(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 191 554 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
07.06.2023 Bulletin 2023/23

(21) Application number: **22207691.1**

(22) Date of filing: **16.11.2022**

(51) International Patent Classification (IPC):
G08B 25/00 *(2006.01)* ***G08B 25/10*** *(2006.01)*
H04W 40/12 *(2009.01)*

(52) Cooperative Patent Classification (CPC):
G08B 25/007; G08B 25/10

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **02.12.2021 JP 2021196373**

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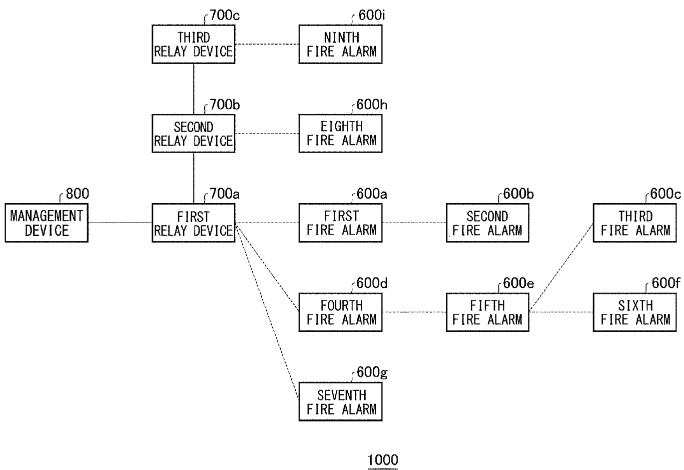
(54) **ALARM SYSTEM, CONTROLLER, ASSIGNMENT METHOD, PROGRAM**

(57) A technology for reducing the delay time in transfer in a multihop network is provided. A first time slot, of a plurality of time slots arranged on a time axis, is assigned to a first fire alarm 600a. A second time slot, of the plurality of time slots arranged on the time axis, different from the first time slot is assigned to a second fire alarm 600b. An order of the first time slot and the second time slot in the plurality of time slots is determined in accordance with a first hop count between the first fire alarm 600a and the first relay device 700a and a second hop count between the second fire alarm 600b and the first relay device 700a.

FIG. 1



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Description

[TECHNICAL FIELD]

[0001] The present disclosure relates to alarm technology and, in particular, to an alarm system, a controller, an assignment method, and a program that use a multihop network.

[BACKGROUND ART]

[0002] A fire alarm outputs an alarm when it detects a fire. By building wireless communication functions in the fire alarm and forming a multihop network by a plurality of fire alarms, it is possible, when one fire alarm detects a fire, for another fire alarm to output an alarm (see, for example, patent literature 1).

[0003] [Patent Literature 1] JP2011-35468

[SUMMARY OF INVENTION]

[TECHNICAL PROBLEM]

[0004] In the case a multihop network is formed by a plurality of fire alarms, it is desired to reduce the delay time in transfer in the multihop network.

[0005] The present disclosure addresses this issue, and a purpose thereof is to provide a technology of reducing the delay time in transfer in a multihop network.

[SOLUTION TO PROBLEM]

[0006] The alarm system according to an embodiment of the present disclosure includes: a plurality of alarms that form a multihop network extending from a relay device. The plurality of alarms include a first alarm and a second alarm. A first time slot, of a plurality of time slots arranged on a time axis, is assigned to the first alarm, and the first alarm transmits a signal in the first time slot, a second time slot, of the plurality of time slots arranged on the time axis, different from the first time slot is assigned to the second alarm, and the second alarm transmits a signal in the second time slot, and an order of the first time slot and the second time slot in the plurality of time slots is determined in accordance with a first hop count between the first alarm and the relay device and a second hop count between the second alarm and the relay device.

[0007] Another embodiment of the present disclosure relates to a controller. The controller is a controller for a plurality of alarms that form a multihop network extending from a relay device, the controller including: an assignment unit that assigns a first time slot, of a plurality of time slots arranged on a time axis, to a first alarm included in the plurality of alarms and assigns a second time slot, of the plurality of time slots arranged on the time axis, different from the first time slot to a second alarm included in the plurality of alarms; and an output unit that outputs a result of assignment in the assignment unit. The assignment unit determines an order of the first time slot and the second time slot in the plurality of time slots in accordance with a first hop count between the first alarm and the relay device and a second hop count between the second alarm and the relay device.

[0008] Still another embodiment of the present disclosure relates to an assignment method. The method is an assignment method adapted for a plurality of alarms that form a multihop network extending from a relay device, the method including: assigning a first time slot, of a plurality of time slots arranged on a time axis, to a first alarm included in the plurality of alarms and assigns a second time slot, of the plurality of time slots arranged on the time axis, different from the first time slot to a second alarm included in the plurality of alarms; and outputting a result of assignment. The assigning determines an order of the first time slot and the second time slot in the plurality of time slots in accordance with a first hop count between the first alarm and the relay device and a second hop count between the second alarm and the relay device.

[0009] Optional combinations of the aforementioned constituting elements, and implementations of the disclosure in the form of methods, apparatuses, systems, recording mediums, and computer programs may also be practiced as additional modes of the present disclosure.

[ADVANTAGEOUS EFFECTS OF INVENTION]

[0010] According to the present disclosure, it is possible to provide information for determining at which position the fire alarm should be constructed to build a multihop network.

[BRIEF DESCRIPTION OF DRAWINGS]

[0011]

Fig. 1 shows a configuration of an alarm system according to the embodiment;
Fig. 2 shows a configuration of the fire alarm of Fig. 1;
Figs. 3A-3D show a configuration of a super frame used in the alarm system of Fig. 1;
Fig. 4 shows a configuration of the relay device of Fig. 1;
Fig. 5 shows an exemplary assignment of time slots in the alarm system 1000 of Fig 1;
Fig. 6 shows an outline of downlink communication in the alarm system of Fig. 1;
Fig. 7 shows an outline of uplink communication in the alarm system of Fig. 1;
Fig. 8 shows an outline of routing in the alarm system of Fig. 1;
Fig. 9 is a sequence chart showing steps of routing in the alarm system of Fig. 1;
Figs. 10A-10B show a data structure of a table maintained in the n+1th fire alarm of Fig. 8;
Figs. 11A-11B show a data structure of a table maintained in the n+3th fire alarm 600n+3 of Fig. 9;
Figs. 12A-12B show an outline of the construction of the alarm system of Fig. 1;
Fig. 13 shows a configuration of the external appliance of Fig. 12A;
Fig. 14 shows a screen displayed on the display unit of Fig. 13;
Figs. 15A-15B shows a partial configuration of the alarm system of Fig. 1;
Fig. 16 shows an outline of downlink communication in the alarm system of Fig. 15A; and
Figs. 17A-17B show an outline of downlink communication in the alarm system of Fig. 15B.

[DESCRIPTION OF EMBODIMENTS]

[0012] A brief summary will be given before describing the present disclosure in specific details. The embodiment relates to an alarm system provided in a facility such as a multi-unit apartment building, an independent housing, an office, and a hospital. In the alarm system, a relay device is connected to a management device, and a plurality of fire alarms are connected to the relay device in a wireless multihop network. In this network, the management device represents the higher level, and the fire alarm with the largest hop count from the relay device represents the lower level. Upon detecting an outbreak of a fire, the fire alarm transfers a result of detection to the relay device, and the relay device transfers the result of detection to the management device. When the result of detection is received, the management device selects one or more fire alarms that should output an alarm and transmits an instruction to output an alarm to the one or more selected fire alarms as the ultimate destinations. The relay device and the fire alarm transfer the instruction to output an alarm to the fire alarm at the ultimate destination, and the fire alarm at the ultimate destination outputs an alarm upon receiving the instruction to output an alarm.

[0013] Given that the line for a signal from the relay device to the fire alarm with the largest hop count from the relay device is referred to as "downlink line", the line for a signal from the fire alarm with the largest hop count to the relay device is referred to as "uplink line". In this embodiment, one frame is formed by arranging a plurality of time slots, and one super frame is formed by arranging a plurality of frames. Further, one fire alarm is allocated to one time slot for the downlink line (hereinafter, "downlink communication time slot") and is also allocated to one time slot for the uplink line (hereinafter, "uplink communication time slot"). The downlink communication time slot is used for transfer on the downlink line, and the uplink communication time slot is used for transfer on the uplink line.

[0014] In the downlink line, a signal for establishing synchronization on the multihop network (hereinafter, "synchronization signal") is periodically transferred in addition to the instruction to output an alarm. On the other hand, the uplink line is used mainly to transfer the result of detection. In the following description, a synchronization signal, a detection result, an instruction to output an alarm may generically be referred to as "communication signals".

[0015] Hereinafter, the embodiment will be described in the order (1) basic configuration, (2) routing, (3) construction, and (4) revision to time slot assignment.

(1) Basic configuration

[0016] Fig. 1 shows a configuration of an alarm system 1000. The alarm system 1000 includes a first fire alarm 600a through a ninth fire alarm 600i, which are generically referred to as fire alarms 600, a first relay device 700a through a third relay device 700c, which are generically referred to as relay devices 700, and a management device 800. The number of fire alarms 600 is not limited to "9", and the number of relay devices 700 is not limited to "3".

[0017] The alarm system 1000 is a system applied to facilities such as houses, offices, and commercial facilities to detect a fire and alert that a fire has broken out. The plurality of fire alarm 600 are, for example, home fire alarms and are provided with fire detection sensors. The plurality of fire alarm 600 are provided on, for example, the ceilings of facilities but may be provided on the walls, etc.

[0018] The first fire alarm 600a through the sixth fire alarm 600f form a wireless multihop network extending from the first relay device 700a. For example, a relay route that links the first relay device 700a, the first fire alarm 600a, and the second fire alarm 600b and a relay route that links the first relay device 700a, the fourth fire alarm 600d, the fifth fire alarm 600e, and the third fire alarm 600c are formed. Further, a relay route that links the first relay device 700a, the fourth fire alarm 600d, the fifth fire alarm 600e, and the sixth fire alarm 600f and a relay route that links the first relay device 700a and the seventh fire alarm 600g are also formed. These relay routes are determined by the respective fire alarm 600 and are shared by the first relay device 700a and the management device 800.

[0019] In these relay routes, the first fire alarm 600a, the fourth fire alarm 600d, and the seventh fire alarm 600g can communicate with the first relay device 700a in "1" hop. The second fire alarm 600b and the fifth fire alarm 600e can communicate with the first relay device 700a in "2" hops. The third fire alarm 600c and the sixth fire alarm 600f can communicate with the first relay device 700a in "3" hops.

[0020] The second relay device 700b, the third relay device 700c, the eighth fire alarm 600h, and the ninth fire alarm 600i are configured in a manner similar to that of the first relay device 700a, the first fire alarm 600a, etc. For example, a multihop network starting from the first relay device 700a is provided on the first floor of a facility, a multihop network starting from the second relay device 700b is provided on the second floor of the facility, and a multihop network starting from the third relay device 700c is provided on the third floor of the facility. Different frequencies are used in the multihop network starting from the first relay device 700a, the multihop network starting from the second relay device 700b, and the multihop network starting from the third relay device 700c. Further, the first relay device 700a, the second relay device 700b, and the third relay device 700c communicate with each other wirelessly or by wire.

[0021] Thus, the relay device 700 communicates with the plurality of fire alarm 600 that form the multinetwork wirelessly and communicates with the other relay devices 700 wirelessly or by wire. It can be said that the relay device 700 relays communication between the plurality of fire alarm 600 included in the multihop network. Further, the first relay device 700a is connected to the management device 800 by a cable and communicates with the management device 800 by wire.

[0022] The management device 800 is, for example, a controller of a home energy management system (HEMS) provided in the facility. The management device 800 can communicate with a plurality of appliances provided in the facility. The plurality of appliances include, for example, air conditioners, illumination appliances, hot water dispensers, etc. having a communication function. Further, the management device 800 can communicate with the first relay device 700a provided in the facility. The management device 800 can also communicate with the second relay device 700b, the third relay device 700c, and the fire alarms 600 via the first relay device 700a.

[0023] Fig. 2 shows a configuration of the fire alarm 600. The fire alarm 600 includes a communication unit 620, a processing unit 622, a control unit 624, a fire detection sensor 630, and a buzzer 632. A publicly known technology may be used in the fire detection sensor 630. For example, the fire detection sensor 630 may be an optical smoke detection sensor and may detect a fire by detecting the smoke in a fire by utilizing diffuse reflection of light. For example, the fire detection sensor 630 may be a heat detection sensor and may detect a fire by detecting the heat from a fire. For example, the fire detection sensor 630 may be a carbon monoxide detection sensor and may detect a fire by detecting the density of carbon monoxide generated by combustion in a fire. For example, the fire detection sensor 630 may be an infrared detection sensor and may detect a fire by detecting infrared rays radiated by combustion in a fire.

[0024] The communication unit 620 communicates with the other fire alarm 600 or the relay device 700 wirelessly. The processing unit 622 processes a signal received by the communication unit 620 or generates a signal that should be transmitted from the communication unit 620. The control unit 624 controls the operation of the communication unit 620 and the processing unit 622. The detail of the control unit 624 will be described later. The buzzer 632 can output a buzzer sound. The fire alarm 600 may be configured not to include the buzzer 632 and include the fire detection sensor 630. In other words, the fire alarm 600 may be configured to have the detection function and the communication function. The fire alarm 600 configured as described above can be said to be a sensor capable of alerting that a fire is detected.

[0025] Figs. 3A-3D show a configuration of a super frame used in the alarm system 1000. As shown in Fig. 3A, a predefined period of time is defined as the super frame 1010. The super frame 1010 is arranged repeatedly. The super frame 1010 is divided into a plurality of frames 1020. As shown in Fig. 3B, one frame 1020 is divided into a plurality of time slots 1030. Fig. 3C shows one time slot 1030. The communication signal is transmitted in the time slot 1030. The duration of the communication signal is shorter than the duration of one time slot 1030.

[0026] Fig. 3D shows the usage of the plurality of time slots 1030 included in the frame 1020 shown in Fig. 3B. Of the plurality of time slots 1030, one or more time slots 1030 in the leading portion are used as "downlink communication time slots". One time slot 1030 following the downlink communication time slots is used as an "uplink communication time slot". One or more time slots 1030 following the uplink communication time slot are used as "backup slots". The number of downlink communication time slots and the number of uplink communication time slots are identical and are equal to or larger than the number of fire alarm 600 included in the multihop network. Backup slots may not be provided.

[0027] Fig. 4 shows a configuration of the relay device 700. The relay device 700 can be said to be a controller for the plurality of fire alarms 600 that form the multihop network. The relay device 700 includes a communication unit 710, a control unit 720. The communication unit 710 includes an output unit 712. The control unit720 includes an assignment unit 722. The communication unit 710 has the communication function for communicating with the plurality of relay devices 700 and also has the communication function for communicating with the management device 800. The control unit 720 controls the operation of the relay device 700.

[0028] By communicating with the plurality of fire alarms 600 that form the multihop network, the communication unit 710 receives the result of routing performed in the respective fire alarms 600. Routing performed in the respective fire alarms 600 will be described later. The result of routing indicates the relay routes as shown in Fig. 1.

[0029] The assignment unit 722 assigns a combination of one downlink communication time slot and one uplink communication time slot shown in Fig. 3D to one fire alarm 600 based on the result of routing. Assignment by the assignment unit 722 will also be described later. The combination of the downlink communication time slot and the uplink communication time slot is changed depending on the fire alarm 600. The output unit 712 outputs the result of assignment by the assignment unit 722 to the plurality of fire alarms 600. The result of assignment shows the correspondence between the combination of the downlink communication slot/the uplink communication slot and the fire alarm 600.

[0030] Fig. 5 shows an exemplary assignment of time slots in the alarm system 1000 as similarly shown in Fig. 3D. The figure shows the assignment of a plurality of time slots 1030 to the first relay device 700a, the first fire alarm 600a through the seventh fire alarm 600g of Fig. 1. "M" in Fig. 5 denotes the first relay device 700a, and "S1" through "S7" denote the first fire alarm 600a through the seventh fire alarm 600g, respectively. The first relay device 700a, the first fire alarm 600a, the fourth fire alarm 600d, the seventh fire alarm 600g, the second fire alarm 600b, the fifth fire alarm 600e, the third fire alarm 600c, and the sixth fire alarm 600f are sequentially allocated to downlink communication time slots, with the first relay device 700a preceding the rest. As described above, the hop count from the first fire alarm 600a, the fourth fire alarm 600d, and the seventh fire alarm 600g to the first relay device 700a is "1". The hop count from the second fire alarm 600b and the fifth fire alarm 600e to the first relay device 700a is "2", and the hop count from the third fire alarm 600c and the sixth fire alarm 600f to the first relay device 700a is "3". In other words, the smaller the hop count to the first relay device 700a, the earlier the downlink communication slot assigned to the fire alarm 600.

[0031] The the sixth fire alarm 600f, the third fire alarm 600c, the fifth fire alarm 600e, the second fire alarm 600b, the seventh fire alarm 600g, the fourth fire alarm 600d, the first fire alarm 600a, and the first relay device 700a are sequentially allocated to uplink communication time slots, with the sixth fire alarm 600f preceding the rest. In other words, the larger the hop count to the first relay device 700a, the earlier the uplink communication time slot assigned to the fire alarm 600.

[0032] To highlight the fifth fire alarm 600e with the hop count "2", the downlink communication slot earlier than the time slot assigned to the sixth fire alarm 600f with the hop count "2" is assigned to the fifth fire alarm 600e. The downlink communication time slot is used when a signal (communication signal) is transferred in a direction away from the first relay device 700a in the multihop network. Further, the uplink communication slot later than the time slot assigned to the sixth fire alarm 600f is assigned to the fifth fire alarm 600e. The uplink communication time slot is used when a signal (communication signal) is transferred in a direction toward the first relay device 700a in the multihop network. In other words, of the plurality of time slots 1030, the relay device 700 determines the time slot 1030 assigned to each fire alarm 600 in accordance with the hop count between the fire alarm 600 and the relay device 700.

[0033] The downlink communication time slot "S5" and the uplink communication time slot "S5" are assigned to the fifth fire alarm 600e, and the fifth fire alarm 600e transmits a signal (communication signal) in the downlink communication time slot "S5" or the uplink communication time slot "S5". The downlink communication time slot "S6" and the uplink communication time slot "S6" are assigned to the sixth fire alarm 600f, and the sixth fire alarm 600f transmits a signal (communication signal) in the downlink communication time slot "S6" or the uplink communication time slot "S6".

[0034] The assignments of time slots 1030 is determined by the assignment unit 722 of the first relay device 700a but may be determined by the management device 800. For example, the first relay device 700a or the management device 800 determines the assignment of the time slots 1030 based on the information on the relay routes. The first relay device 700a or the management device 800 notifies the fire alarms 600 of the assignment of the time slots 1030 thus determined. Therefore, the fire alarms 600 also have the knowledge of the assignment of the time slots 1030. As a result, each fire alarm 600 has the knowledge of the time slot 1030 in which the communication signal should be transmitted and which is assigned to the fire alarm 600. The fire alarm 600 also has the knowledge of the time slot 1030 in which the communication signal from the adjacent fire alarm 600 or the relay device 700 on the relay route can be received.

[0035] In this setup, the communication unit 620 of the fire alarm 600 may perform an intermittent receiving operation to reduce power consumption. In the intermittent receiving operation in the communication unit 620, a receiving operation is performed during a predefined period of time in the leading portion of the time slot 1030, and the receiving operation is suspended in the remainder of the time slot 1030 if a signal (communication signal) is not received during the predefined period of time. When a signal is received during the predefined period of time in the leading portion of the time slot 1030, the receiving operation is continued in the remainder of the time slot 1030.

[0036] Fig. 6 shows an outline of downlink communication in the alarm system 1000. The figure shows downlink communication time slots of Fig. 5. The first relay device 700a periodically transmits a synchronization signal to the plurality of fire alarm 600 that form the multihop network. The synchronization signal is, for example, a beacon signal.

The synchronization signal is transmitted in, for example, the leading frame 1020 of the super frame 1010 shown in Fig. 3A and is not transmitted in the remaining frames 1020. The first relay device 700a transmits the synchronization signal in the time slot 1030 "M" in the leading frame 1020 of the super frame 1010. When the fourth fire alarm 600d receives the synchronization signal in the time slot 1030 "M", the fourth fire alarm 600d transfers the synchronization signal in the time slot 1030 "S4". Further, the fourth fire alarm 600d transmits a response signal to the first relay device 700a in the time slot 1030 "S4". The response signal is, for example, Ack (ACKnowledgment). The response signal may be included in a portion of the synchronization signal.

[0037] The first relay device 700a receives the response signal in the time slot 1030 "S4". When the fifth fire alarm 600e receives the synchronization signal in the time slot 1030 "S4", the fifth fire alarm 600e transfers the synchronization signal and transmits the response signal to the fourth fire alarm 600d in the time slot 1030 "S5". The fourth fire alarm 600d receives the response signal in the time slot 1030 "S5". The fourth fire alarm 600d transfers the response signal from the fifth fire alarm 600e to the first relay device 700a in the time slot 1030 "S4" of the next frame (not shown in Fig. 11).

[0038] When the third fire alarm 600c receives the synchronization signal in the time slot 1030 "S5", the third fire alarm 600c transfers the synchronization signal and transmits the response signal to the fifth fire alarm 600e in the time slot 1030 "S3". When the sixth fire alarm 600f receives the synchronization signal in the time slot 1030 "S5", the sixth fire alarm 600f transfers the synchronization signal and transmits the response signal to the fifth fire alarm 600e in the time slot 1030 "S6".

[0039] The fifth fire alarm 600e receives the response signal in the time slots 1030 "S3" and "S6". The fifth fire alarm 600e transfers the response signal from the third fire alarm 600c and the response signal from the sixth fire alarm 600f to the fourth fire alarm 600d in the time slot 1030 "S5" of the next frame (not shown in Fig. 6). The fourth fire alarm 600d transfers the response signal from the fifth fire alarm 600e to the first relay device 700a in the time slot 1030 "S4" in the frame after next.

[0040] Thus, the synchronization signal is transferred in the frame 1020 in which the first relay device 700a transmitted the synchronization signal. Further, the fire alarm 600 receiving the synchronization signal from the first relay device 700a establishes timing synchronization with the first relay device 700a based on the synchronization signal. A publicly known technology may be used for timing synchronization so that a description thereof is omitted.

[0041] Fig. 7 shows an outline of uplink communication in the alarm system 1000. The figure shows uplink communication time slots of Fig. 5. It is assumed here that the fire detection sensor 630 of the sixth fire alarm 600f detects an outbreak of a fire. The processing unit 622 of the sixth fire alarm 600f causes the communication unit 620 to transmit a detection result. The detection result includes identification information on the sixth fire alarm 600f that has detected the fire. The communication unit 620 of the sixth fire alarm 600f transmits the detection result in the time slot 1030 "S6".

[0042] The fifth fire alarm 600e receives the detection result in the time slot 1030 "S6". Subsequently, the fifth fire alarm 600e transfers the detection result in the time slot 1030 "S5". Further, the fifth fire alarm 600e transmits a response signal to the sixth fire alarm 600f in the time slot 1030 "S5". The response signal may be included in a portion of the detection result.

[0043] The sixth fire alarm 600f receives the response signal in the time slot 1030 "S5". The fourth fire alarm 600d receives the detection result in the time slot 1030 "S5". The fourth fire alarm 600d transfers the detection result and transmits a response signal to the fifth fire alarm 600e in the time slot 1030 "S4".

[0044] The fifth fire alarm 600e receives the response signal in the time slot 1030 "S4". The fifth fire alarm 600e transfers the response signal from the fourth fire alarm 600d to the sixth fire alarm 600f in the time slot 1030 "S5" of the next frame 1020 (not shown in Fig. 12).

[0045] The first relay device 700a receives the detection result in the time slot 1030 "S4". In a manner as already described, the first relay device 700a transmits a response signal in the time slot 1030 "M". The response signal is transferred by the fourth fire alarm 600d and the fifth fire alarm 600e and is received by the sixth fire alarm 600f.

[0046] When the first relay device 700a receives a detection result from the fourth fire alarm 600d, the first relay device 700a transfers the detection result to the management device 800. When the management device 800 receives the detection result, the management device 800 identifies the fire alarm 600 that should output an alarm based on the identification information included in the detection result. The correspondence between the identification information and the information on the fire alarm 600 that should output an alarm is stored in the management device 800 in advance. The management device 800 transmits an instruction to output an alarm to the first relay device 70, designating the identified fire alarm 600 as the ultimate destination.

[0047] When the fire alarms 600 identified by the management device 800 are the third fire alarm 600c and the sixth fire alarm 600f, an instruction to output an alarm is received by the third fire alarm 600c and the sixth fire alarm 600f by transferring the signal in the same manner as illustrated in Fig. 6. In this case, the instruction to output an alarm is transmitted instead of the synchronization signal of Fig. 6. When the instruction to output an alarm is received from the management device 800 by way of the first relay device 700a, the second relay device 700b and the third relay device 700c transfer the instruction to output an alarm to the fire alarm 600. When the communication units 620 of the third fire alarm 600c and the sixth fire alarm 600f receive the instruction to output an alarm, the control unit 624 causes the buzzer

632 to sound an alarm. The control unit 624 may cause a light-emitting device to flash.

(2) Routing

[0048] In the above description, it is assumed that the relay routes as shown in Fig. 1 are formed. A description will be given here of the formation and modification of relay routes with reference also to Fig. 8. Fig. 8 shows an outline of routing in the alarm system 1000. Fig. 8 shows an n+1th fire alarm 600n+1, an n+2th fire alarm 600n+2, an n+3th fire alarm 600n+3, and the relay device 700 of the alarm system 1000. The n+1th fire alarm 600n+1, the n+2th fire alarm 600n+2, and the n+3th fire alarm 600n+3 each corresponds to one of the fire alarms 600 of Fig. 1. Fire alarms 600 other than the n+1th fire alarm 600n+1 and the n+2th fire alarm 600n+2 may be located around the n+3th fire alarm 600n+3. For example, an n+4th fire alarm 600n+4 (not shown) may be located.

[0049] Hereinafter, (2-1) formation of relay route and (2-2) modification of relay route will be described in the stated order.

(2-1) Formation of relay route

[0050] Fig. 9 is a sequence chart showing steps of routing in the alarm system 1000. A routing process will be described by highlighting the n+3th fire alarm 600n+3. Each fire alarm 600 broadcasts a HELLO message an predetermined intervals. The HELLO message includes information on quality of route to the relay device 700. The communication unit 620 of the n+3th fire alarm 600n+3 receives the HELLO message from the n+1th fire alarm 600n+1, the n+2th fire alarm 600n+2, and the n+4th fire alarm 600n+4 (S10, S12, S14).

[0051] The communication unit 620 of the n+3th fire alarm 600n+3 measures the reception power of each HELLO message received, and the processing unit 622 derives the link quality for each fire alarm 600 based on the measured reception power. The link quality varies in accordance with the reception power. The larger the reception power, the smaller the value of link quality. The route quality mentioned above is defined in a manner similar to the link quality. The control unit 624 derives a tentative route cost as follows by adding the link quality of the n+1th fire alarm 600n+1 to the route quality included in the HELLO message from the n+1th fire alarm 600n+1.

$$\text{tentative route cost} = \text{route quality} + Ka \times \text{link quality} + Kb \times C \quad \ldots \text{(expression 1)}$$

where Ka and Kb are coefficients, and C is a predetermined constant. Given that Kb is "0" when the relay route is formed, Kb×C is neglected.

[0052] The control unit 624 also derives a tentative route cost for the other fire alarms 600. The control unit 624 compares a plurality of tentative route costs and selects several fire alarms 600 as preferential link destinations in the ascending order of tentative route cost. In this case, the n+1the fire alarm 600n+1 and the n+2th fire alarm 600n+2 are selected as preferential link destinations, for example.

[0053] The communication unit 620 of the n+3th fire alarm 600n+3 includes the addresses of the selected fire alarm 600 and the link quality identified in the reception in the LINK_REQ submessage of the HELLO message and transmits the resultant message (S16, S18). The n+1th fire alarm 600n+1 and the n+2th fire alarm 600n+2 include the link quality in the reverse direction in the LNK_REP submessage and transmits the resultant message (S20, S22).

[0054] The communication unit 620 of the n+3th fire alarm 600n+3 receives the LINK_REP submessage. The control unit 624 of the n+3th fire alarm 600n+3 compares the link quality included in the LINK_REP submessage from the n+1th fire alarm 600n+1 with the link quality derived based on the reception power already measured and selects the link quality with a larger value. The control unit 624 also derives a definitive route cost as follows by adding the selected link quality and the route quality for the n+1th fire alarm 600n+1.

$$\text{definitive route cost} = \text{route quality} + Ka \times \text{Max(link quality)} + Kb \times C \quad \ldots \text{(expression 2)}$$

where Max indicates selecting the maximum link quality.

[0055] The control unit 624 also derives a definitive route cost for the n+2th fire alarm 600n+2. The control unit 624 compares the definitive route cost for the n+1th fire alarm 600n+1 with the definitive route cost for the n+2th fire alarm 600n+2 and selects the route with a smaller cost as the relay route. The relay route not selected may be used as a substitute route.

[0056] In other words, the n+3th fire alarm 600n+3 derives the definitive route cost (hereinafter, "first cost") for the relay route for communication with the relay device 700 by way of the n+1th fire alarm 600n+1 (hereinafter, "first relay route") by exchanging link quality information with the n+1th fire alarm 600n+1. Further, the n+3th fire alarm 600n+3 derives the definitive route cost (hereinafter, "second cost") for the relay route for communication with the relay device 700 by way of the n+2th fire alarm 600n+2 (hereinafter, "second relay route") by exchanging link quality information with the n+2th fire alarm 600n+2. Further, the n+3th fire alarm 600n+3 compares the first cost and the second cost and selects the relay route with a smaller cost preferentially. By performing a process like this in the respective fire alarms 600, the relay routes are formed. Information relating to the relay route (substitute route) formed in the respective fire alarms 600 is transmitted to the management device 800 by way of the relay device 700. The management device 800 determines the assignment of the time slots 1030 in accordance with the hop count, based on the information relating to the relay route (substitute route).

(2-2) Modification of relay route

[0057] When the relay route is formed as described above, the fire alarms 600 included in the relay route transfer the signal. Transfer of the signal increases the power consumption in the fire alarm 600. In the case the fire alarm 600 is driven by a battery, it is preferred that the power consumption is small. In order to suppress an increase in the power consumption in the fire alarm 600, the relay route is modified.

[0058] The control unit 624 of the n+1th fire alarm 600n+1 included in the first relay route connecting the n+3th fire alarm 600n+3 and the relay device 700 of Fig. 8 measures the communication frequency based on the number of times of communication of the communication unit 620 in a predetermined period of time. The number of times of communication includes at least one of the number of times of transmission or the number of times of reception. The control unit 624 maintains the correspondence between the communication frequency and the power consumption and derives the power consumption based on the communication frequency. In the correspondence, the larger the communication frequency, the larger the power consumption.

[0059] Further, the control unit 624 of the n+1th fire alarm 600n+1 may count the number of other fire alarms 600 that the n+1th fire alarm 600n+1 directly communicates with. The control unit 624 maintains the correspondence between the number of other fire alarms 600 and the power consumption and derives the power consumption based on the number of other fire alarms 600. In the correspondence, the larger the number of other fire alarms 600, the larger the power consumption. Further, the control unit 624 of the n+1th fire alarm 600n+1 may measure the battery level of the n+1th fire alarm 600n+1. The control unit 624 maintains the correspondence between the battery level and the power consumption and derives the power consumption based on the battery level. In the correspondence, the lower the battery level, the larger the power consumption.

[0060] The control unit 624 maintains a threshold value for the power consumption. Figs. 10A-10B show a data structure of a table maintained in the n+1th fire alarm 600n+1. Fig. 10A shows conditions for power consumption and threshold value and shows operations determined by the conditions. When the power consumption grows larger than the threshold value, the control unit 624 determines to transmit a notification indicating an increase in the power consumption. When the power consumption is equal to or smaller than the threshold value, on the other hand, the control unit 624 determines not to transmit a notification. Fig. 10B will be described later, and reference is made back to Fig. 8. When it is determined to transmit a notification, the communication unit 620 of the n+1th fire alarm 600n+1 transmits a notification to the n+3th fire alarm 600n+3.

[0061] As described above, the control unit 624 of the n+3th fire alarm 600n+3 determines the relay route based on the definitive route cost of expression (2). Depending on whether a notification is received from the n+1th fire alarm 600n+1, the control unit 624 controls the values of Ka, Kb of expression (2). Figs. 11A-11B show a data structure of a table maintained in the n+3th fire alarm 600n+3. Fig. 11A show values of the coefficients Ka, Kb responsive to the case of reception of a notification and the case of non-reception of a notification. The coefficients Ka and Kb are related such that Ka+Kb=1.

[0062] When a notification is not received, the coefficient Ka will be "A1" and the coefficient Kb will be "B1". The case of non-reception of a notification includes the case of (2-1) formation of relay route. For example, "A1" is "1" and "B1" is "0". When a notification is not received, therefore, the third term on the right side of expression (2) is neglected.

[0063] When a notification is received, the coefficient Ka will be "A2" and the coefficient Kb will be "B2". "B2" is a value larger than "0" so that "A2" is a value smaller than "1". A2 and B2 may be such that A2>B2, A2=B2, or A2<B2. When a notification is received, therefore, the impact from the third term on the right side of expression (2) will be large, and the definitive route cost will be larger as compared with the case of non-reception of a notification. As a result, it will be less likely that the first relay route including the n+1th fire alarm 600n+1 is selected. In other words, the n+3th fire alarm 600n+3 makes it less likely that the first relay route including the n+1th fire alarm 600n+1 is selected when a notification from the n+1th fire alarm 600n+1 is received.

[0064] The second term on the right side of the definitive route cost given by expression (2) is "Ka×Max (link quality)" and so can be said to be an indicator (hereinafter, "first indicator") determined by the information on quality of link with the n+1th fire alarm 600n+1. The third term on the right side of the definitive route cost given by expression (2) is "Kb×C" and so can be said to be an indicator (hereinafter, "second indicator") determined by the power consumption in the n+1th fire alarm 600n+1. When a notification is received, the control unit 624 makes it less likely that the first relay route is selected, by increasing the impact from the second indicator in the definitive route cost. Such a process is also performed in relation to the other fire alarms 600.

[0065] The values of the coefficients Ka, Kb are hitherto adjusted in two steps. However, the values of the coefficients Ka, Kb may be adjusted in three or more steps. Fig. 10B shows conditions for power consumption and threshold value and shows operations determined by the conditions. The control unit 624 of the n+1th fire alarm 600n+1 defines the first threshold value and the second threshold value larger than the firs threshold value for power consumption. When the power consumption is larger than the first threshold value and equal to or smaller than the second threshold value, the control unit 624 determines to transmit the first notification indicating an increase in the power consumption. When the power consumption grows larger than the second threshold value, the control unit 624 determines to transmit the second notification indicating a further increase in the power consumption. When the power consumption is equal to or smaller than the first threshold value, on the other hand, the control unit 624 determines not to transmit the first notification or the second notification. Reference is made back to Fig. 8. When it is determined to transmit the first notification, the communication unit 620 of the n+1th fire alarm 600n+1 transmits the first notification to the n+3th fire alarm 600n+3. When it is determined to transmit the second notification, the communication unit 620 transmits the second notification to the n+3th fire alarm 600n+3.

[0066] Depending on whether the first notification or the second notification from the n+1th fire alarm 600n+1 is received, the control unit 624 of the n+3th fire alarm 600n+3 controls the values of Ka, Kb of expression (2). Fig. 11B show values of Ka, Kb responsive to the case of non-reception of the first notification or the second notification and the case of reception of the first notification or the second notification. In this case, too, the coefficients Ka and Kb are related such that Ka+Kb=1.

[0067] When the first notification or the second notification is not received, the coefficient Ka will be "A1" and the coefficient Kb will be "B1". For example, "A1" is "1" and "B1" is "0". When the first notification is received, the coefficient Ka will be "A2" and the coefficient Kb will be "B2". When the second notification is received, the coefficient Ka will be "A3" and the coefficient Kb will be "B3". "B3" is a value larger than "B2" and "A3" is a value larger than "A2". In other words, the control unit 624 increases the impact from the second indicator in the definitive route cost when the second notification is received from the n+1th fire alarm 600n+1 by an amount larger than than when the first notification is received.

(3) Construction

[0068] A description will now be given of a technology for facilitating the construction of a multihop network of the alarm system 1000. In particular, a technology of providing information for determining at which position the fire alarm 600 should be constructed. Figs. 12A-12B show an outline of the construction of the alarm system 1000. Fig. 12A shows the first example. The alarm system 1000 includes an external appliance 900 in addition to the features of Fig. 8. The external appliance 900 is, for example, a computer and can communicate with the management device 800.

[0069] Routing in a multihop network is performed after several fire alarms 600 are provided near the relay device 700 instead of being performed after all of the fire alarms 600 are provided. After routing for the several fire alarms 600 is completed, several additional fire alarms 600 are provided, and routing is updated. Thus, routing is updated to adapt to the fire alarms 600 additionally provided in steps.

[0070] It is assumed here that the n+1th fire alarm 600n+1 and the n+2th fire alarm 600n+2 are provided before the n+3th fire alarm 600n+3 is provided. Each of the n+1th fire alarm 600n+1 and the n+2th fire alarm 600n+2 derives the definitive route cost through the aforementioned process before selecting a relay route based on the definitive route cost. The communication unit 620 of each of the n+1th fire alarm 600n+1 and the n+2th fire alarm 600n+2 transmits the information relating to the relay route. The information relating to the relay route includes the definitive route cost. The information relating to the relay route may also include the definitive route cost for a relay route other than the selected relay route (e.g. the substitute route).

[0071] The information relating to the relay route transmitted from the n+1th fire alarm 600n+1 and the n+2th fire alarm 600n+2 is transferred along the relay route and received by the relay device 700. The relay device 700 transmits the information relating to the relay route to the management device 800. The management device 800 receives the information relating to the relay route.

[0072] Fig. 13 shows a configuration of the external appliance 900. The external appliance 900 is, for example, a personal computer or a table terminal device. The external appliance 900 includes a communication unit 902, a control unit 924, and a display unit 906. The communication unit 902 performs a communication process for communicating with the management device 800. The constructor manipulates the external appliance 900 to access the management device 800, and the communication unit 902 receives the information relating to the relay route from the management device 800. The control unit 904 generates a screen based on the information relating to the relay route and displays the generated screen on the display unit 906.

[0073] Fig. 14 shows a screen displayed on the display unit 906. The identification information on each fire alarm 600, the cost, etc. are displayed as the information relating to the relay route. The constructor checks the status of the relay route by checking the information relating to the relay route displayed on the display unit 906.

[0074] The constructor additionally provides the n+3th fire alarm 600n+3 as a new fire alarm 600 in the multihop network. The plurality of fire alarms 600 including the n+1th fire alarm 600n+1, the n+2th fire alarm 600n+2, and the n+3th fire alarm 600n+3 update the definitive route cost when the new fire alarm 600 is added and updates the relay route based on the updated definitive route cost. The communication unit 620 of each of the plurality of fire alarms 600 transmits the information relating to the relay route. In a manner as already described, the management device 800 receives the information relating to the relay route, and the external appliance 900 displays the updated information relating to the relay route.

[0075] Fig. 12B shows the second example. The alarm system 1000 includes an external appliance 910 and an information processing device 912 in addition to the features of Fig. 13. The external appliance 910 is a communication device capable of receiving a signal transmitted from the fire alarm 600 and the relay device 700. The information processing device 912 is, for example, a computer and is connected to the external appliance 910. The same process as described above is performed in the multihop network. The external appliance 910 receives the information relating to the relay route, and the information processing device 912 displays the updated information relating to the relay route. The information processing device 912 displays the updated information relating to the relay route.

[0076] Derivation of the definitive route cost may be started or terminated by an instruction of the constructor. For example, the external appliance 900 or the external appliance 910 may transmit an instruction to search for a relay route to each fire alarm 600 in response to a user operation of the constructor in the user operation unit (not shown) provided in the external appliance 900 or the information processing device 912. In that process, each of the plurality of fire alarms 600 starts deriving the cost upon receiving the instruction to search for a relay route from the external appliance 900 or the external appliance 910.

[0077] When a plurality of fire alarms 600 are searching for a relay route, the external appliance 900 or the external appliance 910 may transmit the instruction to search for a relay route to each fire alarm 600 in response to a user operation of the constructor in the user operation unit (not shown) provided in the external appliance 900 or the information processing device 912. In that process, each of the plurality of fire alarms 600 terminates the derivation of the cost upon receiving the instruction to terminate the search for a relay route from the external appliance 900 or the external appliance 910.

[0078] The user operation unit (not shown) that receives an instruction from the constructor may be provided in each fire alarm 600. Each of the plurality of fire alarms 600 starts deriving the cost upon receiving the instruction to search for a relay route. Further, each of the plurality of fire alarms 600 terminates the derivation of the cost upon receiving the instruction to terminate the search for a relay route.

(4) Revision to time slot assignment

[0079] As described above, the time slots 1030 should be assigned to the respective fire alarms 600 in accordance with the hop count between the relay device 700 and the fire alarm 600. However, assignment may not be in accordance with the hop count in the construction of the alarm system 1000. In such an assignment of the time slots 1030, a large transfer delay in the communication signal could result. A description will now be given of the process of revising the assignment when an assignment in accordance with the hop count is not made after the alarm system 1000 is constructed and while the alarm system 1000 is in operation.

[0080] Figs. 15A-15B show a partial configuration of the alarm system 1000. Fig. 15A shows a configuration of the first stage of the alarm system 1000. The m+1th fire alarm 600m+1 is connected to the relay device 700, and the m+2th fire alarm 600m+2 is connected to the m+1th fire alarm 600m+1 to form a multihop network. The hop count between the relay device 700 and the m+1th fire alarm 600m+1 is "1", and the hop count between the relay device 700 and the m+2th fire alarm 600m+2 is "2".

[0081] Fig. 16 shows an outline of downlink communication in the alarm system 1000. "M" denotes the time slot 1030 assigned to the relay device 700, "S1" denotes the time slot 1030 assigned to the m+1th fire alarm 600m+1, and "S2" denotes the time slot 1030 assigned to the m+2th fire alarm 600m+2. As in the foregoing examples, the smaller the hop count, the earlier the time slot 1030 assigned to the fire alarm 600.

[0082] The relay device 700 transmits the communication signal in the time slot 1030 "M", and the m+1th fire alarm 600m+1 receives the communication signal in the time slot 1030 "M". The m+1th fire alarm 600m+1 transmits the communication signal in the time slot 1030 "S1", and the m+2th fire alarm 600m+2 receives the communication signal in the time slot 1030 "S1". The m+2th fire alarm 600m+2 transmits the communication signal in the time slot 1030 "S2". A description of transmission and reception of a response signal is omitted in the above description.

[0083] Fig. 15B shows a configuration of the second stage of the alarm system 1000. The configuration is derived from adding the m+3th fire alarm 600m+3 to Fig. 15B. The m+3th fire alarm 600m+3 is connected to the relay device 700, the m+1th fire alarm 600m+1 is connected to the m+3th fire alarm 600m+3, and the m+2th fire alarm 600m+2 is connected to the m+1th fire alarm 600m+1 to form a multihop network.

[0084] Figs. 17A-17B show an outline of downlink communication in the alarm system 1000. The time slot 1030 "S3" in Fig. 17A is provided later than the time slot 1030 "S2". The newly added m+3th fire alarm 600m+3 is allocated to the time slot 1030 "S3".

[0085] The relay device 700 transmits the communication signal in the time slot 1030 "M", and the m+3th fire alarm 600m+3 receives the communication signal in the time slot 1030 "M". The m+3th fire alarm 600m+3 transmits the communication signal in the time slot 1030 "S3", and the m+1th fire alarm 600m+1 receives the communication signal in the time slot 1030 "S3". The m+1th fire alarm 600m+1 transmits the communication signal in the time slot 1030 "S1" of the next frame 1020, and the m+2th fire alarm 600m+2 receives the communication signal in the time slot 1030 "S1". The m+2th fire alarm 600m+2 transmits the communication signal in the time slot 1030 "S2".

[0086] In other words, the time slot 1030 "S3", which is later than the time slot 1030 "S1" assigned to the m+1th fire alarm 600m+1 with the hop count "2", is assigned to the m+3th fire alarm 600m+3 with the hop count "1" to the relay device 700 so that a transfer delay is produced. A description of transmission and reception of a response signal is omitted in the above description.

[0087] To suppress such a transfer delay, the assignment is modified by the relay device 700 or the management device 800 after the m+3th fire alarm 600m+3 is added. When the time slot 1030 "S1" and the time slot 1030 "S2" are provided earlier than the time slot 1030 "S3" in the downlink communication, for example, the assignment unit 722 of the relay device 700 modifies the assignment such that the time slot 1030 "S1" and the time slot 1030 "S2" are provided later than the time slot 1030 "S3". The downlink communication is communication on the downlink line, and the signal is transferred in a direction away from the relay device 700 in the multihop network.

[0088] Further, when the time slot 1030 "S1" and the time slot 1030 "S2" are provided later than the time slot 1030 "S3" in the uplink communication, the assignment unit 722 modifies the assignment such that the time slot 1030 "S1" and the time slot 1030 "S2" are provided earlier than the time slot 1030 "S3". The uplink communication is communication on the uplink line, and the signal is transferred in a direction toward the relay device 700 in the multihop network.

[0089] An identification number for identifying the fire alarm 600 is assigned to each fire alarm 600. The identification number is assigned in the order of construction. Referring to Fig. 15B, therefore, the m+3th fire alarm 600m+3 with the identification number "3", the m+1th fire alarm 600m+1 with the identification number "1", and the m+2th fire alarm 600m+2 with the identification number "2" are arranged in the stated order. To manage a plurality of fire alarms 600, it is preferred that the identification numbers are arranged in the order that the fire alarms 600 are arranged along the relay route. The relay device 700 or the management device 800 determines the identification number of each fire alarm 600 in accordance with the hop count. Referring to Fig. 15B, the identification number "S1" is assigned to the m+3th fire alarm 600m+3, the identification number "2" is assigned to the m+1th fire alarm 600m+1, and the identification number "3" is assigned to the m+2th fire alarm 600m+2.

[0090] The device, the system, or the entity that executes the method according to the disclosure is provided with a computer. By causing the computer to run a program, the function of the device, the system, or the entity that executes the method according to the disclosure is realized. The computer is comprised of a processor that operates in accordance with the program as a main hardware feature. The disclosure is non-limiting as to the type of the processor so long as the function is realized by running the program. The processor is comprised of one or a plurality of electronic circuits including a semiconductor integrated circuit (IC) or a large-scale integration (LSI). The plurality of electronic circuits may be integrated in one chip or provided in a plurality of chips. The plurality of chips may be aggregated in one device or provided in a plurality of apparatuses. The program is recorded in a non-transitory recording medium such as a computer-readable ROM, optical disk, and hard disk drive. The program may be stored in a recording medium in advance or supplied to a recording medium via wide area communication network including the Internet.

[0091] According to the embodiment, the relay route with a smaller cost is preferentially selected. When the power consumption in the fire alarm 600 included in the relay route grows large, selection of that relay route is made less likely. Therefore, an increase in the power consumption in the fire alarm 600 included in a multihop networks is suppressed. Further, the cost is derived based on the first indicator determined by the link quality information and the second indicator determined by the power consumption in the other fire alarm 600. When a notification is received from the other fire alarm 600, the impact from the second indicator on the cost is increased so that selection of the relay route including the other fire alarm 600 can be made less likely. Further, the cost is changed merely by increasing the impact from the second indicator so that the process is simplified. Further, the first threshold value and the second threshold value are defined for power consumption, and the impact from the second indicator on the cost is changed in accordance with the magnitude of power consumption relative to the first threshold value and the second threshold value. Therefore, detailed setting of the relay route is enabled. Further, the power consumption is derived based on the communication frequency so that the power consumption can be estimated easily. Further, the power consumption is derived based on the number of other fire alarms 600 directly in communication so that the power consumption can be estimated easily. Further, the power consumption is derived based on the battery level of the fire alarm 600 so that the power consumption can be estimated easily.

[0092] Further, each of the plurality of fire alarms 600 transmits the information relating to the relay route to the external appliance 900 or the external appliance 910 so that it is possible to provide information for determining at which position the fire alarm 600 should be constructed to build a multihop network. Further, the information for determining at which position the fire alarm 600 should be constructed is provided so that the multihop network can be built easily. Further, when a new fire alarm 600 is added, each of the plurality of fire alarms 600 updates the information relating to the relay route and transmits the updated information to the external appliance 900 or the external appliance 910 so that it is possible to provide information for determining at which position the new fire alarm 600 should be constructed. Further, the information relating to the relay route includes the cost so that it is easy to understand the situation of routing. Further, the information relating to the relay route is displayed on the external appliance 900 so that it is easy to check the information relating to the relay route.

[0093] Further, upon receiving an instruction to search for a relay route from the external appliance 900 or the external appliance 910, each of the plurality of fire alarms 600 starts deriving the cost. Therefore, a trigger to start deriving the cost can be provided. Further, upon receiving an instruction to terminate the search for a relay route from the external appliance 900 or the external appliance 910, each of the plurality of fire alarms 600 terminates deriving the cost. Therefore, a trigger to terminate deriving the cost can be provided. Further, upon receiving an instruction to search for a relay route in the user operation unit, each of the plurality of fire alarms 600 starts deriving the cost. Therefore, a trigger to start deriving the cost can be provided. Further, upon receiving an instruction to terminate the search for a relay route in the user operation unit, each of the plurality of fire alarms 600 terminates deriving the cost. Therefore, a trigger to terminate deriving the cost can be provided.

[0094] Further, the order of the time slots 1030 assigned to the respective fire alarms 600 is determined in accordance with the hop count between the fire alarm 600 and the relay device 700 so that the delay time in transfer in a multihop network can be reduced. Further, the larger the hop count of the fire alarm 600, the later the time slot 1030 assigned to the fire alarm 600 in downlink communication so that the delay time in transfer in a multihop network can be reduced. Further, the larger the hop count of the fire alarm 600, the earlier the time slot 1030 assigned to the fire alarm 600 in uplink communication so that the delay time in transfer in a multihop network can be reduced.

[0095] Further, when the fire alarm 600 with a large hop count is assigned to an earlier time slot 1030 in downlink communication, the assignment is modified such that a later time slot 1030 is assigned to that fire alarm 600. Therefore, the delay time in transfer in a multihop network can be reduced. Further, when the fire alarm 600 with a large hop count is assigned to a later time slot 1030 in uplink communication, the assignment is modified such that an earlier time slot 1030 is assigned to that fire alarm 600. Therefore, the delay time in transfer in a multihop network can be reduced.

[0096] Further, the assignment is modified after the construction of the alarm system 1000 so that the frequency of assignment modification can be reduced. Further, the identification number of the fire alarm 600 is determined in accordance with the hop count so that it is easy to manage the fire alarm 600. The relay device 700 performs the assignment so that the relay device 700 can manage the assignment. Further, the management device 800 performs the assignment so that the management device 800 can manage the assignment.

[0097] Embodiments of the present disclosure may be summarized as follows.

(Item 1-1)

[0098] An alarm system (1000) including a plurality of alarms (600) that form a multihop network extending from a relay device (700), wherein

the plurality of alarms (600) include a first alarm (600), a second alarm (600), and a third alarm (600),
the third alarm (600) is capable of communicating with the first alarm (600) and the second alarm (600),
the third alarm (600) derives a first cost for a first relay route for communicating with the relay device (700) via the first alarm (600), by exchanging information on quality of link with the first alarm (600), and derives a second cost for a second relay route for communicating with the relay device (700) via the second alarm (600), by exchanging information on quality of link with the second alarm (600),
the third alarm (600) selects the first relay route preferentially when the first cost is smaller than the second cost,
when power consumption in the first alarm (600) grows larger than a threshold value, the first alarm (600) transmits a notification indicating an increase in power consumption to the third alarm (600), and
when the third alarm (600) receives the notification from the first alarm (600), the third alarm (600) makes it less likely that the first relay route is selected.

(Item 1-2)

[0099] The alarm system (1000) according to (item 1-1), wherein the third alarm (600) derives the first cost based on a first indicator determined by the information on quality of link with the first alarm (600) and a second indicator determined by power consumption in the first alarm (600), and
when the third alarm (600) receives the notification from the first alarm (600), the third alarm (600) makes it less likely that the first relay route is selected by increasing an impact from the second indicator in the first cost.

(Item 1-3)

[0100] The alarm system (1000) according to (item 1-2), wherein the first alarm (600) defines a first threshold value for power consumption and a second threshold value larger than the first threshold value,

when the power consumption in the first alarm (600) grows larger than the first threshold value, the first alarm (600) transmits a first notification to the third alarm (600),
when the power consumption in the first alarm (600) grows larger than the second threshold value, the first alarm (600) transmits a second notification to the third alarm (600), and
the third alarm (600) increases the impact from the second indicator in the first cost when the second notification is received from the first alarm (600) by an amount larger than when the first notification is received.

(Item 1-4)

[0101] The alarm system (1000) according to any one of (item 1-1) through (item 1-3), wherein the first alarm (600) derives the power consumption based on a communication frequency of the first alarm (600), and
the larger the communication frequency, the larger the power consumption in the first alarm (600).

(Item 1-5)

[0102] The alarm system (1000) according to any one of (item 1-1) through (item 1-3), wherein the first alarm (600) derives the power consumption based on the number of other alarms (600) that the first alarm (600) directly communicates with, and
the larger the number of other alarms (600), the larger the power consumption in the first alarm (600).

(Item 1-6)

[0103] The alarm system (1000) according to any one of (item 1-1) through (item 1-3), wherein the first alarm (600) derives the power consumption based on a battery level of the first alarm (600), and
the lower the battery level, the larger the power consumption in the first alarm (600).

(Item 1-7)

[0104] The alarm system (1000) according to any one of (item 1-1) through (item 1-6), wherein the third alarm (600) makes it less likely that the first relay route is selected when the third alarm (600) receives a user operation.

(Item 1-8)

[0105] An alarm (600) of a plurality of alarms (600) that form a multihop network extending from a relay device (700), including:

a communication unit (620) capable of communicating with a first alarm (600) and a second alarm (600) of the plurality of alarms (600); and
a control unit (624) that derives a first cost for a first relay route for communicating with the relay device (700) via the first alarm (600), by exchanging information on quality of link with the first alarm (600) through the communication unit (620), derives a second cost for a second relay route for communicating with the relay device (700) via the second alarm (600), by exchanging information on quality of link with the second alarm (600) through the communication unit (620), and then selects the first relay route preferentially when the first cost is smaller than the second cost, wherein
the communication unit (620) receives a notification indicating an increase in power consumption from the first alarm

when power consumption in the first alarm (600) grows larger than a threshold value, and
when the communication unit (620) receives the notification from the first alarm (600), the control unit (624) makes it less likely that the first relay route is selected.

(Item 1-9)

[0106] A route setting method in an alarm (600) of a plurality of alarms (600) that form a multihop network extending from a relay device (700), the alarm (600 being capable of communicating with a first alarm (600) and a second alarm (600) of the plurality of alarms (600), the method including:

deriving a first cost for a first relay route for communicating with the relay device (700) via the first alarm (600), by exchanging information on quality of link with the first alarm (600), and deriving a second cost for a second relay route for communicating with the relay device (700) via the second alarm (600), by exchanging information on quality of link with the second alarm (600);
selecting the first relay route preferentially when the first cost is smaller than the second cost;
when power consumption in the first alarm (600) grows larger than a threshold value, receiving a notification indicating an increase in power consumption from the first alarm (600); and
when the notification from the first alarm (600) is received, making it less likely that the first relay route is selected.

(Item 1-10)

[0107] A program for execution by an alarm (600) of a plurality of alarms (600) that form a multihop network extending from a relay device (700), the alarm (600 being capable of communicating with a first alarm (600) and a second alarm (600) of the plurality of alarms (600), the program including computer-implemented modules including:

a module that derives a first cost for a first relay route for communicating with the relay device (700) via the first alarm (600), by exchanging information on quality of link with the first alarm (600), and deriving a second cost for a second relay route for communicating with the relay device (700) via the second alarm (600), by exchanging information on quality of link with the second alarm (600);
a module that derives a first cost for a first relay route for communicating with the relay device (700) via the first alarm (600), by exchanging information on quality of link with the first alarm (600), and deriving a second cost for a second relay route for communicating with the relay device (700) via the second alarm (600), by exchanging information on quality of link with the second alarm (600);
a module that, when power consumption in the first alarm (600) grows larger than a threshold value, receives a notification indicating an increase in power consumption from the first alarm (600); and
a module that, when the notification from the first alarm (600) is received, makes it less likely that the first relay route is selected.

(Item 2-1)

[0108] An alarm system (1000) including: a plurality of alarms (600) that form a multihop network extending from a relay device (700), wherein

each of the plurality of alarms (600) derives, by exchanging information on quality of link with other alarms (600) around, a cost for a relay route for communicating with the relay device (700) via the other alarms (600) around and then selects a relay route based on the cost, and
each of the plurality of alarms (600) transmits information relating to the relay route to an external appliance.

(Item 2-2)

[0109] The alarm system (1000) according to (item 2-1), wherein a new alarm (600) is added to the plurality of alarms (600) in the multihop network,

the plurality of alarms (600) updates the cost when the new alarm (600) is added and updates the relay route based on the cost thus updated,
each of the plurality of alarms (600) transmits information relating to the relay route thus updated to the external appliance.

(Item 2-3)

[0110] The alarm system (1000) according to claim (item 2-1) or (item 2-2), wherein the information relating to the relay route includes the cost.

(Item 2-4)

[0111] The alarm system (1000) according to any one of (item 2-1) through (item 2-3), wherein the information relating to the relay route transmitted from each of the plurality of alarms (600) is displayed on the external appliance.

(Item 2-5)

[0112] The alarm system (1000) according to any one of (item 2-1) through (item 2-4), wherein each of the plurality of alarms (600) starts deriving the cost when an instruction to search for a relay route is received from the external appliance.

(Item 2-6)

[0113] The alarm system (1000) according to any one of (item 2-1) through (item 2-4), wherein each of the plurality of alarms (600) terminates deriving the cost when an instruction to terminate a search for a relay route is received from the external appliance.

(Item 2-7)

[0114] The alarm system (1000) according to any one of (item 2-1) through (item 2-4), wherein each of the plurality of alarms (600) starts deriving the cost when an instruction to search for a relay route is received.

(Item 2-8)

[0115] The alarm system (1000) according to any one of (item 2-1) through (item 2-4), wherein each of the plurality of alarms (600) terminates deriving the cost when an instruction to terminate a search for a relay route is received.

(Item 2-9)

[0116] An external appliance (900, 910) capable of communicating with a plurality of alarms (600) that form a multihop network extending from a relay device (700), wherein
each of the plurality of alarms (600) includes:

a communication unit (902) that derives a const for a relay route for communicating with the relay device (700) via other alarms (600) around, by exchanging information on quality of link with the other alarms (600) around, selects the relay route based on the cost, and receives information relating to the relay route from each of the plurality of alarms (600); and
a display unit (906) that displays the information relating to the relay route received by the communication unit (902).

(Item 2-10)

[0117] A display method in an external appliance capable of communicating with a plurality of alarms (600) that form a multihop network extending from a relay device (700), the method including:

in each of the plurality of alarms (600), deriving a const for a relay route for communicating with the relay device (700) via other alarms (600) around, by exchanging information on quality of link with the other alarms (600) around, selecting the relay route based on the cost, and receiving information relating to the relay route from each of the plurality of alarms (600); and
displaying the information relating to the relay route received.

(Item 2-11)

[0118] A program for execution by an external appliance (900, 910) capable of communicating with a plurality of alarms

(600) that form a multihop network extending from a relay device (700), the program comprising computer-implemented modules including:

in each of the plurality of alarms (600), deriving a const for a relay route for communicating with the relay device (700) via other alarms (600) around, by exchanging information on quality of link with the other alarms (600) around, selecting the relay route based on the cost, and receiving information relating to the relay route from each of the plurality of alarms (600); and
displaying the information relating to the relay route received.

(Item 3-1)

[0119] An alarm system (1000) including: a plurality of alarms (600) that form a multihop network extending from a relay device (700), wherein the plurality of alarms (600) include a first alarm (600) and a second alarm (600),
a first time slot, of a plurality of time slots arranged on a time axis, is assigned to the first alarm (600), and the first alarm (600) transmits a signal in the first time slot, a second time slot, of the plurality of time slots arranged on the time axis, different from the first time slot is assigned to the second alarm (600), and the second alarm (600) transmits a signal in the second time slot, and an order of the first time slot and the second time slot in the plurality of time slots is determined in accordance with a first hop count between the first alarm (600) and the relay device (700) and a second hop count between the second alarm (600) and the relay device (700).

(Item 3-2)

[0120] The alarm system (1000) according to (item 3-1), wherein, in the case a signal is transferred in a direction away from the relay device (700) in the multihop network, the second time slot is provided later than the first time slot when the second hop count is larger than the first hop count.

(Item 3-3)

[0121] The alarm system (1000) according to (item 3-1), wherein, in the case a signal is transferred in a direction toward the relay device (700) in the multihop network, the second time slot is provided earlier than the first time slot when the second hop count is larger than the first hop count.

(Item 3-4)

[0122] The alarm system (1000) according to (item 3-2), wherein, in the case the second time slot is provided earlier than the first time slot, assignment is modified such that the second time slot is provided later than the first time slot.

(Item 3-5)

[0123] The alarm system (1000) according to (item 3-3), wherein, in the case the second time slot is provided later than the first time slot, assignment is modified such that the second time slot is provided earlier than the first time slot.

(Item 3-6)

[0124] The alarm system (1000) according to (item 3-4) or (item 3-5), wherein the assignment is modified after the alarm system (1000) is constructed.

(Item 3-7)

[0125] The alarm system (1000) according to any one of (item 3-1) through (item 3-6), wherein identification numbers of the first alarm (600) and the second alarm (600) are determined in accordance with the first hop count and the second hop count.

(Item 3-8)

[0126] The alarm system (1000) according to any one of (item 3-1) through (item 3-7), wherein the relay device (700) performs assignment.

(Item 3-9)

[0127] The alarm system (1000) according to any one of (item 3-1) through (item 3-7), further including: a management device connected to the relay device (700), wherein the management device performs assignment.

(Item 3-10)

[0128] A controller for a plurality of alarms (600) that form a multihop network extending from a relay device (700), including: an assignment unit that assigns a first time slot, of a plurality of time slots arranged on a time axis, to a first alarm (600) included in the plurality of alarms (600) and assigns a second time slot, of the plurality of time slots arranged on the time axis, different from the first time slot to a second alarm (600) included in the plurality of alarms (600; and an output unit that outputs a result of assignment in the assignment unit, wherein the assignment unit determines an order of the first time slot and the second time slot in the plurality of time slots in accordance with a first hop count between the first alarm (600) and the relay device (700) and a second hop count between the second alarm (600) and the relay device (700).

(Item 3-11)

[0129] An assignment method adapted for a plurality of alarms (600) that form a multihop network extending from a relay device (700), including: assigning a first time slot, of a plurality of time slots arranged on a time axis, to a first alarm (600) included in the plurality of alarms (600) and assigns a second time slot, of the plurality of time slots arranged on the time axis, different from the first time slot to a second alarm (600) included in the plurality of alarms (600; and outputting a result of assignment, wherein the assigning determines an order of the first time slot and the second time slot in the plurality of time slots in accordance with a first hop count between the first alarm (600) and the relay device (700) and a second hop count between the second alarm (600) and the relay device (700).

(Item 3-12)

[0130] A program for execution by a controller for a plurality of alarms (600) that form a multihop network extending from a relay device (700), the program including computer-implemented modules including: a module that assigns a first time slot, of a plurality of time slots arranged on a time axis, to a first alarm (600) included in the plurality of alarms (600) and assigns a second time slot, of the plurality of time slots arranged on the time axis, different from the first time slot to a second alarm (600) included in the plurality of alarms (600; and a module that outputs a result of assignment, wherein the module that assigns determines an order of the first time slot and the second time slot in the plurality of time slots in accordance with a first hop count between the first alarm (600) and the relay device (700) and a second hop count between the second alarm (600) and the relay device (700).

[0131] Described above is an explanation based on an exemplary embodiment. The embodiment is intended to be illustrative only and it will be understood by those skilled in the art that various modifications to constituting elements and processes could be developed and that such modifications are also within the scope of the present invention.

[0132] The n+3th fire alarm 600n+3 according to the embodiment receiving a notification from the n+1th fire alarm 600n+1 makes it less likely that the fist relay route including the n+1th fire alarm 600n+1 is selected. Alternatively, for example, the n+3th fire alarm 600n+3 receiving a user operation makes it less likely that the first relay route is selected. The user operation is received by, for example, the management device 800, the external appliance 900, the external appliance 910, or the fire alarm 600. According to this variation, the relay route can be modified in accordance with the user's intent.

[0133] The fire alarms 600 of the embodiment exchange link quality to determine the relay route. Alternatively, however, the fire alarms 600 may exchange the value of power consumption. The value of power consumption is reflected in C, i.e., the third term on the right side of expression (1) and expression (2). For example, the larger the value of power consumption, the larger the value of "C". According to this variation, the impact of power consumption can be reflected in the tentative route cost or the definitive route cost.

[REFERENCE SIGNS LIST]

[0134] 600 fire alarm, 620 communication unit, 622 processing unit, 624 control unit, 630 fire detection sensor, 632 buzzer, 700 relay device, 710 communication unit, 712 output unit, 720 control unit, 722 assignment unit, 800 management device, 900 external appliance, 902 communication unit, 904 control unit, 906 display unit, 910 external appliance, 912 information processing device, 1000 alarm system

Claims

1. An alarm system (1000) comprising:

   a plurality of alarms (600) that form a multihop network extending from a relay device (700), wherein
   the plurality of alarms (600) include a first alarm (600) and a second alarm (600),
   a first time slot, of a plurality of time slots arranged on a time axis, is assigned to the first alarm (600), and the first alarm (600) transmits a signal in the first time slot,
   a second time slot, of the plurality of time slots arranged on the time axis, different from the first time slot is assigned to the second alarm (600), and the second alarm (600) transmits a signal in the second time slot, and
   an order of the first time slot and the second time slot in the plurality of time slots is determined in accordance with a first hop count between the first alarm (600) and the relay device (700) and a second hop count between the second alarm (600) and the relay device (700).

2. The alarm system (1000) according to claim 1, wherein
   in the case a signal is transferred in a direction away from the relay device (700) in the multihop network, the second time slot is provided later than the first time slot when the second hop count is larger than the first hop count.

3. The alarm system (1000) according to claim 1, wherein
   in the case a signal is transferred in a direction toward the relay device (700) in the multihop network, the second time slot is provided earlier than the first time slot when the second hop count is larger than the first hop count.

4. The alarm system (1000) according to claim 2, wherein
   in the case the second time slot is provided earlier than the first time slot, assignment is modified such that the second time slot is provided later than the first time slot.

5. The alarm system (1000) according to claim 3, wherein
   in the case the second time slot is provided later than the first time slot, assignment is modified such that the second time slot is provided earlier than the first time slot.

6. The alarm system (1000) according to claim 4 or 5, wherein
   the assignment is modified after the alarm system (1000) is constructed.

7. The alarm system (1000) according to any one of claims 1 through 6, wherein
   identification numbers of the first alarm (600) and the second alarm (600) are determined in accordance with the first hop count and the second hop count.

8. The alarm system (1000) according to any one of claims 1 through 7, wherein
   the relay device (700) performs assignment.

9. The alarm system (1000) according to any one of claims 1 through 7, further comprising:

   a management device connected to the relay device (700), wherein
   the management device performs assignment.

10. A controller for a plurality of alarms (600) that form a multihop network extending from a relay device (700), comprising:

    an assignment unit that assigns a first time slot, of a plurality of time slots arranged on a time axis, to a first alarm (600) included in the plurality of alarms (600) and assigns a second time slot, of the plurality of time slots arranged on the time axis, different from the first time slot to a second alarm (600) included in the plurality of alarms (600; and
    an output unit that outputs a result of assignment in the assignment unit, wherein
    the assignment unit determines an order of the first time slot and the second time slot in the plurality of time slots in accordance with a first hop count between the first alarm (600) and the relay device (700) and a second hop count between the second alarm (600) and the relay device (700).

11. An assignment method adapted for a plurality of alarms (600) that form a multihop network extending from a relay device (700), comprising:

assigning a first time slot, of a plurality of time slots arranged on a time axis, to a first alarm (600) included in the plurality of alarms (600) and assigns a second time slot, of the plurality of time slots arranged on the time axis, different from the first time slot to a second alarm (600) included in the plurality of alarms (600; and
outputting a result of assignment, wherein
the assigning determines an order of the first time slot and the second time slot in the plurality of time slots in accordance with a first hop count between the first alarm (600) and the relay device (700) and a second hop count between the second alarm (600) and the relay device (700).

12. A program for execution by a controller for a plurality of alarms (600) that form a multihop network extending from a relay device (700), the program comprising computer-implemented modules including:

a module that assigns a first time slot, of a plurality of time slots arranged on a time axis, to a first alarm (600) included in the plurality of alarms (600) and assigns a second time slot, of the plurality of time slots arranged on the time axis, different from the first time slot to a second alarm (600) included in the plurality of alarms (600; and
a module that outputs a result of assignment, wherein
the module that assigns determines an order of the first time slot and the second time slot in the plurality of time slots in accordance with a first hop count between the first alarm (600) and the relay device (700) and a second hop count between the second alarm (600) and the relay device (700).

FIG. 1

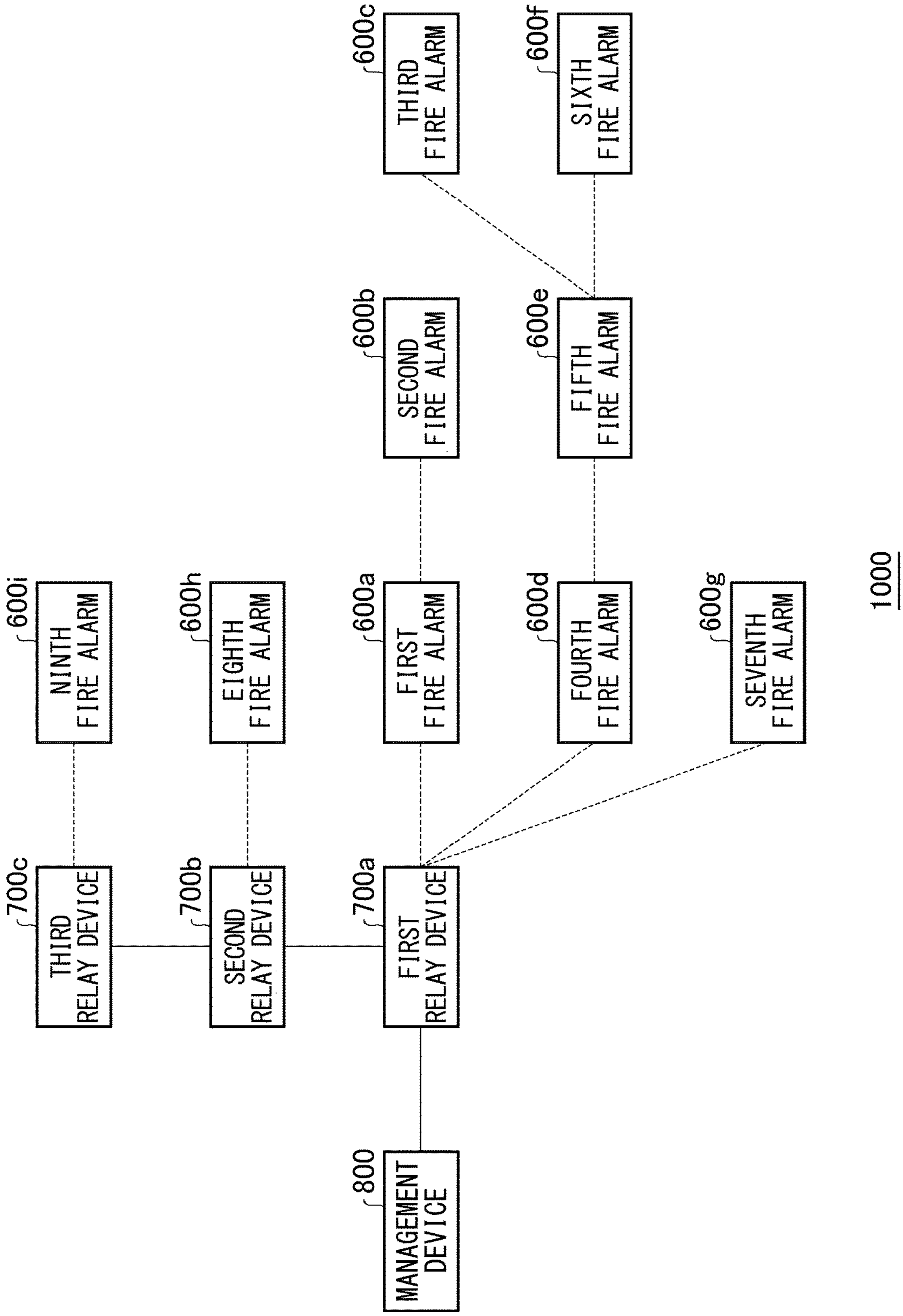

1000
800
MANAGEMENT DEVICE
700a
FIRST RELAY DEVICE
700b
SECOND RELAY DEVICE
700c
THIRD RELAY DEVICE
600a
FIRST FIRE ALARM
600b
SECOND FIRE ALARM
600c
THIRD FIRE ALARM
600d
FOURTH FIRE ALARM
600e
FIFTH FIRE ALARM
600f
SIXTH FIRE ALARM
600g
SEVENTH FIRE ALARM
600h
EIGHTH FIRE ALARM
600i
NINTH FIRE ALARM

FIG. 2

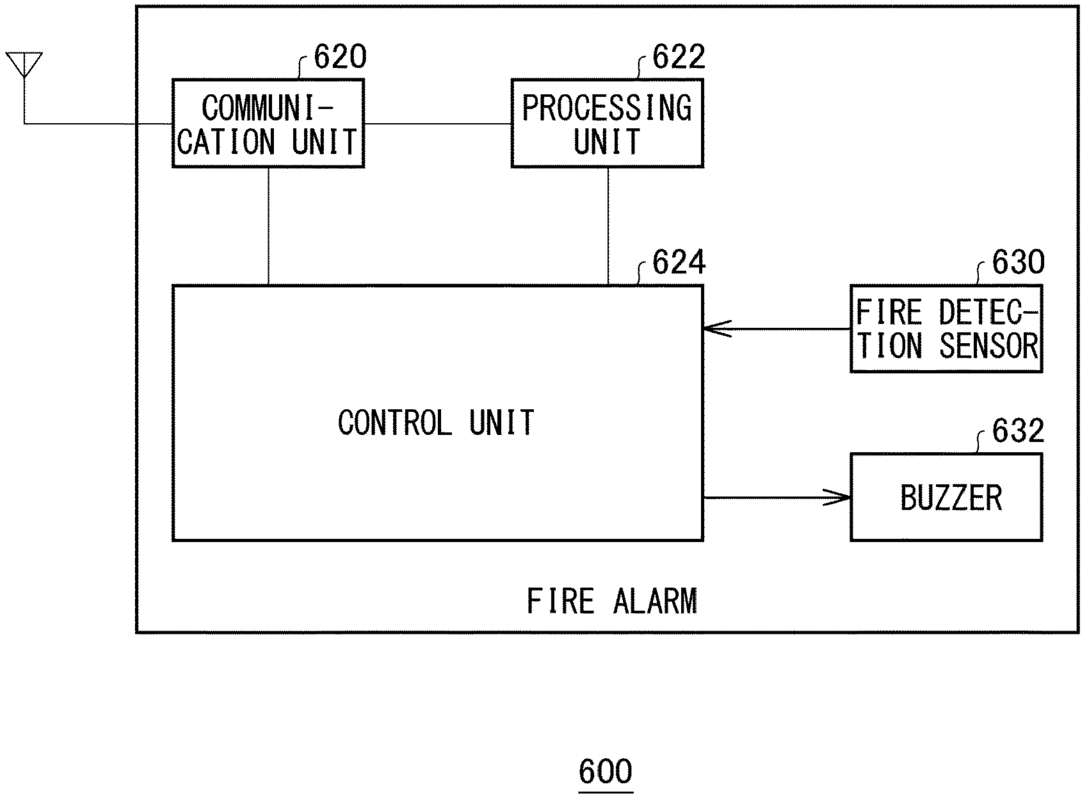

620
COMMUNI-
CATION UNIT
622
PROCESSING
UNIT
624
CONTROL UNIT
630
FIRE DETEC-
TION SENSOR
632
BUZZER
FIRE ALARM
600

FIG. 3A

FIG. 3B

FIG. 3C

FIG. 3D

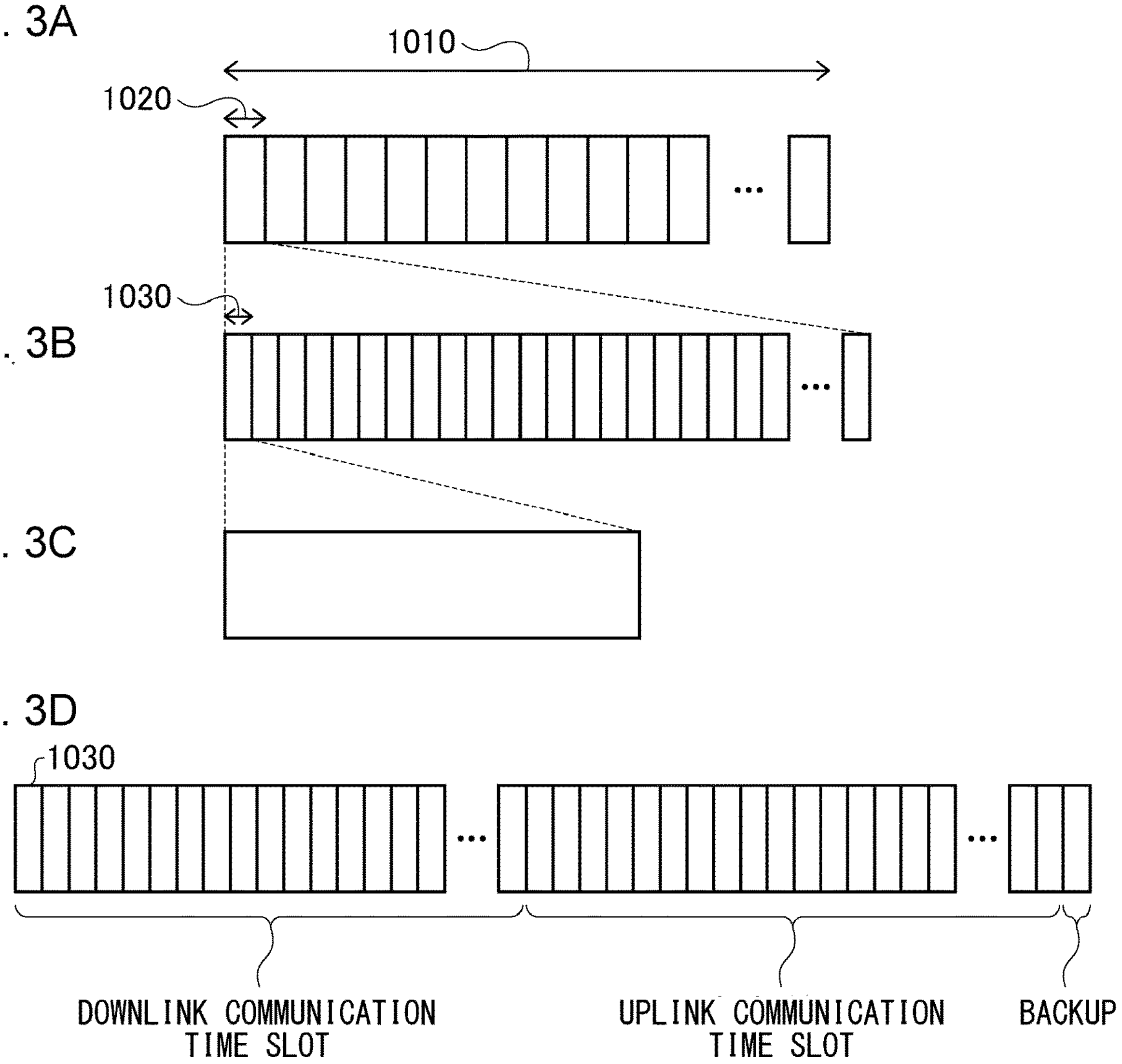


FIG. 4

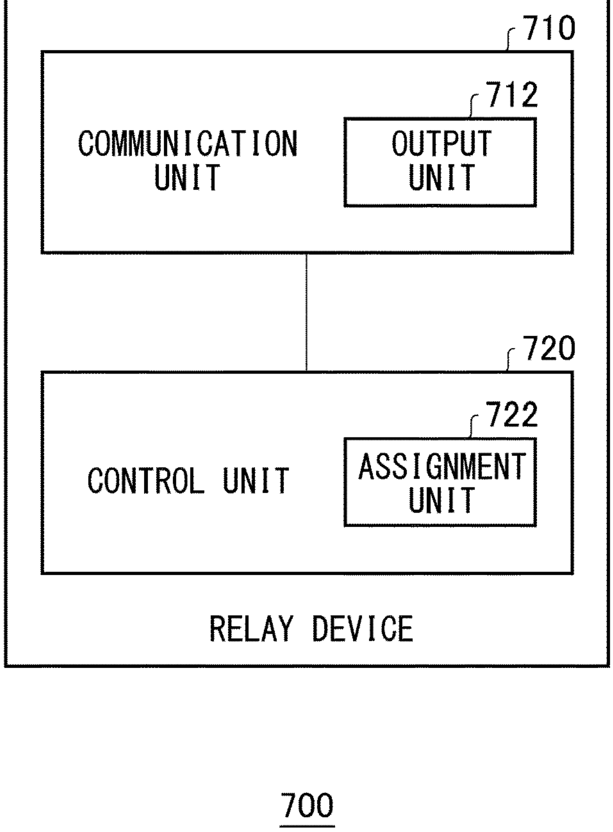

710
COMMUNICATION UNIT
712
OUTPUT UNIT
720
CONTROL UNIT
722
ASSIGNMENT UNIT
RELAY DEVICE
700

FIG. 5

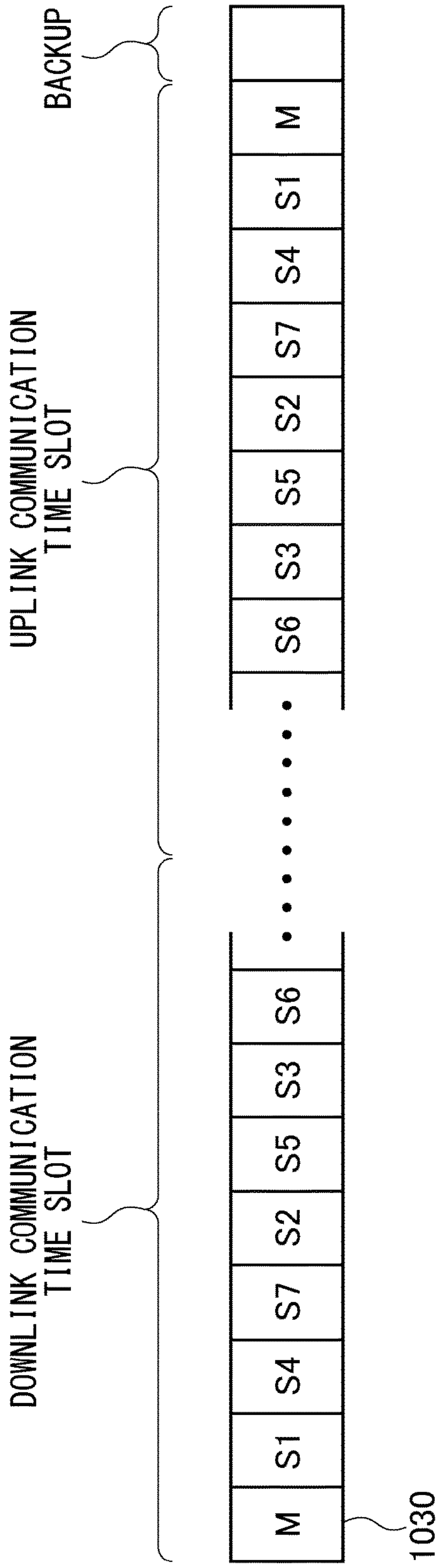

DOWNLINK COMMUNICATION TIME SLOT
UPLINK COMMUNICATION TIME SLOT
BACKUP
M
S1
S4
S7
S2
S5
S3
S6
S6
S3
S5
S2
S7
S4
S1
M
1030

FIG. 6

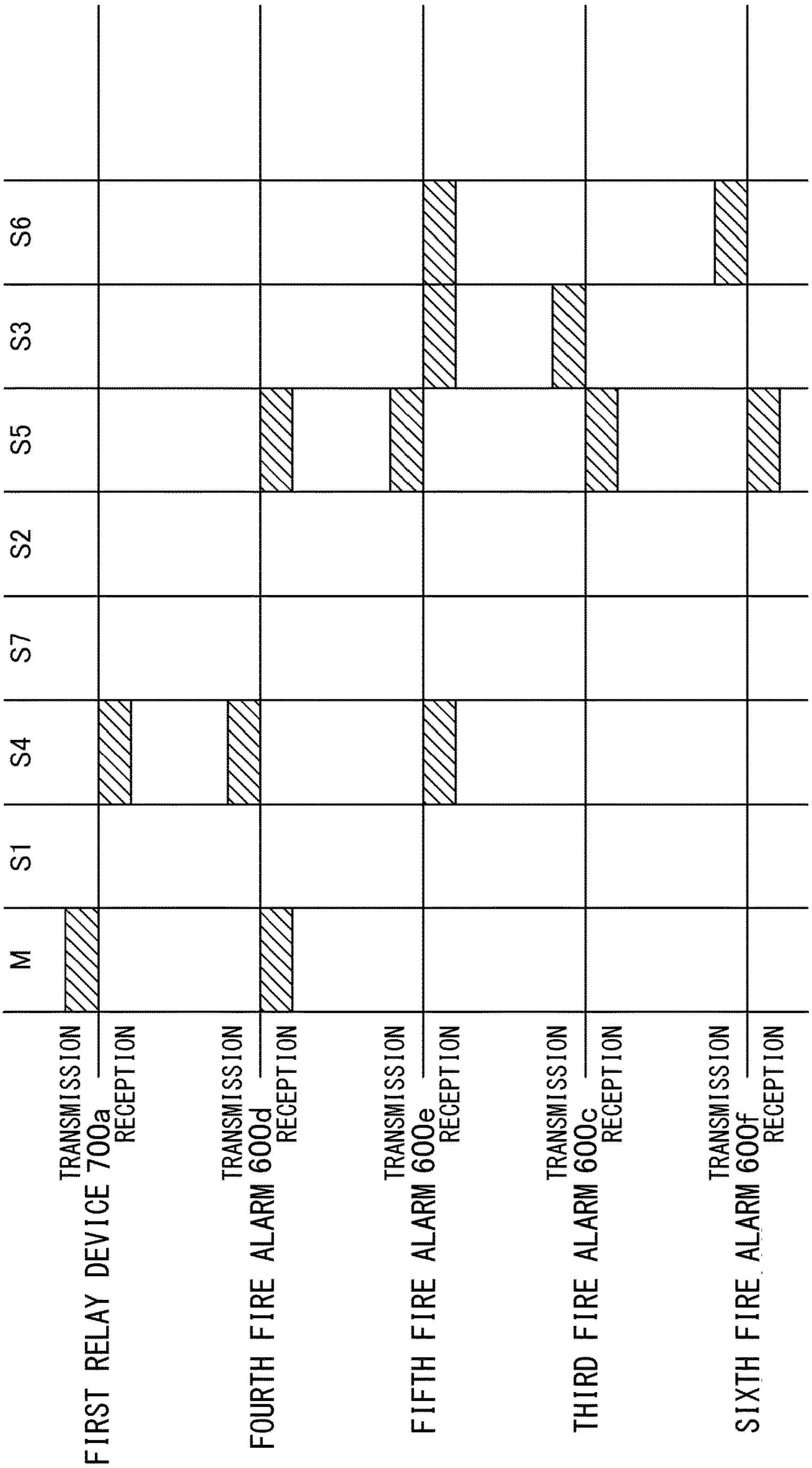

M
S1
S4
S7
S2
S5
S3
S6
FIRST RELAY DEVICE 700a
TRANSMISSION
RECEPTION
FOURTH FIRE ALARM 600d
TRANSMISSION
RECEPTION
FIFTH FIRE ALARM 600e
TRANSMISSION
RECEPTION
THIRD FIRE ALARM 600c
TRANSMISSION
RECEPTION
SIXTH FIRE ALARM 600f
TRANSMISSION
RECEPTION

FIG. 7

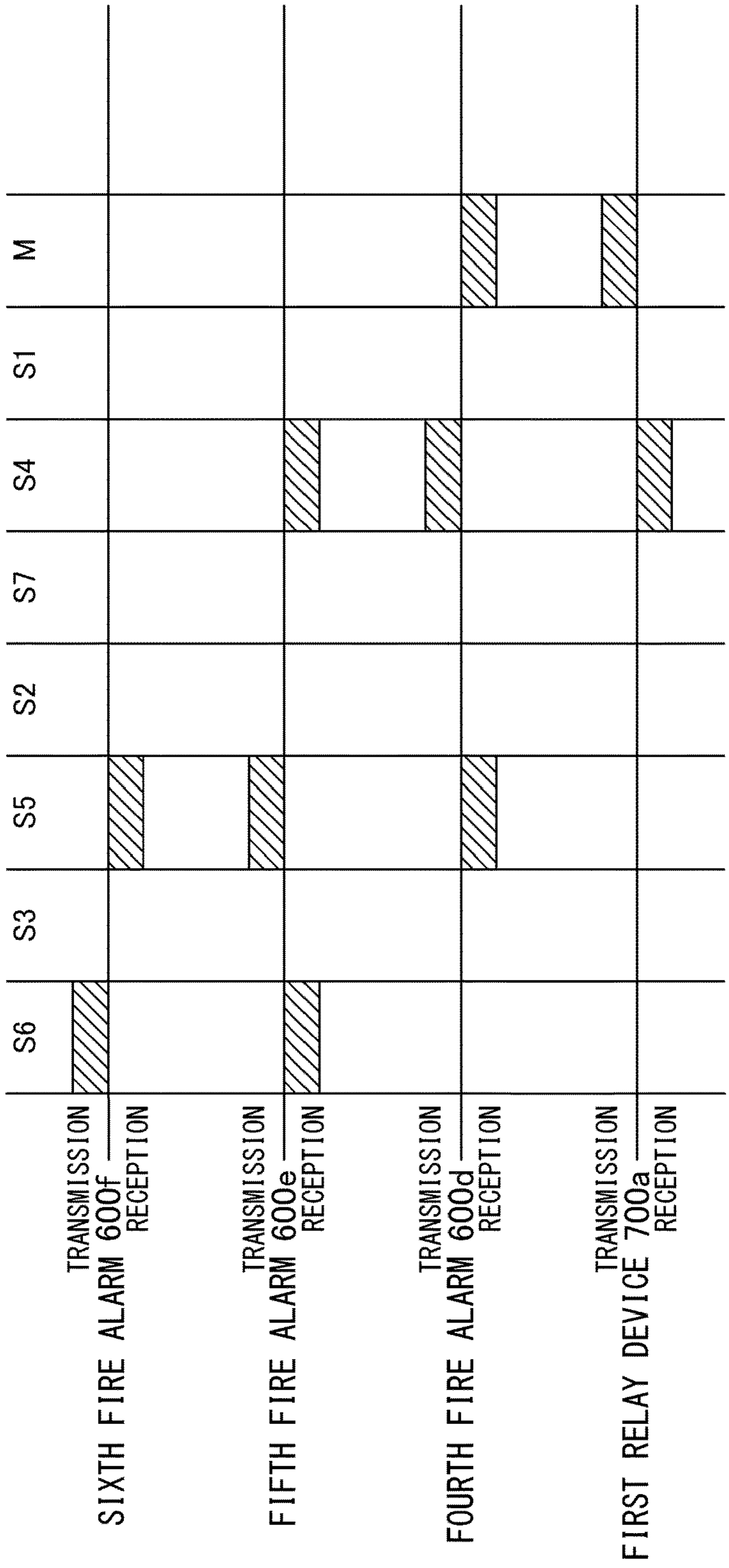

S6
S3
S5
S2
S7
S4
S1
M
SIXTH FIRE ALARM 600f
TRANSMISSION
RECEPTION
FIFTH FIRE ALARM 600e
TRANSMISSION
RECEPTION
FOURTH FIRE ALARM 600d
TRANSMISSION
RECEPTION
FIRST RELAY DEVICE 700a
TRANSMISSION
RECEPTION

FIG. 8

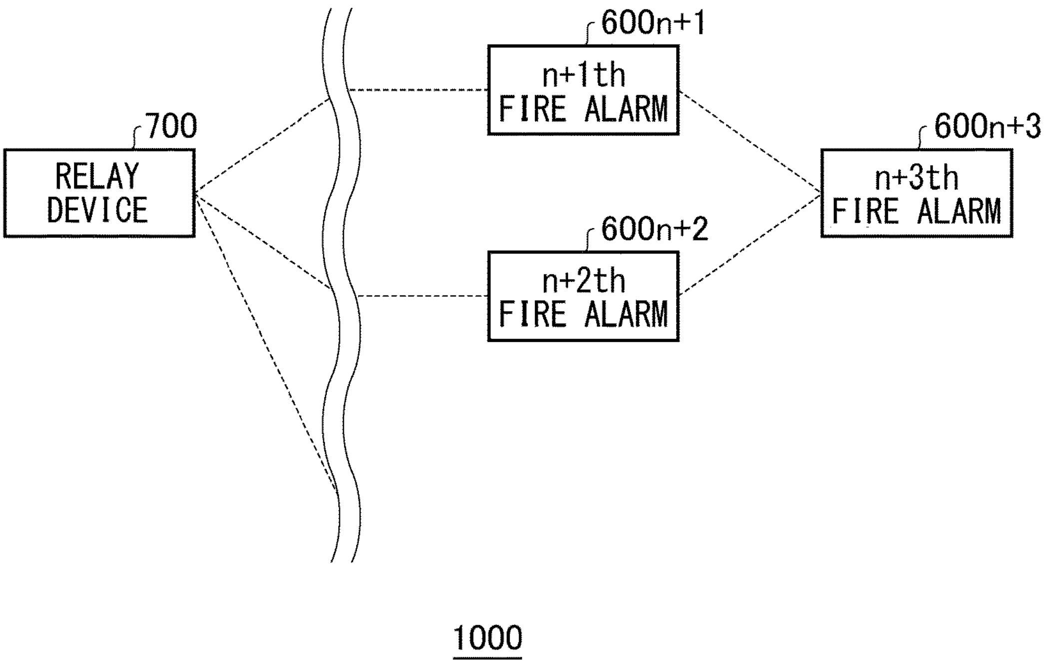

600n+1
n+1th
FIRE ALARM
700
RELAY
DEVICE
600n+3
n+3th
FIRE ALARM
600n+2
n+2th
FIRE ALARM
1000

FIG. 9

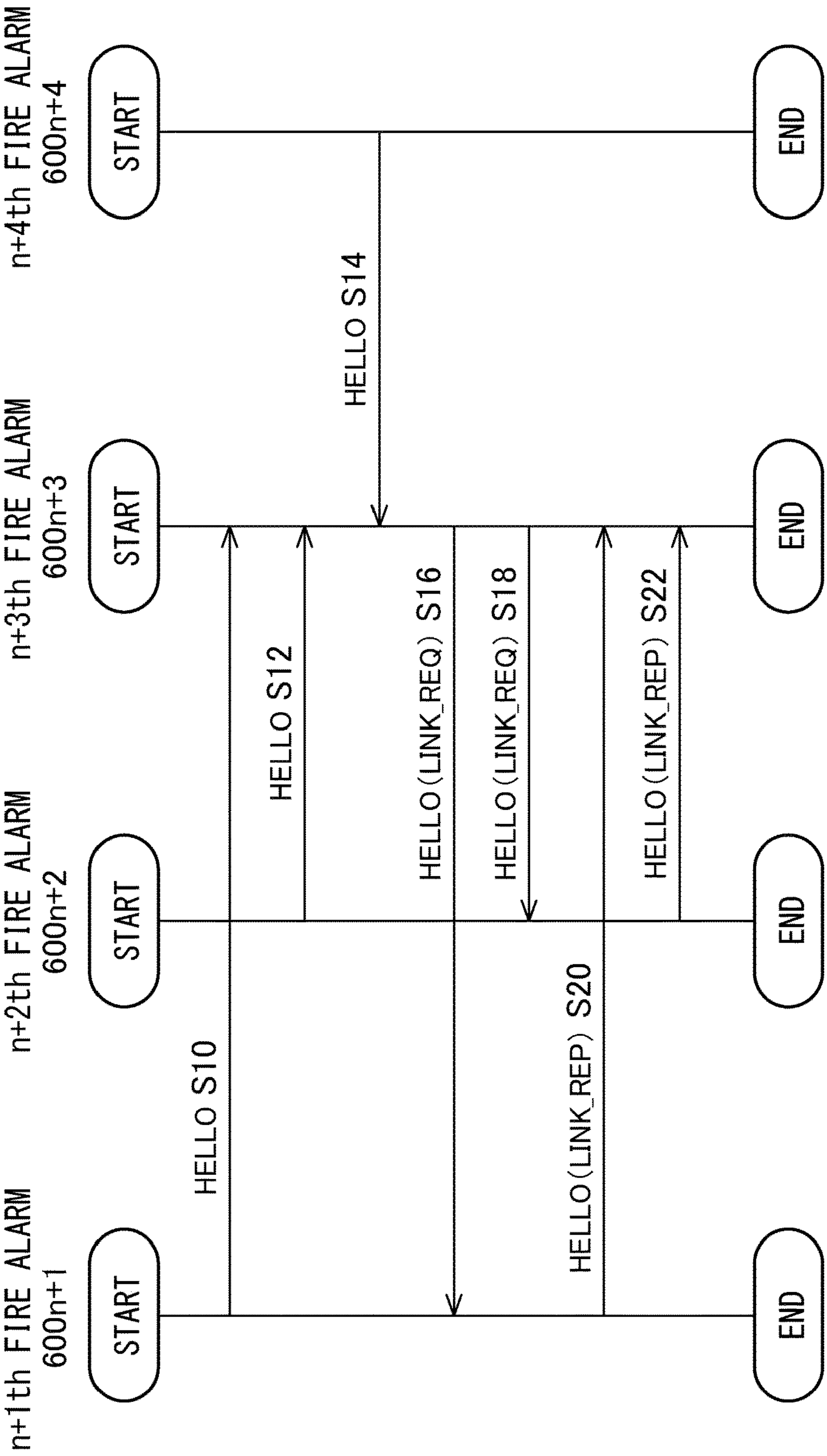

n+1th FIRE ALARM
600n+1
n+2th FIRE ALARM
600n+2
n+3th FIRE ALARM
600n+3
n+4th FIRE ALARM
600n+4
START
START
START
START
HELLO S10
HELLO S12
HELLO S14
HELLO(LINK_REQ) S16
HELLO(LINK_REQ) S18
HELLO(LINK_REP) S20
HELLO(LINK_REP) S22
END
END
END
END

FIG. 10A

CONDITION	OPERATION
POWER CONSUMPTION ≦ THRESHOLD VALUE	NONE
POWER CONSUMPTION > THRESHOLD VALUE	TRANSMIT NOTIFICATION

FIG. 10B

CONDITION	OPERATION
POWER CONSUMPTION ≦ FIRST THRESHOLD VALUE	NONE
FIRST THRESHOLD VALUE < POWER CONSUMPTION ≦ SECOND THRESHOLD VALUE	TRANSMIT FIRST NOTIFICATION
POWER CONSUMPTION > SECOND THRESHOLD VALUE	TRANSMIT SECOND NOTIFICATION

600n+1

FIG. 11A

CONDITION	Ka	Kb
NO RECEPTION	A1	B1
RECEIVE NOTIFICATION	A2	B2

FIG. 11B

CONDITION	Ka	Kb
NO RECEPTION	A1	B1
RECEIVE FIRST NOTIFICATION	A2	B2
RECEIVE SECOND NOTIFICATION	A3	B3

600n+3

FIG. 12A

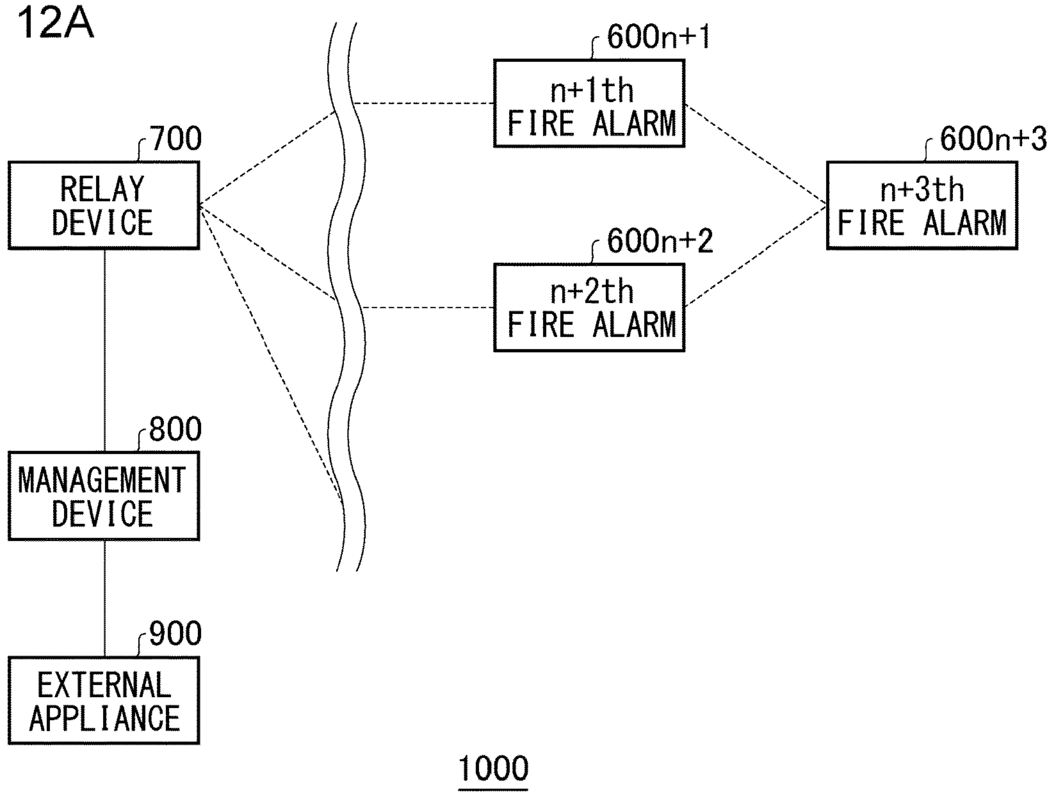


FIG. 12B

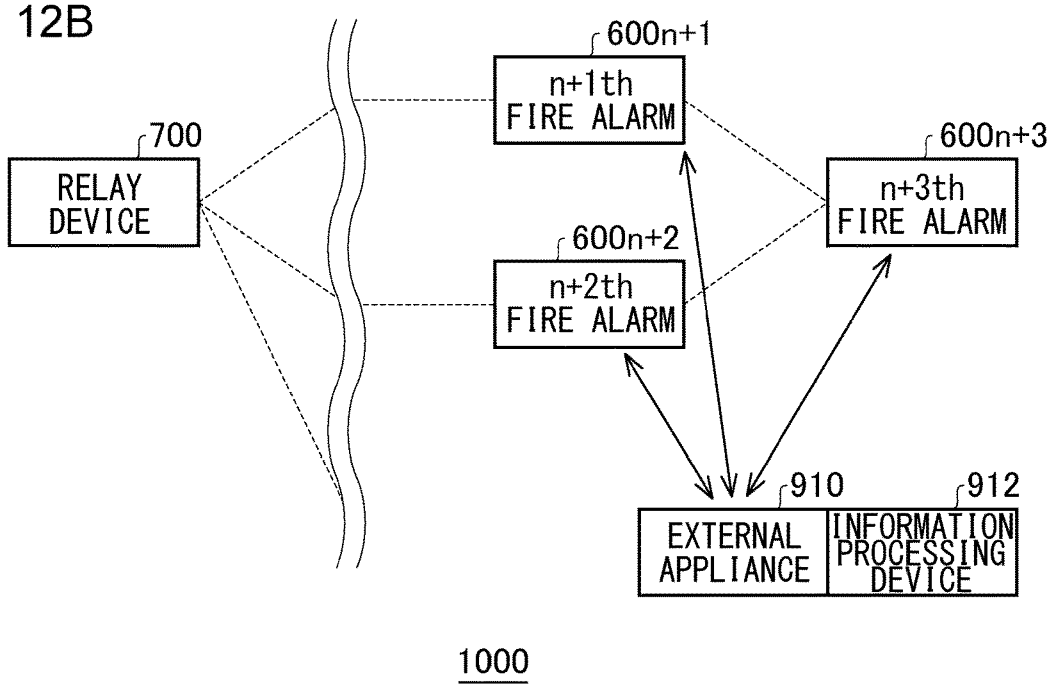
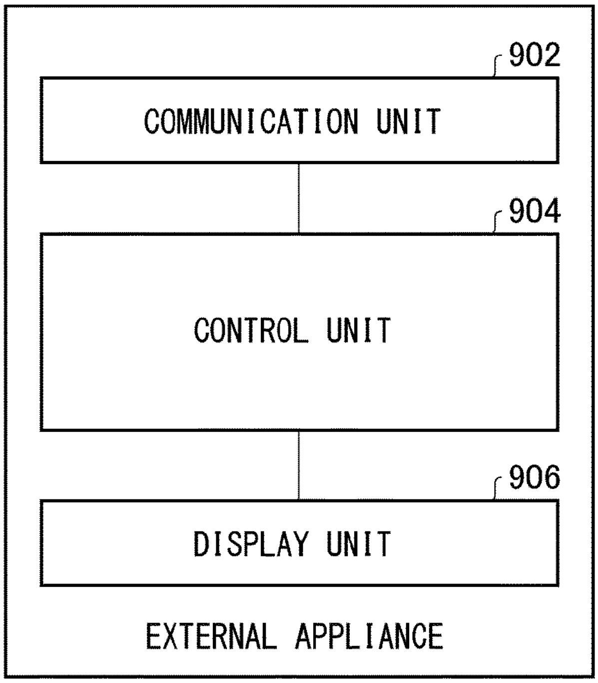


FIG. 13



900

FIG. 14

FIRE ALARM ID	・・・	COST
1		C1
2		C2
⋮		⋮
X	・・・	CX

906

FIG. 15A

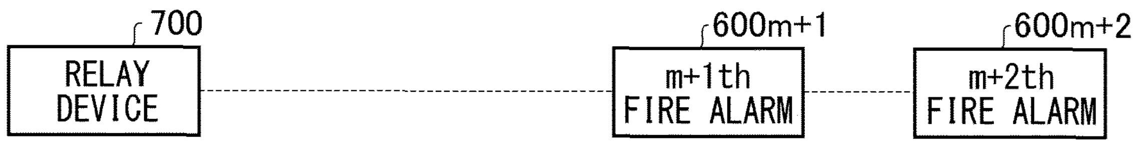
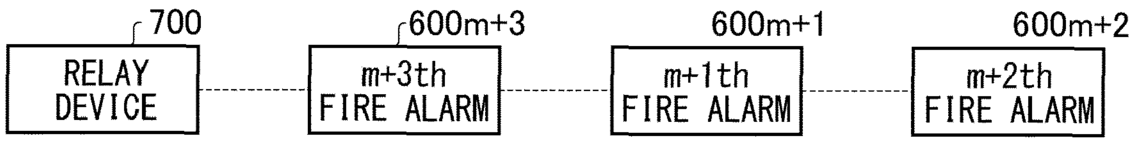


FIG. 15B



1000

FIG. 16

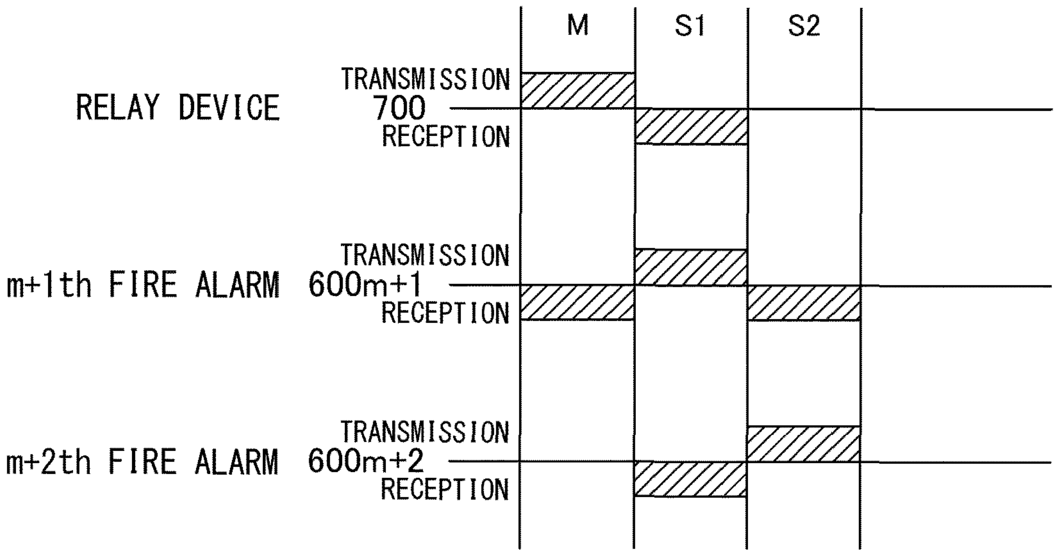


FIG. 17A

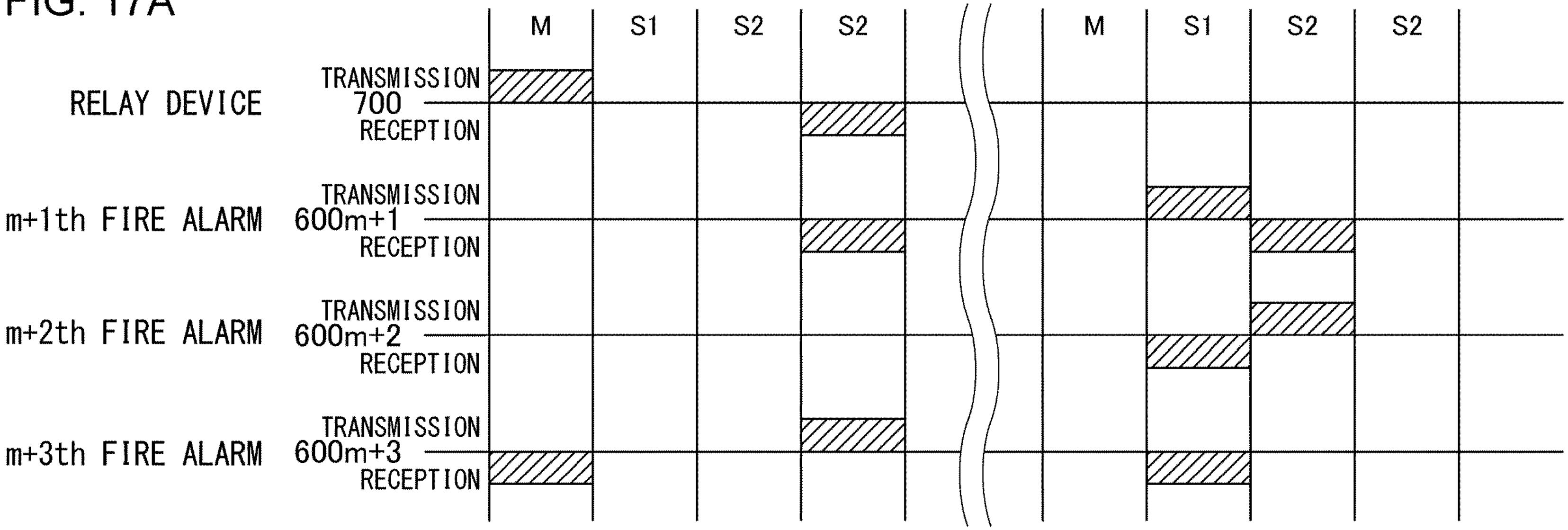
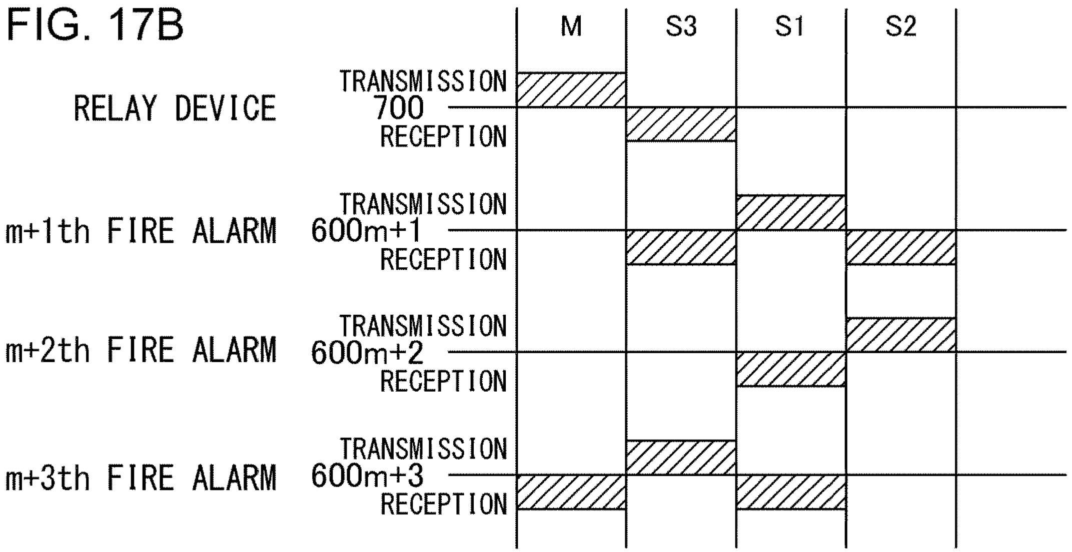


FIG. 17B



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EUROPEAN SEARCH REPORT

Application Number
EP 22 20 7691

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2018/270733 A1 (TOHZAKA YUJI [JP] ET AL) 20 September 2018 (2018-09-20) * paragraph [0004] * * paragraph [0026] * * paragraph [0028] - paragraph [0029]; figure 1 * * paragraph [0031] - paragraph [0032]; figure 2 * * paragraph [0033] - paragraph [0034]; figure 3 * * paragraph [0076] - paragraph [0099]; figure 8 * * paragraph [0112]; figure 11 * * paragraph [0136] - paragraph [0140]; figure 14 * -----	1-12	INV. G08B25/00 G08B25/10 H04W40/12
Y	US 2004/224713 A1 (SCHREYER KARLHEINZ [DE] ET AL) 11 November 2004 (2004-11-11) * paragraph [0002] * * paragraph [00015] * * paragraphs [0021], [0023]; figure 1 * * paragraph [0025] - paragraph [0029]; figures 2,3 * -----	1-12	
			TECHNICAL FIELDS SEARCHED (IPC)
			G08B H04L H04W

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	27 March 2023	Heß, Rüdiger

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 20 7691

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The members are as contained in the European Patent Office EDP file on
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27-03-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2018270733 A1	20-09-2018	CN 108633067 A	09-10-2018
		JP 6955880 B2	27-10-2021
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