electrically short-circuited by the slave.

[0004] As an automatic fire alarm system, there is also a system having a cooperation function with other apparatuses such as a smoke prevention and discharge facility and an emergency broadcasting facility. In this type of automatic fire alarm system, the slave has a function of generating a cooperation notification for causing other apparatuses to work in cooperation, and the master executes the cooperative working with other apparatuses by receiving the cooperation notification from the slave.

[0005] Patent Literature (PTL) 1, for example, discloses a P-type automatic fire alarm system having a configuration in which a plurality of fire sensors, which are slaves, are connected to a plurality of sensor lines drawn from a fire signal receiving apparatus, which is the master of the P-type automatic fire alarm system. With the automatic fire alarm system disclosed in PTL 1, the slaves each perform a fire detection operation by using power supplied from the fire signal receiving apparatus, and output a fire notification to the master upon detection of a fire.

Citation List

Patent Literature

[0006] PTL 1: Japanese Unexamined Patent Application Publication No. 2002-8154

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0007] Usually, a plurality of slaves provided in a P-

type automatic fire alarm system each perform a fire detection operation at a predetermined periodic time period based on a clock source provided in the slave. For this reason, there is a possibility that the plurality of slaves may perform a fire detection operation in the same time slot. If such a case arises, power is intensively required in that time slot by the plurality of slaves to perform their operation, and thus a large amount of electric current flows through the pair of electric wires in the time slot. In such a situation, the master may erroneously detect a fire notification due to a change in the electric current consumption.

[0008] Accordingly, the present invention has been made in view of the problem described above, and it is an object of the present invention to provide a slave for an automatic fire alarm system with which it is possible to suppress an increase in the electric current consumed in the same time slot, and an automatic fire alarm system using such a slave.

SOLUTION TO PROBLEM

[0009] To address the problem described above, a slave for an automatic fire alarm system according to an aspect of the present invention is a slave for an automatic fire alarm system electrically connected to a pair of electric wires to which a voltage is applied, the slave including: a storage that stores identification information unique to the slave; a communicator that receives a synchronization signal transmitted from a master in order to synchronize with another slave, the synchronization signal being a signal indicated by a change in the voltage applied to the pair of electric wires; and a processor that performs, by using power supplied from the master, a fire detection operation in an operation time slot allocated according to the identification information stored in the storage when the communicator receives the synchronization signal.

[0010] An automatic fire alarm system according to an aspect of the present invention includes: the slave as described above; and the master that applies a voltage to the pair of electric wires.

ADVANTAGEOUS EFFECT OF INVENTION

[0011] With a slave for an automatic fire alarm system and an automatic fire alarm system using such a slave that are configured as described above, it is possible to suppress an increase in the electric current consumed in the same time slot.

BRIEF DESCRIPTION OF DRAWINGS

[0012]

FIG. 1 is a diagram illustrating a schematic configuration of an automatic fire alarm system according to Embodiment 1.

FIG. 2 is a diagram illustrating an overall configuration of the automatic fire alarm system according to Embodiment 1.

FIG. 3 is a diagram illustrating a configuration of a transmitter circuit included in a slave according to Embodiment 1.

FIG. 4 is a flowchart illustrating the operations of the slave according to Embodiment 1.

FIG. 5A is a diagram illustrating the allocation of operation time slots according to Embodiment 1.

FIG. 5B is a diagram illustrating the allocation of operation time slots according to Embodiment 1.

FIG. 6 is a diagram illustrating changes in the electric current drawn by the slave according to Embodiment 1.

FIG. 7 is a flowchart illustrating the operations of a slave according to Embodiment 2.

FIG. 8A is a diagram illustrating the allocation of operation time slots and response time slots according to Embodiment 2.

FIG. 8B is a diagram illustrating the allocation of operation time slots and response time slots according to Embodiment 2.

FIG. 9 is a diagram illustrating changes in the electric current drawn by the slave according to Embodiment 2.

FIG. 10 is a flowchart illustrating the operations of a slave according to Embodiment 3.

FIG. 11A is a diagram illustrating the allocation of operation time slots and response time slots according to Embodiment 3.

FIG. 11B is a diagram illustrating the allocation of operation time slots and response time slots according to Embodiment 3.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0013] Hereinafter, a slave for an automatic fire alarm system according to embodiments of the present invention and an automatic fire alarm system using the same will be described in detail with reference to the drawings. Note that the embodiments described below show preferred specific examples of the present invention. Accordingly, the numerical values, shapes, materials, structural elements, the arrangement and connection of the structural elements, steps, the order of the steps, and the like shown in the following embodiments are merely examples, and therefore do not limit the scope of the present invention. Accordingly, among the structural elements described in the following embodiments, structural elements not recited in any one of the independent claims are described as arbitrary structural elements.

[0014] In addition, the diagrams are schematic representations, and thus are not necessarily true to scale. Also, in the diagrams, structural elements that are the same are given the same reference numerals.

1. EMBODIMENT 1

[0015] Hereinafter, automatic fire alarm system A1 according to the present embodiment will be described.

1.1 Overview

[0016] As shown in FIG. 1, automatic fire alarm system A1 according to the present embodiment includes at least one slave 10 and one master 20.

[0017] Master 20 includes applicator 21 that applies a voltage to a pair of electric wires 51 and 52.

[0018] Slave 10 is electrically connected to the pair of electric wires 51 and 52, and slave 10 includes communicator 14, storage 17 and processor 19.

[0019] Storage 17 stores identification information that is unique to slave 10.

[0020] Communicator 14 receives a synchronization signal transmitted from master 20 in order to synchronize with another slave 10, the synchronization signal being a signal indicated by a change in the voltage applied to the pair of electric wires 51 and 52.

[0021] In response to communicator 14 receiving the synchronization signal, processor 19 performs a fire detection operation in an operation time slot allocated according to the identification information stored in storage 17.

[0022] That is to say, each slave 10 included in automatic fire alarm system A1 according to the present embodiment performs a fire detection operation in an operation time slot allocated thereto.

[0023] For this reason, with automatic fire alarm system A1 according to the present embodiment, the number of slaves 10 that perform a fire detection operation in the same time slot can be limited, and therefore automatic fire alarm system A1 according to the present embodiment is advantageous in that it is possible to suppress an increase in the power consumed in the same time slot, or in other words, suppress an increase in the electric current consumed in the same time slot.

[0024] Hereinafter, automatic fire alarm system A1 according to the present embodiment will be described in detail. It is to be noted, however, that the configuration described below is merely an example of the present invention, and the present invention is not limited to the embodiments described below, and therefore various modifications other than the embodiments described below can be made according to the design or the like without departing from the technical concept of the present invention.

1.2 Overall Configuration

[0025] In the present embodiment, an example will be described in which automatic fire alarm system A1 is used in a collective housing (apartment), but the application of automatic fire alarm system A1 is not limited to a collective housing, and automatic fire alarm system A1 is

also applicable to various types of buildings such as, for example, a commercial facility, a hospital, a hotel and a multi-tenant building.

[0026] As shown in FIG. 2, in automatic fire alarm system A1 according to the present embodiment, one master 20 and a plurality of slaves B1, B2, B3... are provided for one collective housing 60. Hereinafter, the plurality of slaves B1, B2, B3... will be collectively referred to simply as "slave 10" unless it is necessary to make a distinction therebetween.

[0027] Furthermore, in automatic fire alarm system A1, a pair of electric wires 51 and 52 is provided in each of the first to fourth floors. In short, four pairs of electric wires 51 and 52 are provided in the entirety of collective housing 60, with a set of two (two-wire type) electric wires 51 and 52 being treated as one pair. In this example, a maximum of 40 to 80 slaves 10 can be connected to each pair of electric wires 51 and 52. Furthermore, in one master 20, a maximum of 50 to 200 lines (50 to 200 pairs of electric wires 51 and 52) can be connected. Accordingly, for example, in the case where it is possible to connect a maximum of 40 slaves 10 to each pair of electric wires 51 and 52, and it is possible to, in one master 20, connect a maximum of 50 lines (50 pairs of electric wires 51 and 52), a maximum of 2000 ($= 40 \times 50$) slaves 10 can be connected to one master 20. Note that the numerical values given above are merely examples, and the present invention is not limited to the numerical values given above.

[0028] Also, in a terminal end of one pair of electric wires 51 and 52 (the end that is positioned opposite to master 20), the pair of electric wires 51 and 52 are electrically connected via terminating resistor 40. For this reason, master 20 can detect a disconnection between the pair of electric wires 51 and 52 by monitoring the electric current flowing through the pair of electric wires 51 and 52. However, terminating resistor 40 is not a required constituent element, and thus may be omitted.

[0029] Automatic fire alarm system A1 is basically configured such that slave 10 that is a heat sensor, a smoke sensor, a flame sensor or the like detects the occurrence of a fire, and a notification of the occurrence of the fire (fire notification) is issued from slave 10 to master 20 that is a receiving apparatus. However, slave 10 is not limited to a sensor that detects the occurrence of a fire, and may include a signal transmitter and the like. The signal transmitter is an apparatus that has a push button switch (not shown), and in response to the push button switch being manually operated by a person having found a fire, issues a notification of the occurrence of the fire (fire notification) to master 20.

[0030] Also, automatic fire alarm system A1 has a cooperation function of causing another apparatus 30 such as a smoke prevention and discharge facility or an emergency broadcasting facility to work in cooperation in response to master 20 receiving a notification (cooperation notification) for causing another apparatus 30 to work in cooperation from slave 10. Accordingly, in the event of

the occurrence of a fire, automatic fire alarm system A1 can control a fire door of the smoke prevention and discharge facility or inform the occurrence of the fire by sound or voice by using the emergency broadcasting facility.

[0031] Another apparatus 30 is capable of performing communication with master 20 by way of, for example, a wired connection, and works in cooperation with automatic fire alarm system A1 upon receiving an instruction from master 20. As used herein, another apparatus 30 includes various apparatuses such as a smoke prevention and discharge facility (a fire door, a smoke discharge facility and the like), an emergency broadcasting facility, an external alarming apparatus, and a fire extinguishing facility (a sprinkler and the like), and thus is not limited to a particular apparatus (facility). The external alarming apparatus refers to an apparatus that reports an alarm to an external party concerned, a fire department, a security company and the like.

[0032] As a commonly used automatic fire alarm system, there is a proprietary-type (P-type) system. The P-type automatic fire alarm system issues a notification of the occurrence of a fire to a master as a result of a pair of electric wires being electrically short-circuited by a slave.

[0033] Automatic fire alarm system A1 according to the present embodiment is basically a P-type automatic fire alarm system. To be more specific, the present embodiment will be described based on the assumption that in a collective housing in which a P-type automatic fire alarm system has already been installed, the receiving apparatus (master 20) and slaves (slaves 10) are replaced while the existing lines (electric wires 51 and 52) are used without being replaced. Automatic fire alarm system A1 according to the present embodiment may be used as a newly introduced automatic fire alarm system.

1.3 Configuration of Master 20

[0034] In the present embodiment, master 20 is a P-type receiving apparatus that receives, from slave 10, a notification of the occurrence of a fire (fire notification) and a notification for causing another apparatus 30 to work in cooperation (cooperation notification). Master 20 is installed in, for example, an administration office of a building (collective housing 60).

[0035] As shown in FIG. 1, master 20 includes, in addition to applicator 21, resistor 22, receiver 23, transmitter 24, display 25 that displays various types of information, operator 26 that receives an input of an operation from a user, and processor 27 that controls the constituent elements.

[0036] Resistor 22 is connected between applicator 21 and at least one of the pair of electric wires 51 and 52. In the example shown in FIG. 1, resistor 22 is interposed between applicator 21 and electric wire 51, which is one (high potential side) of the pair of electric wires 51 and 52. However, the present invention is not limited thereto,

and resistor 22 may be interposed between applicator 21 and electric wire 52, which is the other one (low potential side) of the pair of electric wires 51 and 52, or may be interposed between applicator 21 and each of the pair of electric wires 51 and 52.

[0037] Receiver 23 receives a voltage signal produced by converting an electric current signal from slave 10 to a voltage change on the pair of electric wires 51 and 52 by a voltage drop by resistor 22.

[0038] Transmitter 24 regularly transmits a synchronization signal to slave 10.

[0039] Upon receiving a notification of the occurrence of a fire (fire notification) from slave 10, master 20 displays the location of the fire and the like on display 25.

[0040] Processor 27 is composed mainly of a microcontroller (microcomputer), and implements a desired function by executing a program stored in a memory (not shown). The program may be written into the memory in advance, or may be provided by being stored in a storage medium such as a memory card. To be specific, processor 27 controls transmitter 24 to transmit a transmission signal and a synchronization signal.

[0041] Also, master 20 includes cooperator 28 for causing another apparatus 30 to work in corporation. With this configuration, upon receiving a cooperation notification from slave 10, master 20 can issue an instruction from cooperator 28 to another apparatus 30 so as to cause another apparatus 30 to work in cooperation.

[0042] As described above, master 20 functions as a power supply for operating the entirety of automatic fire alarm system A1 including slave 10 connected to the pair of electric wires 51 and 52, by applicator 21 applying a voltage to the pair of electric wires 51 and 52. Here, as an example, the voltage applied to the pair of electric wires 51 and 52 by applicator 21 is a direct current of 24 V, but the present invention is not limited to this value.

[0043] Furthermore, master 20 includes backup power supply 29 including a storage battery so as to secure supply of power for operating automatic fire alarm system A1 in the event of a power failure. Master 20 uses a commercial power supply, an independent power generation facility or the like (not shown) as the main power supply. Applicator 21 automatically switches the power supply source from the main power supply to backup power supply 29 in the event of a power failure of the main power supply, and upon recovery from the power failure of the main power supply, automatically switches from backup power supply 29 to the main power supply. The specifications of backup power supply 29 such as capacity are determined so as to satisfy the standards prescribed by the ministerial ordinance.

[0044] Also, resistor 22 has two functions: a first function of converting the electric current signal transmitted from slave 10 to a voltage signal as described above; and a second function of limiting the electric current flowing through the pair of electric wires 51 and 52 in the event that the pair of electric wires 51 and 52 are short-circuited. In short, resistor 22 has both the first function

serving as an electric current-to-voltage converting element and the second function serving as an electric current limiting element. Here, as an example, the resistance value of resistor 22 is set to 400 Ω or 600 Ω , but the present invention is not limited to this value.

[0045] Receiver 23 and transmitter 24 are electrically connected between resistor 22 and the pair of electric wires 51 and 52. However, receiver 23 is not necessarily connected between resistor 22 and the pair of electric wires 51 and 52, and may be electrically connected, for example, between applicator 21 and resistor 22.

[0046] Here, receiver 23 receives the electric current signal from slave 10 as a voltage signal (voltage change) on the pair of electric wires 51 and 52. That is, the current value of the electric current (drawn electric current) drawn from the pair of electric wires 51 and 52 by slave 10 corresponds to the magnitude of the voltage drop by resistor 22, and thus receiver 23 can receive a fire notification or a cooperation notification from slave 10 as a signal voltage. To rephrase it, receiver 23 receives a voltage signal corresponding to the current value of the drawn electric current that is drawn by slave 10 as a fire notification or a cooperation notification.

[0047] Transmitter 24 transmits an electric current signal, which was generated on the pair of electric wires 51 and 52 as a result of changing the electric current flowing from the pair of electric wires 51 and 52, to slave 10 as a synchronization signal. The electric current signal sent (generated) on the pair of electric wires 51 and 52 by transmitter 24 is converted to a voltage signal by the voltage drop by resistor 22, and slave 10 receives the voltage signal as a synchronization signal from master 20. To rephrase it, the voltage change (voltage signal) generated on the pair of electric wires 51 and 52 when transmitter 24 changes the electric current flowing from the pair of electric wires 51 and 52 is received by slave 10 as a voltage signal.

1.4 Configuration of Slave 10

[0048] Slave 10 includes diode bridge 11, power supply circuit 12, sensor 13, communicator 14, storage 17, determiner 18, and processor 19.

[0049] In diode bridge 11, the pair of electric wires 51 and 52 is electrically connected to its input terminal side, and power supply circuit 12 and communicator 14 are electrically connected to its output terminal side. Power supply circuit 12 generates power for operating slave 10 from the power on the pair of electric wires 51 and 52. Sensor 13 detects the occurrence of a fire.

[0050] Communicator 14 includes transmitter circuit 15 and receiver circuit 16.

[0051] Transmitter circuit 15 transmits, to master 20, the current value of the electric current (drawn electric current) drawn from the pair of electric wires 51 and 52 as an electric current signal. The electric current signal sent (generated) on the pair of electric wires 51 and 52 by transmitter circuit 15 is converted to a voltage signal

by the voltage drop by resistor 22, and master 20 receives the voltage signal as a signal from slave 10. To rephrase it, by transmitter circuit 15 adjusting the current value of the drawn electric current that is drawn from the pair of electric wires 51 and 52, a voltage signal corresponding to the current value is received by master 20.

[0052] FIG. 3 shows a specific example of transmitter circuit 15. That is, as shown in FIG. 3, transmitter circuit 15 includes first drawer 151 and second drawer 152, and each of first drawer 151 and second drawer 152 draws an electric current.

[0053] First drawer 151 includes a series circuit that is composed of semiconductor device 153, resistor 154 and light emitting diode (LED) 155 that are electrically connected between a pair of output terminals of diode bridge 11. Second drawer 152 includes a series circuit that is composed of semiconductor device 156 and resistor 157 that are electrically connected between the pair of output terminals of diode bridge 11.

[0054] In this example, semiconductor devices 153 and 156 are npn-type transistors, and their collectors are electrically connected to a high potential-side output terminal of diode bridge 11. Furthermore, the emitter of semiconductor device 153 is electrically connected to a circuit ground (a low potential-side output terminal of diode bridge 11) via resistor 154 and light emitting diode 155. The emitter of semiconductor device 156 is electrically connected to the circuit ground (the low potential-side output terminal of diode bridge 11) via resistor 157. The base of each of semiconductor devices 153 and 156 is electrically connected to processor 19, which will be described later. Semiconductor devices 153 and 156 are not limited to npn-type transistors, and may be, for example, pnp-type transistors.

[0055] With this configuration, transmitter circuit 15 causes first drawer 151 to draw an electric current when semiconductor device 153 is turned on by processor 19, and causes second drawer 152 to draw an electric current when semiconductor device 156 is turned on by processor 19. Accordingly, transmitter circuit 15 can change the current value of the drawn electric current between when only first drawer 151 draws an electric current and when both first drawer 151 and second drawer 152 draw an electric current.

[0056] Furthermore, the current value of the electric current drawn by first drawer 151 can be switched in two stages by switching a base current of semiconductor device 153 in two stages. Likewise, the current value of the electric current drawn by second drawer 152 can be switched in two stages by switching a base current of semiconductor device 156 in two stages. In the present embodiment, as described above, transmitter circuit 15 can adjust the current value in a total of four stages: two stages at first drawer 151 and two stages at second drawer 152. The following description will be given based on the assumption that slave 10 can gradually increase the current value of the drawn electric current in four stages by transmitter circuit 15 switching the current value of the

drawn electric current.

[0057] When first drawer 151 draws an electric current, transmitter circuit 15 can illuminate light emitting diode 155. Light emitting diode 155 is disposed in a position viewable from the outside of slave 10, and has a function of informing, by illumination, that slave 10 is in a fire notifying state.

[0058] Receiver circuit 16 receives the synchronization signal from master 20 as a voltage signal (voltage change) on the pair of electric wires 51 and 52. That is, the electric current signal sent (generated) on the pair of electric wires 51 and 52 by master 20 is converted to a voltage signal by the voltage drop by resistor 22, and thus receiver circuit 16 receives the voltage signal as the synchronization signal from master 20. To rephrase it, the voltage change (voltage signal) generated on the pair of electric wires 51 and 52 when master 20 changes the electric current flowing from the pair of electric wires 51 and 52 is received by receiver circuit 16 as a voltage signal.

[0059] Storage 17 stores at least identification information (address) allocated in advance to slave 10. That is, unique identification information is allocated to each of the plurality of slaves B1, B2, B3.... The identification information of each of the plurality of slaves B1, B2, B3... is associated with the installation location (for example, room number) thereof, and registered in master 20.

[0060] Also, storage 17 stores decision conditions based on which determiner 18 decides an operational state (fire notifying state, cooperation notifying state). The decision conditions can be, for example, a threshold value set for the output of sensor 13. The identification information allocated in advance to slave 10 and the decision conditions may be stored in the same storage 17. Alternatively, a plurality of storages 17 may be provided so as to store the identification information and the decision conditions in separate storages 17, respectively.

[0061] Determiner 18 decides an operational state including two states: a fire notifying state and a cooperation notifying state. To be specific, determiner 18 reads the output (sensor value) of sensor 13 and decides the operational state by comparing with the decision conditions stored in storage 17. In the present embodiment, as an example of the decision conditions, if the read sensor value exceeds a first threshold value, determiner 18 decides that the operational state is a fire notifying state. If the read sensor value exceeds a second threshold value (> first threshold value), determiner 18 decides that the operational state is a cooperation notifying state. Note, however, that determiner 18 starts comparison between the sensor value and the second threshold value after, for example, the fire notifying state has been decided, so that determiner 18 can decide a cooperation notifying state after the fire notifying state has been decided. The decision conditions described above are merely examples, and can be changed as appropriate.

[0062] In the present embodiment, determiner 18 decides in which of three states (fire notifying state, coop-

eration notifying state, non-notification state) including a non-notification state (normal state) that is different from the fire notifying state and the cooperation notifying state the current operational state is in. The operational state decided by determiner 18 is not limited to the three states, and may be two states including the fire notifying state and the cooperation notifying state, or may be four states or more.

[0063] Processor 19 controls transmitter circuit 15 and receiver circuit 16 so as to adjust the current value of the drawn electric current according to the output of sensor 13, thereby to transmit an electric current signal from transmitter circuit 15 or receive a synchronization signal from master 20 at receiver circuit 16. In this example, processor 19 is composed mainly of a microcontroller (microcomputer), and implements a desired function by executing a program stored in a memory (not shown). The program may be written into the memory in advance, or may be provided by being stored in a storage medium such as a memory card.

[0064] In response to receiver circuit 16 receiving the synchronization signal, processor 19 starts a fire detection operation in an operation time slot allocated according to the identification information of slave 10 by using power for operation generated by power supply circuit 12. To be specific, in the operation time slot allocated according to the identification information of slave 10, processor 19 causes determiner 18 to read the sensor value and start to decide the state, and controls transmitter circuit 15 according to the result of decision made by determiner 18 so as to control the current value of the drawn electric current. As described above, if determiner 18 decides that the operational state is a fire notifying state, processor 19 adjusts the current value of the drawn electric current to a predetermined fire notification level so as to generate a fire notification. If determiner 18 decides that the operational state is a cooperation notifying state, processor 19 adjusts the current value of the drawn electric current to a predetermined cooperation notification level so as to generate a cooperation notification. As used herein, the cooperation notification level is a value (current value) that is different from the fire notification level, and in the present embodiment, is a current value that is greater than the fire notification level (cooperation notification level > fire notification level).

[0065] Furthermore, in the present embodiment, if a predetermined waiting time elapses after processor 19 has adjusted the current value of the drawn electric current to a predetermined fire notification level, processor 19 transmits a transmission signal representing transmission data from transmitter circuit 15. To be specific, processor 19 transmits the transmission signal from transmitter circuit 15 by increasing or decreasing the current value of the drawn electric current between two values of a first level and a second level. As used herein, the transmission data is, for example, the identification information of slave 10.

[0066] It is assumed here that the first level is equivalent

to the fire notification level, and the second level is a value that is greater than the fire notification level and is smaller than the cooperation notification level (fire notification level = first level < second level < cooperation notification level). In short, slave 10 increases or decreases the current value of the drawn electric current relative to the fire notification level, and thus can transmit the transmission signal during the fire notifying state.

[0067] With this configuration, if a fire occurs and it is decided that the operational state is a fire notifying state, slave 10 generates a fire notification by adjusting the current value of the drawn electric current to the fire notification level. Then, if it is decided that the operational state is a cooperation notifying state, slave 10 generates a cooperation notification by adjusting the current value of the drawn electric current to the cooperation notifying level. Furthermore, in the fire notifying state, slave 10 transmits a transmission signal representing the identification information by increasing or decreasing the current value of the drawn electric current between the first level (fire notification level) and the second level.

[0068] In the present embodiment, slave 10 transmits data including at least the identification information stored in storage 17 to master 20 through communication using a transmission signal. For this reason, after a fire notification is received from slave 10, master 20 can identify slave 10 serving as the notification source that issued the notification based on the identification information indicated by the transmission signal.

[0069] In the present embodiment, determiner 18 and processor 19 are configured as separate components. However, the present invention is not limited thereto, and determiner 18 and processor 19 may together form one component.

1.5 Operation

[0070] Hereinafter, the operations of automatic fire alarm system A1 according to the present embodiment will be described with reference to FIG. 4. FIG. 4 is a flowchart illustrating the operations of slave 10.

[0071] First, in a non-notification state (normal state), master 20 applies a constant voltage (for example, a direct current of 24 V) from applicator 21 to the pair of electric wires 51 and 52.

[0072] Processor 19 of slave 10 decides whether or not receiver circuit 16 has received a synchronization signal transmitted from master 20 (step S5).

[0073] If it is decided that receiver circuit 16 has received a synchronization signal (Yes in step S5), processor 19 decides whether or not an operation time slot corresponding to the identification information of slave 10 has arrived (step S10).

[0074] If it is decided that the operation time slot has arrived (Yes in step S10), processor 19 starts a fire detection operation by using power for operation generated by power supply circuit 12.

[0075] Hereinafter, the fire detection operation will be

described.

[0076] Determiner 18 reads a sensor value (step S15) and decides whether or not the operational state is a fire notifying state (step S20). In the non-notification state, basically, slave 10 does not draw an electric current, and thus the current value of the drawn electric current is 0 (zero). For this reason, if slave 10 that is performing the fire detection operation is in the non-notification state, the electric current flowing through the pair of electric wires 51 and 52 is a total of the electric current flowing through terminating resistor 40 and the electric current required to operate slave 10. Accordingly, the possibility that master 20 may erroneously detect a fire notification in the non-notification state due to the current value of the electric current flowing through the pair of electric wires 51 and 52 is low.

[0077] If determiner 18 decides that the operational state is a fire notifying state (Yes in step S20), processor 19 increases and adjusts the current value of the drawn electric current to a fire notification level (step S25). As a result, a fire notification is generated.

[0078] If a predetermined waiting time elapses from the point in time at which the current value of the drawn electric current was increased, processor 19 transmits a transmission signal representing the identification information of slave 10 from transmitter circuit 15 (step S30). As a result, slave 10 can transmit the identification information thereof to master 20.

[0079] After that, determiner 18 reads a sensor value (step S35) and decides whether or not the operational state is a cooperation notifying state (step S40).

[0080] If it is decided that the operational state is a cooperation notifying state (Yes in step S40), processor 19 increases and adjusts the current value of the drawn electric current to a cooperation notification level (step S45).

[0081] After having increased and adjusted the current value of the drawn electric current to a cooperation notification level, processor 19 decides whether or not the operation time slot has ended (step S50). If it is decided that the operation time slot has ended (Yes in step S50), processor 19 returns to step S5 and waits for reception of a synchronization signal.

[0082] If it is decided that the operational state is not a fire notifying state (No in step S20), processor 19 decides whether or not the operation time slot has ended (step S60). If it is decided that the operation time slot has ended (Yes in step S60), processor 19 returns to step S5 and waits for reception of a synchronization signal. If it is decided that the operation time slot has not ended (No in step S60), the processing returns to step S15, where determiner 18 reads a sensor value.

[0083] If it is decided that the operational state is not a cooperation notifying state (No in step S40), processor 19 decides whether or not the operation time slot has ended (step S65). If it is decided that the operation time slot has ended (Yes in step S65), processor 19 returns to step S5 and waits for reception of a synchronization

signal. If it is decided that the operation time slot has not ended (No in step S65), the processing returns to step S35, where determiner 18 reads a sensor value.

1.6 Specific Example

[0084] The allocation of operation time slots according to the present embodiment will be described with reference to FIGS. 5A and 5B.

[0085] In the present embodiment, as shown in FIG. 5A, entire interval (detection operation interval) Ta from the transmission of a synchronization signal until all of slaves 10 perform their operation is composed of synchronization signal transmission interval Ta1 and notification issuance detection interval Ta2. Notification issuance detection interval Ta2 is composed of operation time slots T1, T2... and T64 having the same time length. That is, the time length of notification issuance detection interval Ta2 is a total length of time of operation time slots T1, T2... and T64. It is assumed here that there are a total of 64 slaves 10 including slaves B1, B2... and B64, and one of operation time slots T1, T2... and T64 is allocated to each slave 10 in one to one correspondence according to the identification information thereof.

[0086] FIG. 5B is a diagram illustrating a transition of the fire detection operation. As described above, one operation time slot is allocated to each of 64 slaves 10 in one to one correspondence. When all of 64 slaves 10 receive a synchronization signal from master 20 in transmission interval Ta1, slave B1 performs a fire detection operation in operation time slot T1, and slave B2 performs a fire detection operation in operation time slot T2. After that, in each operation time slot, slave 10 to which the operation time slot has been allocated sequentially performs a fire detection operation, and in the last operation time slot T64, slave B64 performs a fire detection operation. Each slave 10 performs a fire detection operation in the operation time slot corresponding to the identification information thereof, and is in a standby state in operation time slots other than the operation time slot corresponding to the identification information thereof. For example, slave B1 is in a standby state in operation time slots T2 to T64 other than operation time slot T1 in which slave B1 performs a fire detection operation. Slave B2 is in a standby state in operation time slots T1, and T3 to T64 other than operation time slot T2 in which slave B2 performs a fire detection operation.

[0087] Changes in the electric current drawn by slave 10 in one operation time slot will be described next with reference to FIG. 6.

[0088] FIG. 6 shows changes in the current value of the electric current flowing through the pair of electric wires 51 and 52, with the horizontal axis indicating time and the vertical axis indicating current value. The interval (time length) between time t0 and time t5 shown in FIG. 6 is one operation time slot. In FIG. 6, it is assumed that the current value of the electric current flowing through the pair of electric wires 51 and 52 can be increased

gradually in three stages of I1, I2 and I3 from base current I0 ($I0 < I1 < I2 < I3$) by slave 10 switching the current value of the drawn electric current. As used herein, the base current is an electric current flowing through slave 10 when slave 10 is in a non-notification state.

[0089] The current value of the electric current flowing through the pair of electric wires 51 and 52 is basically "I0" as shown in FIG. 6. In the example shown in FIG. 6, slave 10 that is in operation is in a non-notification state during the period between time t0 and time t1.

[0090] When, as a result of fire detection, slave 10 transitions from the non-notification state to a fire notifying state, as shown in FIG. 6, the current value of the electric current flowing through the pair of electric wires 51 and 52 increases from "I0" to "I1". The example shown in FIG. 6 shows that slave 10 detects a fire notifying state during the period between time t1 and time t4.

[0091] Furthermore, if a predetermined waiting time Wa elapses from the point in time at which the current value increased from "I0" to "I1" that is a current value that indicates a fire notification level, slave 10 transmits a transmission signal representing transmission data from transmitter circuit 15 by increasing or decreasing the current value of the drawn electric current between two values of the first level and the second level. In the example shown in FIG. 6, during the period between time t2 and time t3, slave 10 transmits a transmission signal, and the current value of the electric current flowing through the pair of electric wires 51 and 52 fluctuates between "I1" and "I2".

[0092] After that, when, as a result of decision, slave 10 transitions from the fire notifying state to a cooperation notifying state, as shown in FIG. 6, the current value of the electric current flowing through the pair of electric wires 51 and 52 increases from "I1" to "I3". In the example shown in FIG. 6, slave 10 is in a cooperation notifying state during the period between time t4 and time t5.

[0093] In the present embodiment, as an example, it is assumed that the fire notification level is about 20 mA to 25 mA, the cooperation notification level is about 40 mA to 45 mA, and the difference between the first level and the second level when transmitting a transmission signal is about 13 mA to 18 mA. Also, as another example, it is possible to assume that the fire notification level is about 5 mA to 8 mA, the cooperation notification level is about 15 mA to 20 mA, and the difference between the first level and the second level when transmitting a transmission signal is about 5 mA to 13 mA.

[0094] It is also assumed that the time length of detection operation interval Ta is about one second. In this case, if the total number of slaves 10 is 64, the operation time slot allocated to each slave 10 may be about 15 milliseconds.

[0095] However, these specific numerical values are not intended to limit the scope of the embodiment, and can be changed as appropriate. For example, in the present embodiment, the current value of the drawn electric current is allowed to vary within a predetermined tol-

erance range. As long as the current value is within the tolerance range, master 20 can distinguish whether the operational state of slave 10 is a fire notifying state or a cooperation notifying state.

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1.7 Summation

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[0096] As described above, slave 10 of automatic fire alarm system A1 according to the present embodiment is electrically connected to a pair of electric wires 51 and 52 to which a voltage is applied. Slave 10 includes storage 17, communicator 14 and processor 19. Storage 17 stores identification information that is unique to slave 10, and communicator 14 receives a synchronization signal transmitted from master 20 in order to synchronize with another slave 10, the synchronization signal being a signal indicated by a change in the voltage applied to the pair of electric wires 51 and 52. In response to communicator 14 receiving the synchronization signal, processor 19 performs a fire detection operation in an operation time slot allocated according to the identification information stored in storage 17 by using power supplied from master 20.

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[0097] With this configuration, slave 10 performs a fire detection operation in the operation time slot allocated according to the identification information thereof by using the power supplied from master 20. For this reason, the power consumed by each slave 10, or in other words, the electric current consumed by each slave 10 is dispersed. Accordingly, in automatic fire alarm system A1 that uses slaves 10, it is possible to suppress an increase in the current consumption in the same operation time slot.

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[0098] In this example, communicator 14 includes transmitter circuit 15 that transmits a signal corresponding to the fire detection operation by changing the electric current drawn from the pair of electric wires 51 and 52. In response to a fire detection operation, transmitter circuit 15 transmits a fire notification signal informing the occurrence of a fire and a cooperation notification signal causing another apparatus to work in cooperation. First current value I1 of the electric current drawn by transmitter circuit 15 from the pair of electric wires when transmitting the fire notification signal and second current value I3 of the electric current drawn by transmitter circuit 15 from the pair of electric wires when transmitting the cooperation notification signal may be different.

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[0099] With this configuration, slave 10 can transmit a fire notification and a cooperation notification in a distinguished manner.

[0100] In this example, communicator 14 includes transmitter circuit 15 that transmits a fire notification signal informing the occurrence of a fire by changing the electric current drawn from the pair of electric wires 51 and 52 in response to a fire detection operation. Transmitter circuit 15 may further transmit an identification signal representing the identification information at the point in time at which a predetermined waiting time elapses

after the transmission of the fire notification.

[0101] With this configuration, slave 10 transmits a transmission signal representing the identification information at the point in time at which a predetermined waiting time elapses after the transmission of the fire notification, and thus it is possible to notify master 20 of the transmission source that has transmitted the fire notification.

[0102] Automatic fire alarm system A1 according to the present embodiment may include slaves 10 described above and master 20 that applies a voltage to the pair of electric wires.

[0103] With this configuration, slaves 10 of the automatic fire alarm system each perform a fire detection operation in the operation time slot allocated according to the identification information thereof by using the consumption current supplied from master 20. Accordingly, in automatic fire alarm system A1 that uses slaves 10, it is possible to suppress an increase in the current consumption in the same operation time slot.

2. EMBODIMENT 2

[0104] Automatic fire alarm system A1 according to the present embodiment will be described focusing mainly on differences from Embodiment 1. Automatic fire alarm system A1 according to the present embodiment has the same basic configuration as that of Embodiment 1, and the structural elements that are the same as those of Embodiment 1 are given the same reference numerals, and a description thereof will be omitted as appropriate.

[0105] Embodiment 1 is configured such that a transmission signal is transmitted if a predetermined elapses after slave 10 that is in operation transmits a fire notification to master 20 during an operation time slot, or in other words, communication that uses the transmission signal is performed during the operation time slot. The present embodiment is different from Embodiment 1 in that slave 10 of automatic fire alarm system A1 according to the present embodiment performs communication with master 20 during an interval that is different from the notification issuance detection interval.

2.1 Configuration

[0106] First, transmitter 24 of master 20 according to the present embodiment will be described.

[0107] Transmitter 24 of master 20 includes a first transmitter circuit (not shown) that transmits a synchronization signal and a second transmitter circuit (not shown) that transmits a request signal. The first transmitter circuit of transmitter 24 regularly transmits a synchronization signal. The method for transmitting a synchronization signal is the same as that of Embodiment 1, and thus a description thereof is omitted here. The second transmitter circuit of transmitter 24 regularly transmits, to a plurality of slaves 10, a request signal that requests a response from each of the plurality of slaves

10 in a timing different from the timing of the synchronization signal. To be specific, transmitter 24 transmits a request signal by changing the electric current flowing from the pair of electric wires 51 and 52. As used herein, the request signal is, for example, a signal for checking whether slave 10 is active.

[0108] Next, slave 10 according to the present embodiment will be described.

[0109] Receiver circuit 16 of slave 10 regularly receives, in addition to a synchronization signal, a request signal in a timing different from the timing of reception of the synchronization signal. To be specific, receiver circuit 16 receives the request signal from master 20 as a voltage signal (voltage change) on the pair of electric wires 51 and 52.

[0110] In response to receiver circuit 16 receiving the request signal, transmitter circuit 15 of slave 10 transmits an electric current signal generated as a result of drawing an electric current from the pair of electric wires 51 and 52 to master 20 as a transmission signal. As used herein, the transmission signal is transmission data representing the identification information of slave 10.

[0111] In response to receiver circuit 16 receiving the request signal, processor 19 of slave 10 transmits the transmission signal from transmitter circuit 15 in a response time slot allocated according to the identification information of slave 10.

2.2 Operation

[0112] Hereinafter, the operations of automatic fire alarm system A1 according to the present embodiment will be described with reference to FIG. 7. FIG. 7 is a flowchart illustrating the operations of slave 10.

[0113] In the present embodiment, master 20 regularly transmits a request signal.

[0114] Processor 19 of slave 10 decides whether or not receiver circuit 16 has received a request signal transmitted from master 20 (step S100).

[0115] If it is decided that receiver circuit 16 has received a request signal (Yes in step S100), processor 19 decides whether or not the response time slot corresponding to the identification information of slave 10 has arrived (step S105).

[0116] If it is decided that the response time slot has arrived (Yes in step S105), processor 19 increases the current value of the drawn electric current so as to transmit a response signal from transmitter circuit 15 (step S110).

[0117] After that, processor 19 performs fire detection processing (step S115). In this example, the fire detection processing is the same as the processing shown in FIG. 4, and thus a detailed description thereof is omitted here. In the fire detection processing, when the operation time slot allocated to slave 10 ends, processor 19 of slave 10 returns to step S100. Also, processor 19 according to the present embodiment performs step S35 after execution of step S25 shown in FIG. 4. That is, in the operation time

slot, the transmission of a transmission signal is not performed.

2.3 Specific Example

[0118] In the present embodiment, as shown in FIG. 8A, the entire interval from the transmission of a request signal and a synchronization signal until all of slaves 10 perform their operation is composed of communication interval Tb and detection operation interval Ta. Communication interval Tb is composed of request signal transmission interval Tb1 and response interval Tb2. Response interval Tb2 is composed of response time slots TT1, TT2... and TT64 having the same time length. That is, the time length of notification issuance detection interval Tb2 is a total length of time of operation time slots TT1, TT2... and TT64. As in Embodiment 1, it is assumed here that there are 64 slaves 10, and one of response time slots TT1, TT2... and TT64 is allocated to each slave 10 in one to one correspondence according to the identification information thereof. The configuration of detection operation interval Ta is the same as that of Embodiment 1, and thus a description thereof is omitted here.

[0119] FIG. 8B is a diagram illustrating a transition of a response operation and a transition of a fire detection operation. The transition of the fire detection operation is the same as that shown in FIG. 5B, and thus a description thereof is omitted here.

[0120] Here, the transition of the response operation will be described.

[0121] In response to reception of a request signal from master 20 in transmission interval Tb1, slave B1 performs a response operation in response time slot TT1, and slave B2 performs a response operation in response time slot TT2. After that, in each response time slot, slave 10 to which the response time slot is allocated sequentially performs a response operation, and in the last response time slot TT64, slave B64 performs a response operation. That is, it can be seen that each slave 10 performs a response operation at the point in time at which a waiting time determined according to the identification information thereof elapses.

[0122] Next, changes in the electric current drawn by slave 10 in one response time slot and one operation time slot will be described with reference to FIG. 9.

[0123] FIG. 9 shows changes in the current value of the electric current flowing through the pair of electric wires 51 and 52, with the horizontal axis indicating time and the vertical axis indicating current value. In this example, the interval (time length) between time t0 and time t3 shown in FIG. 9 is one response time slot, and the interval (time length) between time t4 and time t7 is one operation time slot. In FIG. 9, it is assumed that the current value of the electric current flowing through the pair of electric wires 51 and 52 can be increased gradually in three stages of I4, I1 and I3 from base current I0 ($I0 < I4 < I1 < I3$) by slave 10 switching the current value of the drawn electric current.

[0124] The current value of the electric current flowing through the pair of electric wires 51 and 52 is basically "I0" as shown in FIG. 9.

[0125] If slave 10 receives a request signal from master 20 and waiting time Wb elapses from the start of response interval Tb2, or in other words, if the response time slot allocated according to the identification information thereof has arrived, slave 10 transmits a response signal (see time t1 to time t2 shown in FIG. 9). To be specific, slave 10 increases or decreases the current value of the drawn electric current between two values of current value I0 and current value I4 so as to transmit a response signal from transmitter circuit 15.

[0126] After that, slave 10 starts a fire detection operation at time t4 when the operation time slot allocated thereto arrives.

[0127] When, as a result of fire detection, slave 10 transitions from the non-notification state to a fire notifying state, as shown in FIG. 9, the current value of the electric current flowing through the pair of electric wires 51 and 52 increases from "I0" to "I1". The example shown in FIG. 9 shows that slave 10 detects a fire notifying state during the period between time t5 and time t6.

[0128] When, as a result of decision, slave 10 transitions from the fire notifying state to a cooperation notifying state, as shown in FIG. 9, the current value of the electric current flowing through the pair of electric wires 51 and 52 increases from "I1" to "I3" (see time t6 to time t7 shown in FIG. 9).

[0129] In the present embodiment, as an example, it is assumed that the total length of time of detection operation interval Ta and communication interval Tb is about one second. In this case, if there are a total of 64 slaves 10, the operation time slot and the response time slot allocated to each slave 10 may be about 7 milliseconds.

[0130] However, these specific numerical values are not intended to limit the scope of the embodiment, and can be changed as appropriate. For example, in the present embodiment, the current value of the drawn electric current is allowed to vary within a predetermined tolerance range. As long as the current value is within the tolerance range, master 20 can distinguish whether the operational state of slave 10 is a fire notifying state or a cooperation notifying state.

2.4 Summation

[0131] In the present embodiment, master 20 transmits a request signal to slave 10 as a transmission signal, and receives a response signal from slave 10 as a transmission signal. That is, slave 10 and master 20 are capable of bidirectional communication of the transmission signals. However, the present invention is not limited thereto. A configuration is also possible in which slave 10 and master 20 are capable of unidirectional communication of the transmission signals.

[0132] For example, the transmission signals may be

communicated unidirectionally from master 20 to slave 10. In this case, in response to receiving, for example, a transmission signal that is a data write instruction, slave 10 performs data write processing in the response time slot allocated thereto in the response interval. With this configuration, the electric current consumed by the write processing is dispersed. At this time, the transmission of a transmission signal indicating transmission data is not performed in the notification issuance detection interval.

[0133] Alternatively, the transmission signals may be communicated unidirectionally from slave 10 to master 20. In this case, the response interval starts from the end of the notification issuance detection interval. Slave 10 performs a response operation (for example, transmission of the identification information) when a waiting time determined based on the identification information thereof elapses. With this configuration, the electric current consumed by the response operation is dispersed.

[0134] Also, with automatic fire alarm system A1 according to the present embodiment, various types of information can be exchanged between master 20 and slave 10 with the use of communication, and thus not only the identification information of the notification source as described above, but also various types of functions can be added to each slave 10.

[0135] As described above, communicator 14 of slave 10 of automatic fire alarm system A1 according to the present embodiment may perform operation as described below. Communicator 14 performs, by using the power supplied from master 20, communication with master 20 in a communication interval that is different from the notification issuance detection interval having a total length of time of the operation time slots allocated to slave 10 and each of other slaves 10.

[0136] With this configuration, slave 10 performs communication with master 20 in a communication interval that is different from the notification issuance detection interval having the operation time slot allocated thereto. Accordingly, slave 10 can transmit a fire notification and a cooperation notification in a distinguished manner. For example, if slave 10 transmits transmission data to master 20 during the communication interval, master 20 does not erroneously identify the received transmission data as a fire notification or a cooperation notification.

[0137] In this example, communicator 14 may start communication when a time determined based on the identification information elapses after the start of the communication interval.

[0138] With this configuration, slave 10 starts communication when a time determined based on the identification information thereof elapses, and thus with automatic fire alarm system A1 that uses slaves 10, the current consumption required for communication can be dispersed.

3. EMBODIMENT 3

[0139] Automatic fire alarm system A1 according to the

present embodiment will be described focusing mainly on differences from Embodiments 1 and 2. Automatic fire alarm system A1 according to the present embodiment has the same basic configuration as that of Embodiment 2, and the structural elements that are the same as those of Embodiment 2 are given the same reference numerals, and a description thereof will be omitted as appropriate.

[0140] Automatic fire alarm system A1 according to the present embodiment is different from Embodiment 2 in that the synchronization signal also functions as the request signal.

3.1 Configuration

[0141] First, transmitter 24 of master 20 according to the present embodiment will be described.

[0142] As in Embodiment 1, transmitter 24 regularly transmits a synchronization signal to a plurality of slaves 10.

[0143] Next, slave 10 according to the present embodiment will be described.

[0144] Receiver circuit 16 of slave 10 regularly receives the synchronization signal from master 20.

[0145] In response to receiver circuit 16 receiving the synchronization signal, processor 19 of slave 10 transmits a transmission signal from transmitter circuit 15 in a response time slot allocated according to the identification information thereof in the response interval. In response to receiver circuit 16 receiving the synchronization signal, processor 19 transmits a result of detection from transmitter circuit 15 in an operation time slot allocated according to the identification information of slave 10 in the notification issuance detection interval.

3.2 Operation

[0146] Hereinafter, automatic fire alarm system A1 according to the present embodiment will be described with reference to FIG. 10. FIG. 10 is a flowchart illustrating the operations of slave 10.

[0147] Processor 19 of slave 10 determines whether or not receiver circuit 16 has received a synchronization signal transmitted from master 20 (step S200).

[0148] If it is determined that receiver circuit 16 has received a synchronization signal transmitted from master 20 (Yes in step S200), processor 19 determines whether or not the response time slot corresponding to the identification information of slave 10 has arrived (step S205).

[0149] If it is decided that the response time slot has arrived (Yes in step S205), processor 19 increases the current value of the drawn electric current so as to transmit a response signal from transmitter circuit 15 (step S210).

[0150] After that, processor 19 decides whether or not the operation time slot corresponding to the identification information of slave 10 has arrived (step S215).

[0151] If it is decided that the operation time slot has

arrived (Yes in step S215), processor 19 performs fire detection processing (step S220). The fire detection processing is the same as the processing in step S15 and the subsequent steps shown in FIG. 4, and thus a detailed description thereof is omitted here. In the fire detection processing, when the operation time slot allocated to slave 10 ends, processor 19 of slave 10 returns to step S200.

3.3 Specific Example

[0152] In the present embodiment, as shown in FIG. 11A, the entire interval from the transmission of a request signal and a synchronization signal until all of slaves 10 perform their operation is composed of synchronization signal transmission interval Ta1, response interval Tb2 and notification issuance detection interval Ta2. The configuration of response interval Tb is the same as that of Embodiment 2, and the configuration of notification issuance detection interval Ta2 is the same as that of Embodiment 1, and thus a description thereof is omitted here.

[0153] FIG. 11B is a diagram illustrating a transition of a response operation and a transition of a fire detection operation.

[0154] In response to reception of a synchronization signal from master 20 in transmission interval Ta1, slave B1 performs a response operation in response time slot TT1, and slave B2 performs a response operation in response time slot TT2. After that, in each response time slot, slave 10 to which the response time slot is allocated sequentially performs a response operation, and in the last response time slot TT64, slave B64 performs a response operation.

[0155] After the end of response interval Tb2, notification issuance detection interval Ta2 starts, slave B1 performs a fire detection operation in operation time slot T1, and slave B2 performs a fire detection operation in operation time slot T2. After that, in each operation time slot, slave 10 to which the operation time slot is allocated sequentially performs a fire detection operation, and in the last response time slot T64, slave B64 performs a fire detection operation. With this configuration, it can be seen that each slave 10 starts response interval Tb2 and notification issuance detection interval Ta2 at different times in response to reception of a synchronization signal.

[0156] Changes in the electric current drawn by one slave 10 in the response time slot and the operation time slot allocated thereto are the same as those of Embodiment 2 (see FIG. 9), and thus a description thereof is omitted here.

[0157] Also, in the present embodiment, as an example, it is assumed that the total length of time of synchronization signal transmission interval Ta1, response interval Tb2 and notification issuance detection interval Ta2 is about one second. In this case, if there are a total of 64 slaves 10, the operation time slot and the response

time slot allocated to each slave 10 may be about 7 milliseconds.

[0158] However, these specific numerical values are not intended to limit the scope of the embodiment, and can be changed as appropriate. For example, in the present embodiment, the current value of the drawn electric current is allowed to vary within a predetermined tolerance range. As long as the current value is within the tolerance range, master 20 can distinguish whether the operational state of slave 10 is a fire notifying state or a cooperation notifying state.

3.4 Summation

[0159] Automatic fire alarm system A1 according to the present embodiment is configured such that slave 10 performs a response operation and a fire detection operation in the order of the response operation and the fire detection operation, but the present invention is not limited thereto. Slave 10 may perform the fire detection operation and the response operation in this order.

[0160] As described above, processor 19 of slave 10 in automatic fire alarm system A1 according to the present embodiment may perform a fire detection operation and a response operation (communication) in response to communicator 14 receiving a synchronization signal.

[0161] With this configuration, by using the reception of a synchronization signal as a trigger, slave 10 performs communication in the communication interval and a fire detection operation in the notification issuance detection interval. Accordingly, a common trigger can be provided for the communication in the communication interval and the operation in the notification issuance detection interval. Also, in master 20, a signal transmission circuit can be implemented at a lower cost than the configuration in which separate triggers are provided for the fire detection operation and the communication. For example, in the configuration in which separate triggers are provided for the fire detection operation and the communication, as described in Embodiment 2, master 20 is required to include a first transmitter circuit that transmits a synchronization signal and a second transmitter circuit that transmits a request signal. However, by providing a common trigger for the fire detection operation and the communication, it is sufficient that master 20 includes either the first transmitter circuit or the second transmitter circuit. Accordingly, the cost of master 20 is reduced.

4. Variations

[0162] The present invention has been described above by way of Embodiments 1 to 3, but the present invention is not limited to the embodiments given above. For example, the following variations can be conceived.

(1) In each of the embodiments given above, the notification issuance detection interval is time-divid-

ed into the number of slaves 10, but the present invention is not limited thereto.

It is sufficient that the notification issuance detection interval is time-divided into at least two intervals (operation time slots). One or more slave 10 is allocated to each interval obtained by the time division. With this configuration, not all of slaves 10 are allocated to one interval, and thus the electric current consumed by the fire detection operation is dispersed.

(2) In each of the embodiments given above, determiner 18 decides that the operational state is a fire notifying state if the sensor value exceeds the first threshold value, but the present invention is not limited thereto. Determiner 18 may decide that the operational state is a fire notifying state if the read sensor value exceeds the first threshold value a predetermined number of times (for example, three times) in a row.

Likewise, when determiner 18 decides that the operational state is a cooperation notifying state, determiner 18 may decide that the operational state is a cooperation notifying state if the read sensor value exceeds the second threshold value a predetermined number of times (for example, three times) in a row.

(3) In each of the embodiments given above, the fire notification and the cooperation notification are transmitted by transmitting a signal by changing the drawn electric current, but the present invention is not limited thereto.

The fire notification may be transmitted by transmitting a signal by changing the voltage.

Furthermore, likewise, the transmission signal may be transmitted by transmitting a signal by changing the voltage.

(4) Embodiment 2 described above is configured such that slave 10 that is in operation does not transmit a transmission signal in the operation time slot, but the present invention is not limited thereto.

Even in the configuration in which a response interval is provided, slave 10 that is in operation may transmit a transmission signal in the operation time slot.

(5) The embodiments and variations described above may be combined. To be specific, the present invention also encompasses other embodiments obtained by making various modifications that can be conceived by a person having ordinary skill in the art to the above embodiments as well as embodiments implemented by any combination of the structural elements and the functions of the above embodiments without departing from the scope of the present invention.

REFERENCE MARKS IN THE DRAWINGS

[0163]

10 slave

14 communicator
15 transmitter circuit
16 receiver circuit
17 storage
5 19 processor
20 master
21 applicator
A1 automatic fire alarm system

Claims

1. A slave for an automatic fire alarm system electrically connected to a pair of electric wires to which a voltage is applied, the slave comprising:

a storage that stores identification information unique to the slave;

a communicator that receives a synchronization signal transmitted from a master in order to synchronize with another slave, the synchronization signal being a signal indicated by a change in the voltage applied to the pair of electric wires; and

a processor that performs, by using power supplied from the master, a fire detection operation in an operation time slot allocated according to the identification information stored in the storage in response to the communicator receiving the synchronization signal.

2. The slave for an automatic fire alarm system according to claim 1, wherein the communicator performs, by using the power supplied from the master, communication with the master in a communication interval that is different from a notification issuance detection interval whose length is equal to a total length of time of the operation time slot allocated to the slave and an operation time slot allocated to the other slave.

3. The slave for an automatic fire alarm system according to claim 2, wherein the processor performs the fire detection operation and the communication when the communicator receives the synchronization signal.

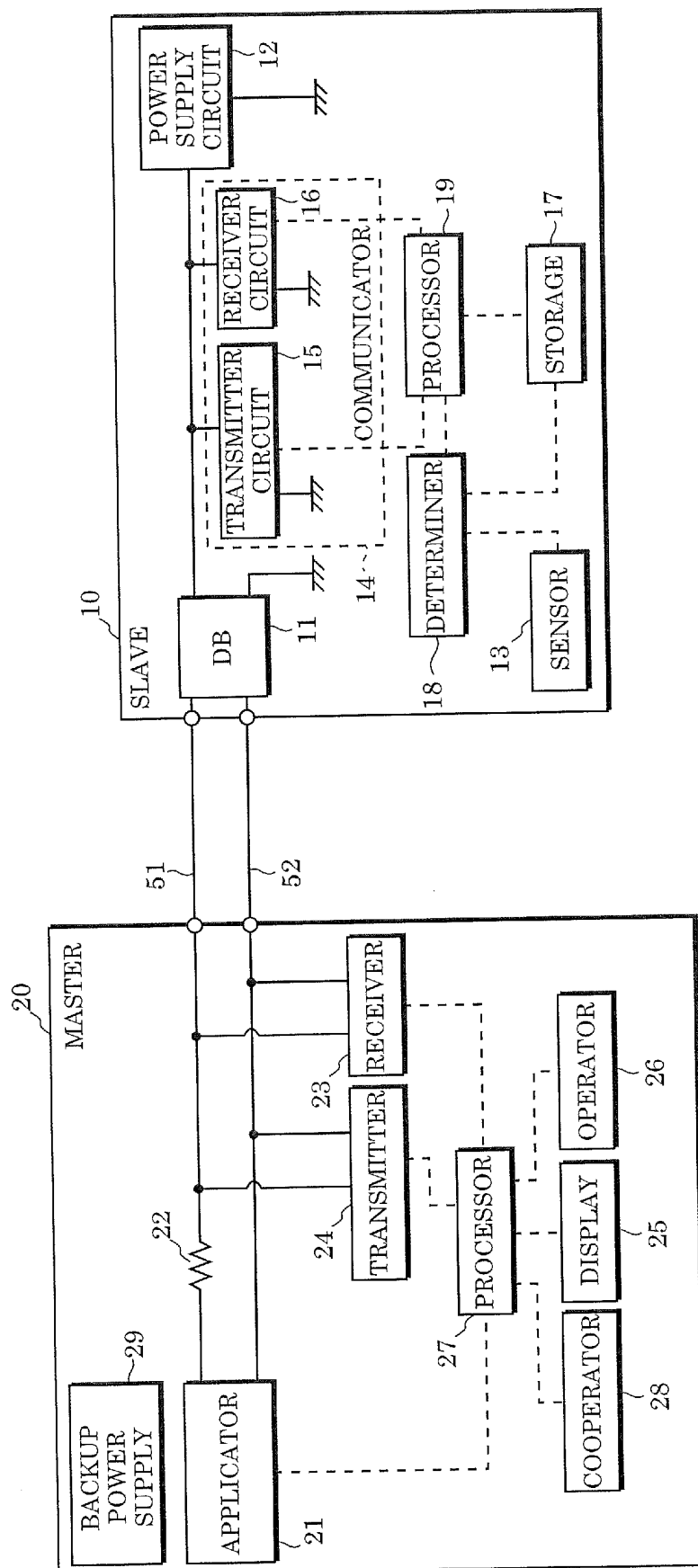
4. The slave for an automatic fire alarm system according to claim 2 or 3, wherein the communicator starts the communication when a time determined based on the identification information elapses after start of the communication interval.

5. The slave for an automatic fire alarm system according to any one of claims 1 to 4, wherein the communicator includes a transmitter circuit that transmits a signal corresponding to the fire

detection operation by changing an electric current drawn from the pair of electric wires,
in response to the fire detection operation, the transmitter circuit transmits a fire notification signal informing occurrence of a fire and a cooperation notification signal causing the other apparatus to work in cooperation, and
a first current value of the electric current drawn from the pair of electric wires by the transmitter circuit when transmitting the fire notification signal and a second current value of the electric current drawn from the pair of electric wires by the transmitter circuit when transmitting the cooperation notification signal are different.

6. The slave for an automatic fire alarm system according to claim 1,
wherein the communicator includes a transmitter circuit that transmits a fire notification signal informing occurrence of a fire by changing an electric current drawn from the pair of electric wires in the fire detection operation, and
the transmitter circuit further transmits an identification signal representing the identification information at a point in time at which a predetermined waiting time elapses after the transmission of the fire notification.
7. An automatic fire alarm system comprising:
the slave according to any one of claims 1 to 6;
and
the master that applies a voltage to the pair of electric wires.

FIG. 1



A1

FIG. 2

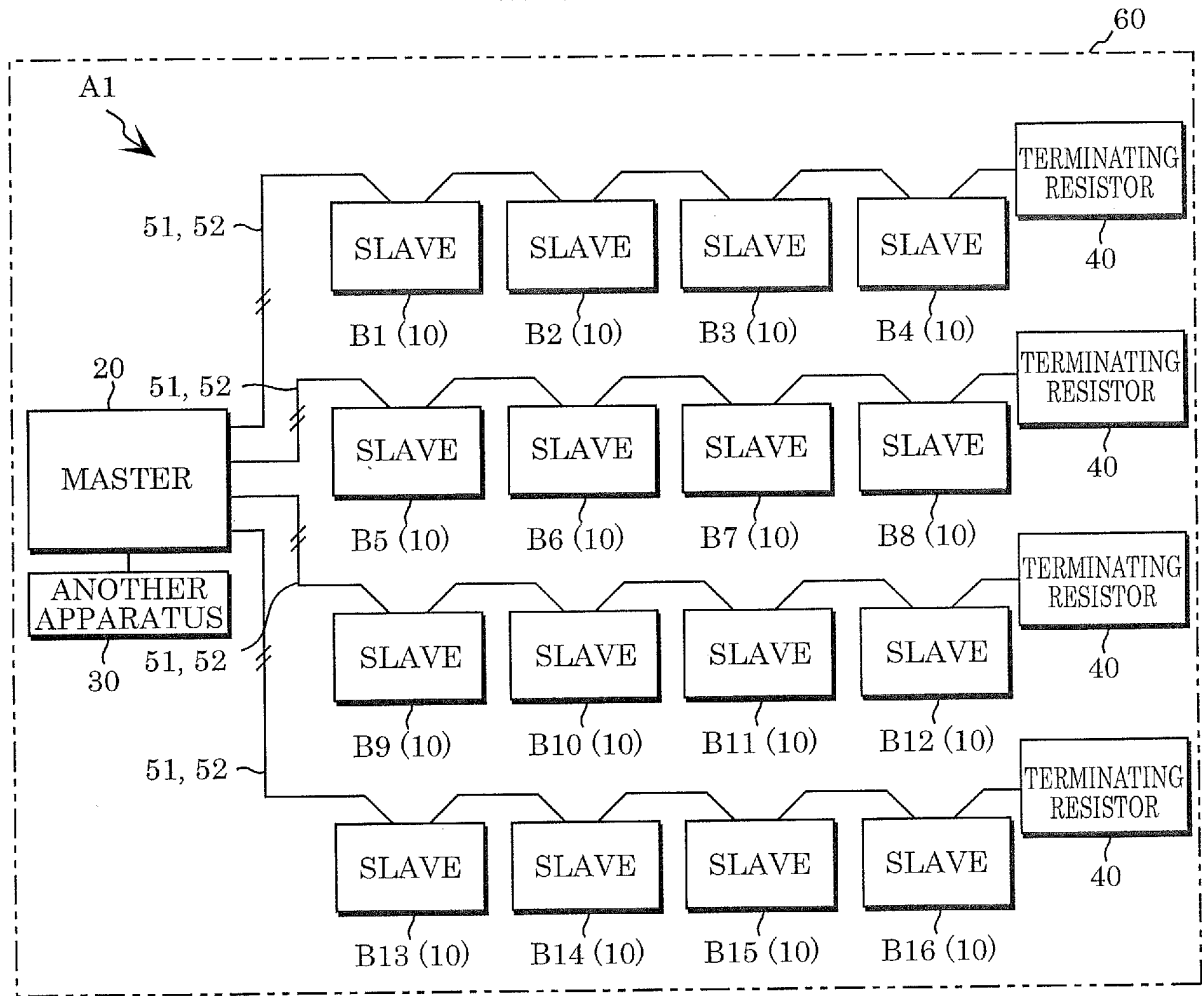


FIG. 3

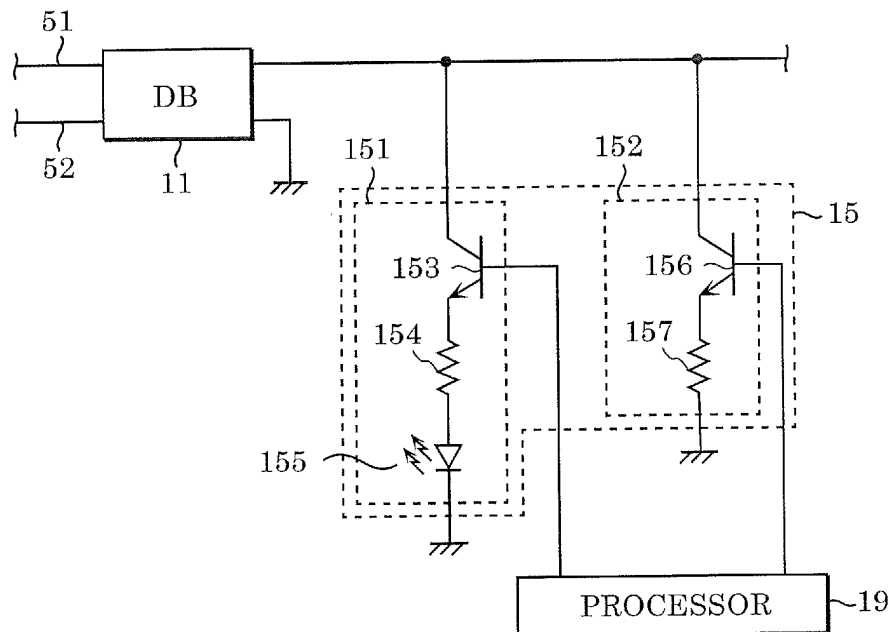


FIG. 4

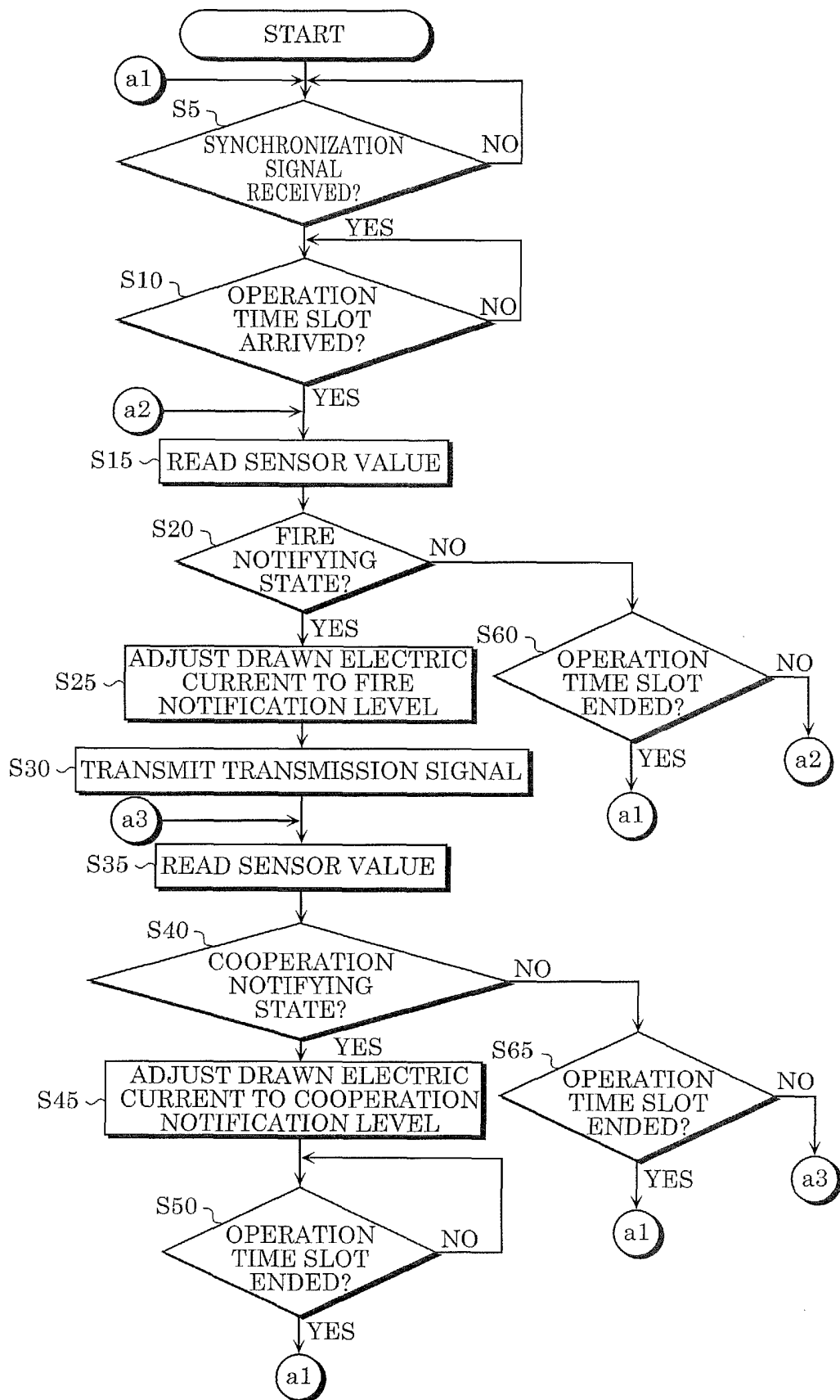


FIG. 5A

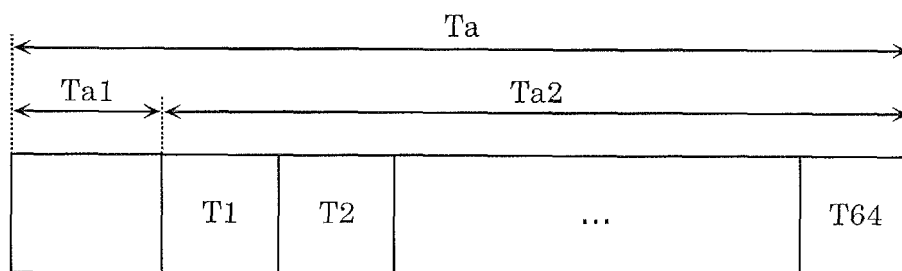


FIG. 5B

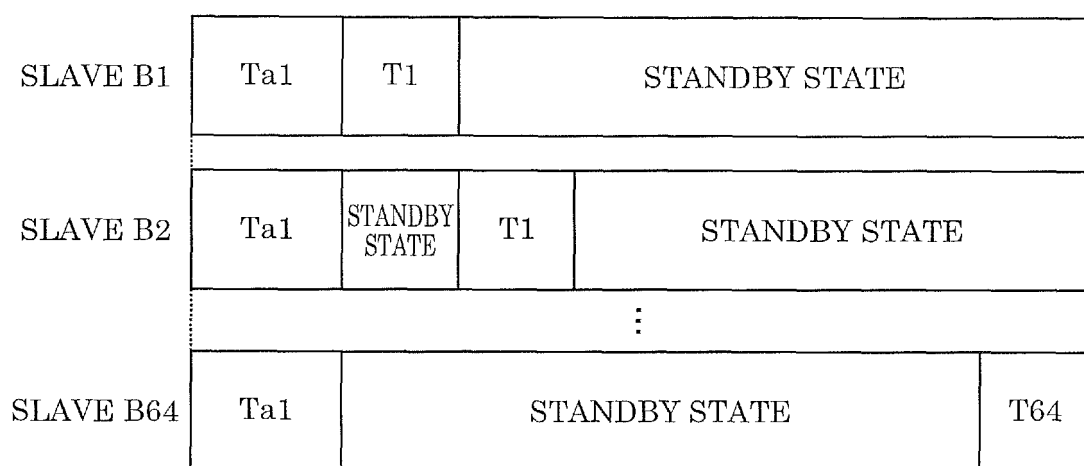


FIG. 6

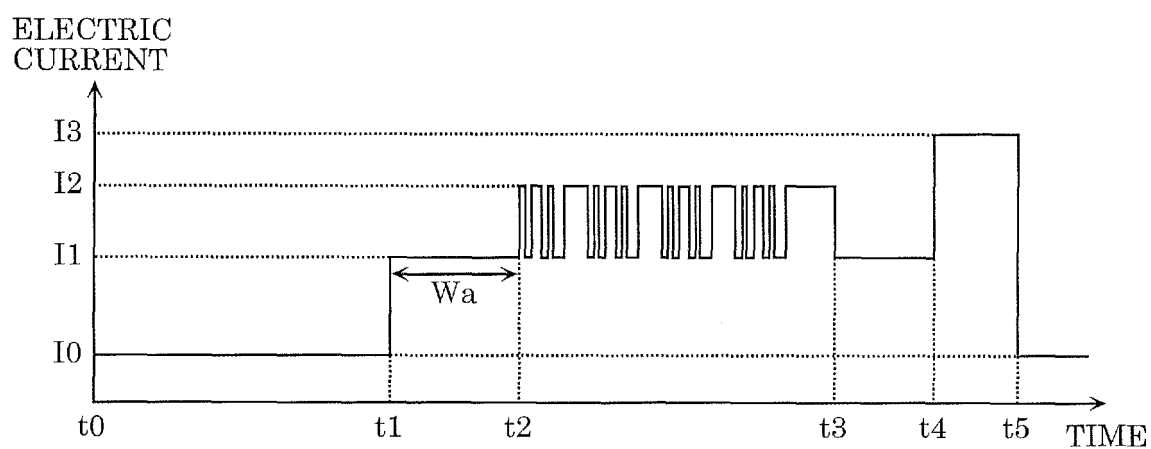


FIG. 7

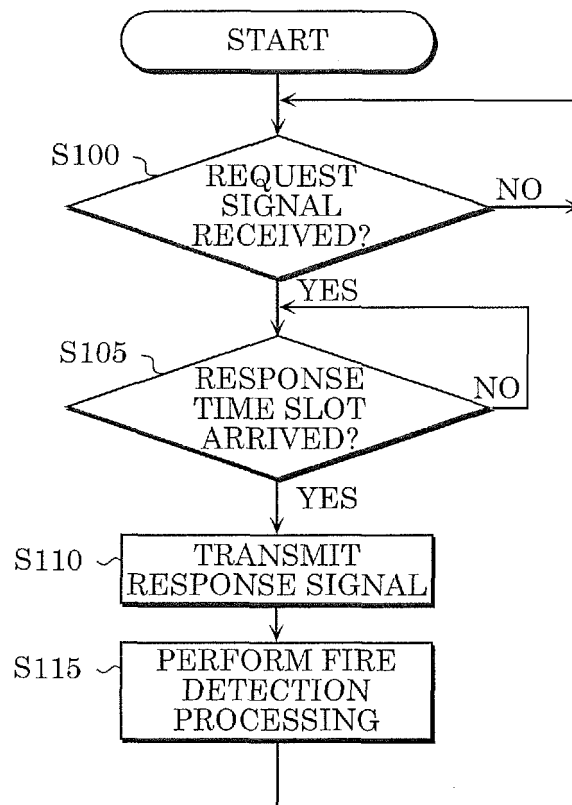


FIG. 8A

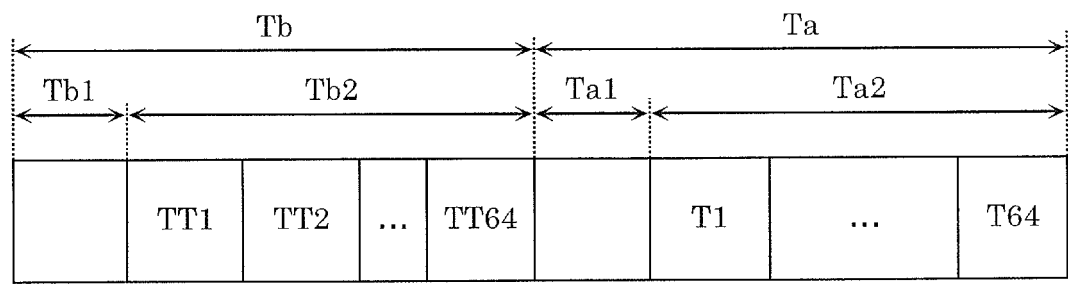


FIG. 8B

SLAVE B1	Tb1	TT1	...	Ta1	T1	...
SLAVE B2	Tb1		TT2	...	Ta1	T2
	⋮					
SLAVE B64	Tb1	...	TT64	Ta1	...	T64

FIG. 9

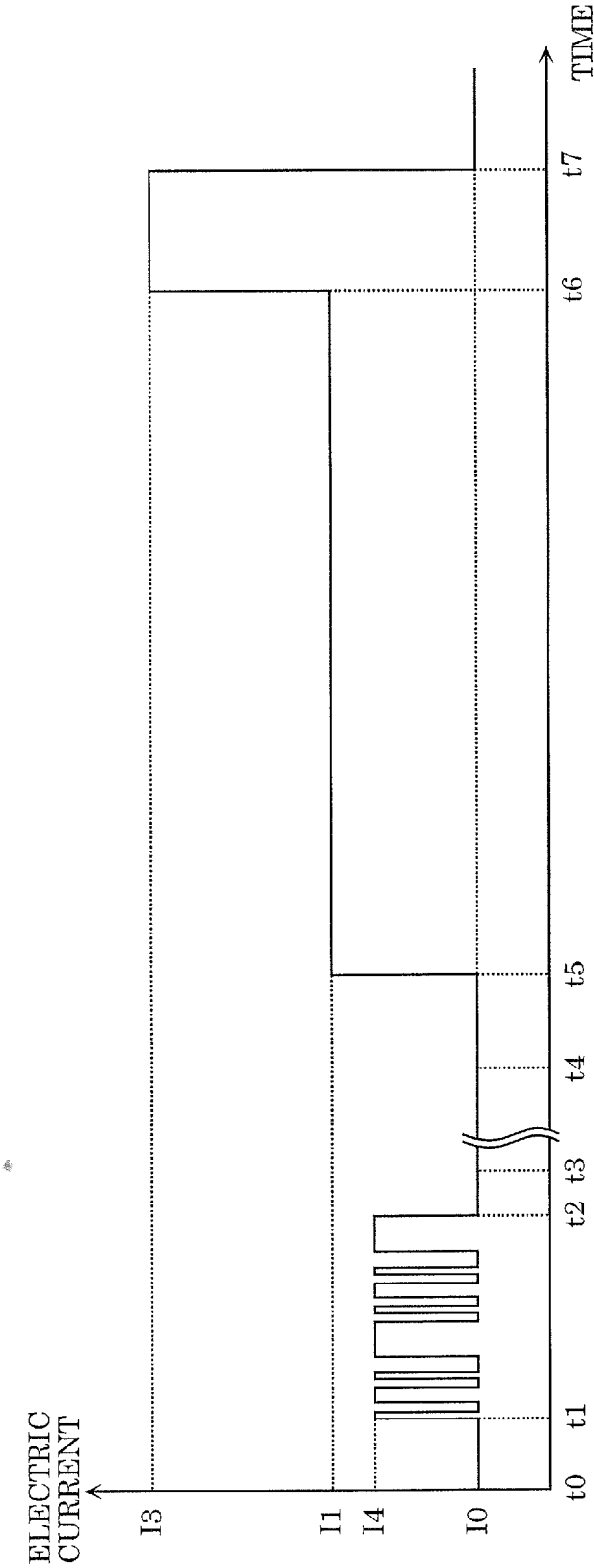


FIG. 10

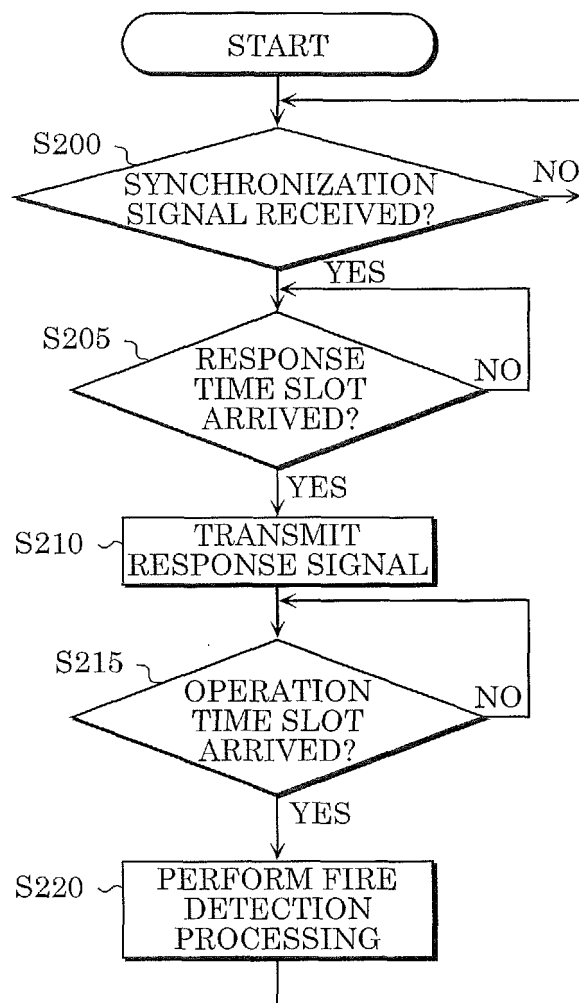


FIG. 11A

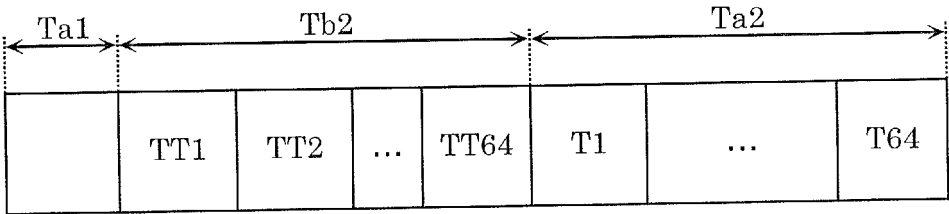
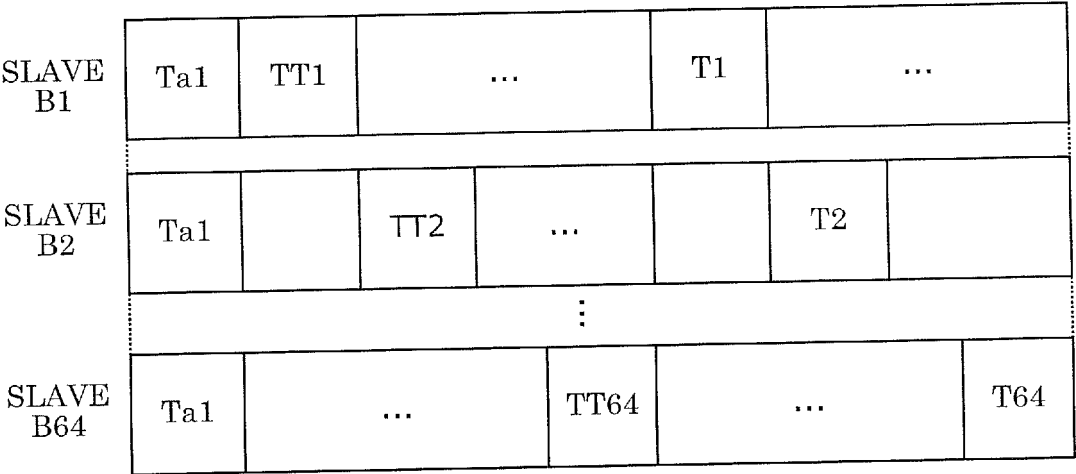


FIG. 11B



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/003490

A. CLASSIFICATION OF SUBJECT MATTER

G08B17/00(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)

G08B17/00

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015

Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2004-303038 A (Nohmi Bosai Ltd.),	1-4, 7
Y	28 October 2004 (28.10.2004), paragraphs [0007] to [0050]; fig. 1 to 9 (Family: none)	5-6
Y	JP 58-133890 U (Hochiki Corp.), 09 September 1983 (09.09.1983), pages 6 to 17; fig. 2 to 3 (Family: none)	5-6
Y	JP 2007-264784 A (Nohmi Bosai Ltd.), 11 October 2007 (11.10.2007), paragraphs [0008], [0011] (Family: none)	6

☐ 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

01 September 2015 (01.09.15)

Date of mailing of the international search report

06 October 2015 (06.10.15)

Name and mailing address of the ISA/
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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2002008154 A [0006]