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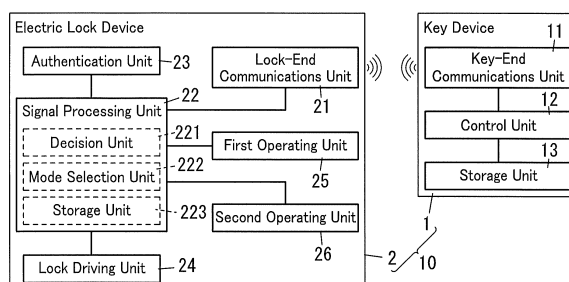
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(54) **ELECTRIC LOCK SYSTEM AND ELECTRIC LOCK DEVICE**

(57) An object of the present invention is to provide an electric lock system and electric lock device that reduce the chances of an entrance of a building being unlocked in an unauthorized manner from outside of the building. An electric lock system (10) according to the present invention includes an electric lock device (2) to lock the entrance of the building, and a key device (1) with the ability to communicate with the electric lock device (2). The electric lock system (10) performs unlocking processing to unlock the entrance based on a result of authentication carried out by an authentication unit (23)

in accordance with authentication information of the key device (1). The electric lock system (10) further includes a decision unit (221) and a mode selection unit (222). The decision unit (221) determines whether the key device (1) is currently located inside or outside of the building. The mode selection unit (222) selects, in accordance with a decision made by the decision unit (221), either an enabling mode that enables the unlocking processing or a disabling mode that disables the unlocking processing, as the operation mode.

FIG. 1



Description

Technical Field

[0001] The present invention generally relates to an electric lock system and an electric lock device, and more particularly relates to an electric lock system configured to unlock an entrance of a building with an electric lock device by making the electric lock device communicate with a key device, and also relates to an electric lock device for use in such an electric lock system.

Background Art

[0002] Electric lock systems for electrically shutting or opening a lock provided for a building's door have been provided (see, for example, Patent Document 1). The electric lock system disclosed in Patent Document 1 includes an electric lock device and a mobile device. The electric lock device includes a sensing unit, a first communications unit, a driving unit for driving a lock, and a control unit. The mobile device includes a memory and a second communications unit. With the memory of the mobile device, registered in advance is authentication information, which is required to shut or open the lock. In a memory for the control unit of the electric lock device, registered in advance is authentication information assigned to the mobile device.

[0003] The control unit collates the authentication information, acquired from the mobile device by making the first and second communications units communicate with each other wirelessly, with the authentication information registered in advance with the memory, and enters an unlocking standby state when finding these two pieces of authentication information matching each other. Then, on receiving, in the unlocking standby state, a detection signal from the sensing unit, the control unit controls the driving unit to open the lock.

[0004] An electric lock system such as the one disclosed in Patent Document 1, however, could allow a key device located inside of a building to be unlocked from outside of the building, when the range in which radio waves are able to reach from a mobile device (corresponding to the key device) is broadened or when the system is adapted to a building with a special layout of rooms.

Citation List

Patent Literature

[0005] Patent Document 1: JP 2016-30894 A

Summary of Invention

[0006] In view of the foregoing background, it is therefore an object of the present invention to provide an electric lock system and electric lock device with ability to

reduce the chances of an entrance of a building being unlocked in an unauthorized manner from outside of the building.

[0007] An electric lock system according to an aspect of the present invention includes an electric lock device and a key device. The electric lock device locks an entrance of a building. The key device is able to communicate with the electric lock device. The electric lock device includes an operating unit, a lock-end communications unit, and an authentication unit. The operating unit is subjected to operation from outside of the building when unlocking the entrance. The key device includes a key-end communications unit to communicate with the lock-end communications unit. The electric lock system performs unlocking processing to unlock the entrance in response to the operation done on the operating unit and based on a result of authentication. The authentication is carried out by the authentication unit in accordance with authentication information of the key device. The authentication information is received at the lock-end communications unit through communication between the lock-end communications unit and the key-end communications unit. The electric lock system further includes a decision unit and a mode selection unit. The decision unit determines whether the key device is currently located inside or outside of the building. The mode selection unit selects, in accordance with a decision made by the decision unit, either an enabling mode that enables the unlocking processing or a disabling mode that disables the unlocking processing, as an operation mode.

[0008] An electric lock device according to another aspect of the present invention is configured to lock an entrance of a building by communicating with a key device including a key-end communications unit. The electric lock device includes an operating unit, a lock-end communications unit, and an authentication unit. The operating unit is subjected to operation from outside of the building when unlocking the entrance. The electric lock device is configured to perform unlocking processing to unlock the entrance in response to the operation done on the operating unit and based on a result of authentication. The authentication is carried out by the authentication unit in accordance with authentication information of the key device. The authentication information is received at the lock-end communications unit through communication between the lock-end communications unit and the key-end communications unit. The electric lock device further includes a decision unit and a mode selection unit. The decision unit determines whether the key device is currently located inside or outside of the building. The mode selection unit selects, in accordance with a decision made by the decision unit, either an enabling mode that enables the unlocking processing or a disabling mode that disables the unlocking processing, as an operation mode.

Brief Description of Drawings

[0009]

FIG. 1 is a block diagram illustrating a configuration for an electric lock system according to an embodiment of the present invention;
FIGS. 2A and 2B illustrate how the electric lock system operates; and
FIG. 3 is a flowchart illustrating how the electric lock system operates.

Description of Embodiments

(1) Overview of electric lock system

[0010] An electric lock system 10 according to an exemplary embodiment of the present invention includes a key device 1 and an electric lock device 2 as shown in FIGS. 2A and 2B.

[0011] The electric lock device 2 is a device for locking the entrance 4 of a building 3. As used herein, the "entrance" of the building 3 refers to a door or a window separating the inside of the building 3 (hereinafter referred to as "the inside 31") from the outside of the building 3 (hereinafter referred to as "the outside 32") and may be a main entrance door, a back door, or a patio door, for example. The electric lock device 2 is installed on the entrance 4. In this embodiment, the electric lock device 2 is configured to be able to communicate with the key device 1 and electrically switch the state of the entrance 4 from a locked state into an unlocked state, and vice versa, by communicating with the key device 1.

[0012] The key device 1 has the capability of communicating with the electric lock device 2. In this embodiment, the method of communication between the key device 1 and the electric lock device 2 is wireless communication via radio waves. The key device 1 is battery driven and formed in an appropriate size so as to be easily portable for a user 5. In this embodiment, the key device 1 is configured as a tag attachable to a bag or any other type of personal belonging carried by the user 5 with him or her.

[0013] In the following description of exemplary embodiments, the building 3 is a single-family dwelling house, and the user 5 is one of the persons living in the building 3 (the single-family dwelling house in this example) who holds (or carries) the key device 1.

[0014] The basic function of the electric lock system 10 is allowing the electric lock device 2 to unlock the entrance 4 by making the key device 1 transmit a key ID (identification), which is stored in advance in the key device 1, to the electric lock device 2. That is to say, successful authentication of the key device's 1 key ID through the communication between the key device 1 and the electric lock device 2 makes the electric lock device 2 ready to unlock the entrance 4. Then, once the authentication has been done successfully, it is not until

the first operating unit 25 or the second operating unit 26 (see FIG. 1 for both of these units) finishes a predetermined operation (i.e., unlocking operation) that the electric lock device 2 unlocks the entrance 4. Consequently, the electric lock device 2 performs the unlocking operation of switching from the locked state into the unlocked state through the communication with the key device 1. In this embodiment, the key ID described above is used as a piece of authentication information of the key device 1.

[0015] Such an unlocking operation is performed by the electric lock device 2 when the user 5 stays outdoors, or is in the outside 32 (i.e., when the user is coming home) and/or when the user 5 stays indoors, or is in the inside 31 (i.e., when the user is going out). In this embodiment, the unlocking operation is performed by the electric lock device 2 both when the user 5 is coming home and when the user 5 is going out. Specifically, when the user 5 is coming home, communication between the electric lock device 2 and the key device 1 held by the user 5, who is still staying in the outside 32 but who has come close enough to the entrance 4 for radio waves to reach the electric lock device 2 from the key device 1, makes the entrance 4 ready to be unlocked. Likewise, when the user 5 is going out, communication between the electric lock device 2 and the key device 1 held by the user 5, who is still staying in the inside 31 but who has come close enough to the entrance 4 for radio waves to reach the electric lock device 2 from the key device 1, makes the entrance 4 ready to be unlocked. Note that when the user 5 is going out, the key ID of the key device 1 does not always have to be authenticated through the communication between the key device 1 and the electric lock device 2, but the entrance 4 may be unlocked just by the unlocking operation by the second operating unit 26.

[0016] Also, even though detailed description thereof will be omitted herein, when the key ID is authenticated successfully through the communication between the electric lock device 2 and the key device 1 and when a predetermined operation (i.e., a locking operation) is performed by either the first operating unit 25 or the second operating unit 26 in a state where the entrance 4 is unlocked, the electric lock device 2 locks the entrance 4. That is to say, the electric lock device 2 is able to perform not only the unlocking operation but also the locking operation of switching its own state from the unlocked state into the locked state through the communication with the key device 1.

(2) Configuration of key device

[0017] Next, the configuration of the key device 1 according to this embodiment will be described with reference to FIG. 1.

[0018] The key device 1 includes a key-end communications unit 11, a control unit 12, and a storage unit 13.

[0019] The storage unit 13 may be implemented as a nonvolatile memory, for example. In the storage unit 13,

stored is a key ID unique to the key device 1.

[0020] The key-end communications unit 11 is configured to be able to communicate with the electric lock device 2. The method of communication between the key-end communications unit 11 and (a lock-end communications unit 21 of) the electric lock device 2 may be wireless communication via radio waves such as Bluetooth™ radio waves. In this embodiment, the key device 1 not only transmits signals to the electric lock device 2 but also receives a connection request signal, an ID request signal, and other signals from (the lock-end communications unit 21) of the electric lock device 2. That is to say, the key-end communications unit 11 has signal transmitting and receiving capabilities and communicates bidirectionally with the lock-end communications unit 21.

[0021] In this embodiment, the control unit 12 is implemented as a microcomputer including, as its major components, a central processing unit (CPU) and a memory. In other words, since the control unit 12 is configured as a computer including a CPU and a memory, the computer functions as the control unit 12 by making the CPU execute a program stored in the memory. In this embodiment, the program to be executed by the CPU is stored in advance in the memory of the microcomputer. However, this is only an example and should not be construed as limiting. Alternatively, the program may also be downloaded via a telecommunications line such as the Internet or distributed after having been stored on a storage medium such as a memory card.

[0022] The control unit 12 controls the key-end communications unit 11. The control unit 12 allows the entrance 4 to be unlocked by the electric lock device 2 at least by making the key-end communications unit 11 receive a signal from (the lock-end communications unit 21 of) the electric lock device 2. Specifically, the control unit 12 makes the key-end communications unit 11 receive a connection request signal from the lock-end communications unit 21. The connection request signal is transmitted to have the communication between the key-end communications unit 11 and the lock-end communications unit 21 started. In response to the connection request signal, the control unit 12 has an ACK (acknowledgement) signal transmitted as a response signal from the key-end communications unit 11 to the lock-end communications unit 21. When communication is established between the key-end communications unit 11 and the lock-end communications unit 21, the control unit 12 reads out the key ID from the storage unit 13 and makes the key-end communications unit 11 transmit a signal including the key ID (hereinafter referred to as an "ID signal") to the lock-end communications unit 21.

(3) Configuration of electric lock device

[0023] Next, the configuration of the electric lock device 2 will be described with reference to FIG. 1.

[0024] The electric lock device 2 includes the lock-end

communications unit 21, a signal processing unit 22, an authentication unit 23, a lock driving unit 24, the first operating unit 25, and the second operating unit 26. The signal processing unit 22 includes a decision unit 221, a mode selection unit 222, and a storage unit 223. The electric lock device 2 may be built in a door (such as a main entrance door) serving as the entrance 4 (see FIG. 2A). The electric lock device 2 may operate with power supplied from an external power supply such as a utility grid (commercial power supply) or may be driven by a battery.

[0025] The lock-end communications unit 21 is configured to be able to communicate with (the key-end communications unit 11 of) the key device 1. The lock-end communications unit 21 and (the key-end communications unit 11 of) the key device 1 communicate with each other bidirectionally as described above, and therefore, the lock-end communications unit 21 has signal transmitting and receiving capabilities.

[0026] At least one registration ID is registered with (or stored in) the authentication unit 23. The registration ID corresponds to the key ID of the key device 1. For example, if each of the residents of the building 3 has their own key device 1 individually (i.e., if the electric lock system 10 includes a plurality of key devices 1), then a plurality of registration IDs respectively corresponding to the key IDs of those key devices 1 are registered with the authentication unit 23. The lock driving unit 24 switches the state of the electric lock device 2 from the locked state into the unlocked state, and vice versa, by driving the lock of the entrance 4.

[0027] In this embodiment, the signal processing unit 22 is implemented as a microcomputer including, as its major components, a CPU and a memory. In other words, since the signal processing unit 22 is configured as a computer including a CPU and a memory, the computer functions as the signal processing unit 22 by making the CPU execute a program stored in the memory. In this embodiment, the program to be executed by the CPU is stored in advance in the memory of the microcomputer. However, this is only an example and should not be construed as limiting. Alternatively, the program may also be downloaded via a telecommunications line such as the Internet or distributed after having been stored on a storage medium such as a memory card.

[0028] The signal processing unit 22 controls the lock-end communications unit 21, the authentication unit 23, and the lock driving unit 24. The signal processing unit 22 makes the lock-end communications unit 21 transmit a connection request signal to (the key-end communications unit 11 of) the key device 1 at regular intervals. On finding that the lock-end communications unit 21 has received a response signal (ACK signal) from the key device 1 in response to the connection request signal, the signal processing unit 22 decides that communication has been established and instructs the lock-end communications unit 21 to transmit a signal requesting a key ID (hereinafter referred to as an "ID request signal") to the

key-end communications unit 11. When the lock-end communications unit 21 receives a signal including the key ID (hereinafter referred to as an "ID signal") in response to the ID request signal, the signal processing unit 22 instructs the authentication unit 23 to collate the key ID included in the ID signal with the registration ID registered in advance with the authentication unit 23, thus performing authentication processing on the key ID. When the key ID is successfully authenticated, the signal processing unit 22 controls the lock driving unit 24 to unlock the entrance 4, which is triggered, in this embodiment, by a predetermined operation (i.e., an unlocking operation) performed on the first operating unit 25 or the second operating unit 26.

[0029] The first operating unit 25 and the second operating unit 26 each have the function of accepting the user's 5 operation. For example, the first operating unit 25 may be implemented as a press button switch provided on the outside 32 of the entrance 4, while the second operating unit 26 may be implemented as a press button switch provided on the inside 31 of the entrance 4. Alternatively, each of the first and second operating units 25 and 26 may also be configured as a door handle provided for the door of the entrance 4 or may also be configured as a touchscreen sensor that senses the user 5 put his or her hand on the door handle, for instance. Note that the second operating unit 26 is provided in the inside 31 of the entrance 4, and therefore, is usually operated by the residents of the building 3. That is why to unlock the entrance 4 from the inside 31, the authentication processing does not have to be performed on the key ID of the key device 1. Nevertheless, the authentication processing may or may not be performed on the key ID of the key device 1 when the entrance 4 is unlocked from the inside 31.

[0030] The decision unit 221 is provided for the signal processing unit 22. A computer may function as the decision unit 221 by making its CPU execute a program stored in its memory. The decision unit 221 determines whether the key device 1 is currently located indoors (in the inside 31) or outdoors (in the outside 32). In this case, the decision unit 221 determines whether the key device 1 is currently located in the inside 31 or the outside 32 by seeing if a predetermined condition (hereinafter referred to as a "first condition") is satisfied after the entrance 4 has been unlocked through a predetermined operation (i.e., the unlocking operation) performed on the first operating unit 25. In addition, the decision unit 221 also determines whether the key device 1 is currently located in the inside 31 or the outside 32 by seeing if a prescribed condition (hereinafter referred to as a "second condition") is satisfied after the entrance 4 has been unlocked through a predetermined operation (i.e., the unlocking operation) performed on the second operating unit 26.

[0031] In this embodiment, the first operating unit 25 is provided for the outside 32 of the entrance 4 as described above. That is to say, the user 5 is supposed to

perform the unlocking operation on the first operating unit 25 from the outside 32. The predetermined condition may be that the main entrance door to serve as the entrance 4 be once opened and then shut again, for example. In that case, it is presumed that the user 5 has entered the inside 31 from the outside 32 by passing through the entrance 4. Therefore, when finding that this condition is satisfied, the decision unit 221 decides that the key device 1 be currently located indoors (i.e., in the inside 31 of the building 3). Nevertheless, this condition alone does not always allow a final decision to be made that the key device 1 be currently located in the inside 31. For this reason, the decision unit 221 actually presumes that the key device 1 would be currently located in the inside 31.

[0032] On the other hand, the second operating unit 26 is provided for the inside 31 of the entrance 4 as described above. That is to say, the user 5 is supposed to perform the unlocking operation on the second operating unit 26 from the inside 31. The prescribed condition may be that the main entrance door to serve as the entrance 4 be once opened and then shut again, for example. In that case, it is presumed that the user 5 has gone out from the inside 31 into the outside 32 by passing through the entrance 4. Therefore, when finding that this condition is satisfied, the decision unit 221 decides that the key device 1 be currently located outdoors (i.e., in the outside 32 of the building 3). Nevertheless, this condition alone does not always allow a final decision to be made that the key device 1 be currently located in the outside 32. For this reason, the decision unit 221 actually presumes that the key device 1 would be currently located in the outside 32.

[0033] The mode selection unit 222, as well as the decision unit 221, is provided for the signal processing unit 22. A computer may function as the mode selection unit 222 by making its CPU execute a program stored in its memory. The mode selection unit 222 is configured to select, based on the decision made by the decision unit 221, an operating mode for the electric lock device 2. As the operation mode of the electric lock device 2, selected is either an "enabling mode" that enables the first operating unit 25 to perform the unlocking operation from the outside 32 or a "disabling mode" that disables the first operating unit 25 from performing the unlocking operation from the outside 32. As used herein, the "enabling mode" is a mode that allows the entrance 4 to be unlocked when the key ID of the key device 1 is successfully authenticated and when the predetermined operation (unlocking operation) has been performed on the first operating unit 25. On the other hand, the "disabling mode" is a mode that does not allow the entrance 4 to be unlocked even when the key ID of the key device 1 is successfully authenticated and when the predetermined operation (unlocking operation) has been performed on the first operating unit 25.

[0034] Speaking of mode selection, if the decision unit 221 has decided that the key device 1 be currently located outdoors (in the outside 32 of the building 3), it is pre-

sumed that the user 5 holding the key device 1 would be currently located in the outside 32, and therefore, the mode selection unit 222 suitably selects the "enabling mode" as the operation mode of the electric lock device 2. In that case, since the operation mode of the electric lock device 2 is the "enabling mode," the user 5 who has come home from a place away home may unlock the entrance 4 by performing the unlocking operation on the first operating unit 25 as shown in FIG. 2A, for example. That is to say, the electric lock system 10 according to this embodiment is configured to accept the unlocking operation by the first operating unit 25 when the operation mode of the electric lock device 2 is the "enabling mode."

[0035] On the other hand, if the decision unit 221 has decided that the key device 1 be currently located indoors (in the inside 31 of the building 3), it is presumed that the user 5 holding the key device 1 would be currently located in the inside 31, and therefore, the mode selection unit 222 suitably selects the "disabling mode" as the operation mode of the electric lock device 2. In that case, since the operation mode of the electric lock device 2 is the "disabling mode," a suspicious person 6 who does not hold the key device 1 cannot unlock the entrance 4 even if he or she has performed the unlocking operation on the first operating unit 25 as shown in FIG. 2B, for example. That is to say, the electric lock system 10 according to this embodiment is configured to reject the unlocking operation by the first operating unit 25 when the operation mode of the electric lock device 2 is the "disabling mode." As can be seen, selecting the "disabling mode" as the operation mode of the electric lock device 2 when the key device 1 is currently located in the inside 31 reduces the chances of the entrance 4 of the building 3 being unlocked in an unauthorized manner from outside of the building 3.

[0036] The storage unit 223 may be implemented as a memory of a microcomputer, for example. In the storage unit 223, stored is the operation mode, selected by the mode selection unit 222, for the electric lock device 2.

(4) Operation

[0037] Next, it will be described with reference to FIG. 3 how the electric lock system 10 (more specifically, the electric lock device 2) according to this embodiment operates. FIG. 3 is a flowchart illustrating an exemplary operation of the electric lock system 10 (more specifically, the electric lock device 2). Note that in the following description, the key ID of the key device 1 is supposed to have already been authenticated successfully through communication between the key device 1 and the electric lock device 2.

[0038] First of all, in Step ST1, the signal processing unit 22 of the electric lock device 2 determines whether or not a first operation has been performed. As used herein, the "first operation" refers to a predetermined operation (unlocking operation) performed by the user 5 on the first operating unit 25. If the first operation has been per-

formed (i.e., if the answer is YES in Step ST1), then the signal processing unit 22 determines, in Step ST2, whether or not the operation mode of the electric lock device 2 is the "enabling mode." If the operation mode of the electric lock device 2 is the "enabling mode" (i.e., if the answer is YES in Step ST2), then the signal processing unit 22 unlocks, in Step ST3, the entrance 4 by having the lock of the entrance 4 driven by the lock driving unit 24. In other words, the signal processing unit 22 makes the lock driving unit 24 carry out the unlocking processing in response to the unlocking operation performed on the first operating unit 25.

[0039] Thereafter, the decision unit 221 of the signal processing unit 22 determines, in Step ST4, whether or not the predetermined condition described above is satisfied. If the predetermined condition is satisfied (i.e., if the answer is YES in Step ST4), then the decision unit 221 decides (more exactly, presumes) that the key device 1 be currently located indoors (in the inside 31 of the building 3). Then, the mode selection unit 222 selects, in accordance with the decision made by the decision unit 221, the "disabling mode" as the operation mode of the electric lock device 2 in Step ST5. That is to say, in that case, the operation mode of the electric lock device 2 that has been the "enabling mode" switches into the "disabling mode." The operation mode selected by the mode selection unit 222, namely, the "disabling mode" in this case, is stored in the storage unit 223. Note that if the operation mode of the electric lock device 2 turns out to be the "disabling mode" in Step ST2 or unless the predetermined condition is satisfied in Step ST4, the process goes back to Step ST1.

[0040] If it turns out in Step ST1 that the first operation has not been performed (i.e., if the answer is NO in Step ST1), then the signal processing unit 22 determines, in Step ST6, whether or not a second operation has been performed. As used herein, the "second operation" refers to a predetermined operation (unlocking operation) performed by the user 5 on the second operating unit 26. If the second operation has been performed (i.e., if the answer is YES in Step ST6), then the signal processing unit 22 unlocks, in Step ST7, the entrance 4 by having the lock of the entrance 4 driven by the lock driving unit 24. Thereafter, the signal processing unit 22 determines, in Step ST8, whether or not the operation mode of the electric lock device 2 is the "disabling mode." If the operation mode of the electric lock device 2 is the "disabling mode" (i.e., if the answer is YES in Step ST8), then the decision unit 221 of the signal processing unit 22 determines, in Step ST9, whether or not the prescribed condition described above is satisfied. If the prescribed condition is satisfied (i.e., if the answer is YES in Step ST9), then the decision unit 221 decides (more exactly, presumes) that the key device 1 be currently located outdoors (in the outside 32 of the building 3). Then, the mode selection unit 222 selects, in accordance with the decision made by the decision unit 221, the "enabling mode" as the operation mode of the electric lock device 2 in Step ST10.

That is to say, in that case, the operation mode of the electric lock device 2 that has been the "disabling mode" switches into the "enabling mode." The operation mode selected by the mode selection unit 222, namely, the "enabling mode" in this case, is stored in the storage unit 223. Note that unless the second operation has been performed in Step ST6, unless the operation mode of the electric lock device 2 turns out to be the "disabling mode" in Step ST8, or unless the prescribed condition is satisfied in Step ST8, the process goes back to Step ST1.

[0041] In a situation where the operation mode of the electric lock device 2 has switched into the "enabling mode" by satisfying the prescribed condition, if the key-end communications unit 11 and the lock-end communications unit 21 still continue communicating with each other, then the operation mode of the electric lock device 2 is suitably turned back into the "disabling mode" again. In that case, since the key device 1 still stays within the range in which the key device 1 is able to communicate with the electric lock device 2 even though the prescribed condition described above is satisfied, the decision unit 221 may decide (more exactly, presume) that the key device 1 be currently located indoors (in the inside 31 of the building 3). Therefore, in that case, even if the "enabling mode" has once been selected as the operation mode of the electric lock device 2, the "disabling mode" is suitably selected again.

[0042] Furthermore, in a situation where the operation mode of the electric lock device 2 has switched into the "enabling mode" by satisfying the prescribed condition, if the strength of the received signal remains unchanged for a certain amount of time, then the operation mode of the electric lock device 2 is suitably turned back into the "disabling mode" again. In that case, since the received signal strength indicator (RSSI) hardly changes even though the prescribed condition described above is satisfied, the decision unit 221 may decide (more exactly, presume) that the key device 1 be currently located indoors (in the inside 31 of the building 3). Therefore, in that case, even if the "enabling mode" has once been selected as the operation mode of the electric lock device 2, the "disabling mode" is suitably selected again. This allows, even if the operation mode has once turned into the "enabling mode" because the user 5 who is staying home has temporarily opened the lock of the entrance 4 to see a visitor off, for example, the operation mode may be turned back into the "disabling mode" again. This ensures a sufficiently high degree of security.

(5) Variations

[0043] Next, some variations of this embodiment will be described.

[0044] The building 3 does not have to be a single-family dwelling house but may also be a non-single-family dwelling house (such as a dwelling unit of a multi-family dwelling house) or a non-dwelling house such as an office, a store, or a nursing care facility.

[0045] In the embodiment described above, the key device 1 is a tag device. However, this is only an example and should not be construed as limiting. The key device 1 may also be implemented as an IC card or any other form of product with communications ability and may even be implemented as a general-purpose mobile telecommunications device such as a smartphone.

[0046] In addition, the method of communication between the key device 1 and the electric lock device 2 does not have to be compliant with the Bluetooth™ standard, but may also be wireless communication using any other type of radio waves as a communication medium or optical communication using an infrared ray or any other type of light as a communication medium.

[0047] Furthermore, in the embodiment described above, the key ID is authenticated by the electric lock device 2. However, this is only an example and should not be construed as limiting. Alternatively, the key ID may also be authenticated by the key device 1, for example. Specifically, in that case, a lock ID stored in advance in the electric lock device 2 may be transmitted from the electric lock device 2 to the key device 1 and collated with the key ID by the key device 1. If these two IDs match each other, then an authentication signal may be transmitted to the electric lock device 2. In that case, the electric lock device 2 allows the entrance 4 to be unlocked upon receiving the authentication signal from the key device 1.

[0048] Furthermore, in the embodiment described above, the decision unit 221 is provided for the electric lock device 2. However, this is only an example and should not be construed as limiting. Alternatively, the decision unit may also be provided for the key device 1. In that case, information about the open or closed state of the main entrance door to serve as the entrance 4 is transmitted from the electric lock device 2 to the key device 1. The decision unit of the key device 1 determines, based on the information about the open or closed state, whether the key device 1 is currently located inside or outside of the building 3. Then, the decision made by the decision unit is transmitted from the key device 1 to the electric lock device 2, and the mode selection unit 222 of the electric lock device 2 selects, based on the decision made, the operation mode for the electric lock device 2.

[0049] Furthermore, in the embodiment described above, the authentication processing is performed on the key ID of the key device 1 before the predetermined operation (i.e., the unlocking operation) is performed on the first operating unit 25. However, this is only an example and should not be construed as limiting. Alternatively, the authentication processing may also be performed on the key ID after the predetermined operation has been performed on the first operating unit 25.

[0050] Furthermore, in the embodiment described above, the electric lock system 10 is configured not to accept the unlocking operation by the first operating unit 25 when the operation mode of the electric lock device 2 is the "disabling mode." However, this is only an exam-

ple and should not be construed as limiting. Alternatively, the electric lock system 10 may also be configured not to receive the key ID from the key device 1, for example. If the key ID is not received, then the authentication unit 23 does not perform the authentication processing. That is why even if the unlocking operation is performed on the first operating unit 25, the entrance 4 is not unlocked. This also reduces the chances of the entrance 4 of the building 3 being unlocked in an unauthorized manner from outside of the building 3 as in the embodiment described above. Still alternatively, the electric lock system 10 may also be configured not to receive the response signal when the operation mode is the "disabling mode" for the key device 1 that has transmitted a response signal in response to the connection request signal.

[0051] Furthermore, in the embodiment described above, the operation of the electric lock system 10 has been described in terms of the operation modes of the electric lock device 2 by way of example. However, the operation of the electric lock system 10 may also be described in terms of the operation modes of the key device 1. In that case, the electric lock system 10 may be configured not to receive the connection request signal from the electric lock device 2 or not to receive the ID request signal when the operation mode of the key device 1 is the "disabling mode." Alternatively, the electric lock system 10 may also be configured not to transmit the ID signal in response to the ID request signal transmitted from the electric lock device 2. In any case, this also reduces the chances of the entrance 4 of the building 3 being unlocked in an unauthorized manner from outside of the building 3 as in the embodiment described above.

[0052] Optionally, the operation modes described above may include both the operation mode of the key device 1 and the operation mode of the electric lock device 2. In that case, the mode selection unit 222 selects, in accordance with the decision made by the decision unit 221, both the operation mode of the key device 1 and the operation mode of the electric lock device 2 simultaneously.

[0053] Furthermore, in the embodiment described above, only one key device 1 is provided. However, this is only an example and should not be construed as limiting. Alternatively, a plurality of key devices 1 may be provided. In that case, a plurality of operation modes are suitably defined as operation modes for enabling or disabling the unlocking processing from outside of the building 3 so that each of those operation modes is associated one to one with any one of the plurality of key devices 1.

[0054] Furthermore, in a situation where a plurality of key devices 1 are used, the electric lock system 10 is suitably configured to select, at a time, a plurality of operation modes associated one to one with the plurality of key devices 1 collectively, if the key-end communications units 11 of the plurality of key devices 1 are currently located in an area where the key-end communications units 11 are able to communicate with the lock-end communications unit 21 of the electric lock device 2.

[0055] Furthermore, in the embodiment described above, the "predetermined condition" and the "prescribed condition" are each only an example. Optionally, the received signal strength indicator may be used as the "predetermined condition" and the "prescribed condition." In that case, on finding that the received radio wave strength that has once increased as the user 5 comes closer to the entrance 4 decreases as the user 5 goes away from the entrance 4, the decision may be made that the "predetermined condition" and the "prescribed condition" are satisfied. Note that the "predetermined condition" and the "prescribed condition" may be the same as in the embodiment described above and this variation but may also be different from each other.

[0056] Optionally, if the key device 1 is a device with a phone call capability such a smartphone, the electric lock system 10 may also be configured to select the "enabling mode" as the operation mode of the electric lock device 2 in response to a phone call from a key device 1 in the outside 32 to another key device 1 in the inside 31. For example, if the user 5 has left the key device 1 behind in the inside 31 to switch the operation mode of the electric lock device 2 into the "disabling mode" unintentionally, even the user 5 him- or herself cannot unlock the entrance 4 from outside of the building 3. That is why the electric lock system 10 is suitably configured to switch the operation mode by utilizing the phone call capability so as to be able to unlock the entrance 4 from outside of the building 3 even in such a situation.

(Resume)

[0057] As is clear from the foregoing description of embodiments, an electric lock system (10) according to a first aspect includes an electric lock device (2) and a key device (1). The electric lock device (2) is configured to lock an entrance (4) of a building (3). The key device (1) is able to communicate with the electric lock device (2). The electric lock device (2) includes an operating unit (first operating unit (25)), a lock-end communications unit (21), and an authentication unit (23). The operating unit is subjected to operation from outside of the building (3) when unlocking the entrance (4). The key device (1) includes a key-end communications unit (11) configured to communicate with the lock-end communications unit (21). The electric lock system (10) performs unlocking processing to unlock the entrance (4) in response to the operation done on the operating unit and based on a result of authentication. The authentication is carried out by the authentication unit (23) in accordance with authentication information of the key device (1). The authentication information is received at the lock-end communications unit (21) through communication between the lock-end communications unit (21) and the key-end communications unit (11). The electric lock system (10) further includes a decision unit (221) and a mode selection unit (222). The decision unit (221) determines whether the key device (1) is currently located inside or outside

of the building (3). The mode selection unit (222) selects, in accordance with a decision made by the decision unit (221), either an enabling mode that enables the unlocking processing or a disabling mode that disables the unlocking processing, as an operation mode.

[0058] According to the first aspect, if the decision unit (221) has decided that the key device (1) be currently located inside of the building (3), the mode selection unit (222) selects the disabling mode, thus disabling the unlocking processing from outside of the building (3). This reduces the chances of the entrance (4) of the building (3) being unlocked in an unauthorized manner from outside of the building (3). In addition, this also allows the mode selection unit (222) to automatically select the operation mode in accordance with a decision made by the decision unit (221). This eliminates the chances of forgetting to select the operation mode and increases the degree of security.

[0059] In an electric lock system (10) according to a second aspect, which may be implemented in conjunction with the first aspect, the operating unit serves as a first operating unit (25). The electric lock device (2) further includes a second operating unit (26) subjected to operation from inside of the building (3) when unlocking the entrance (4). The electric lock device (2) is configured to be able to unlock the entrance (4) whenever the second operating unit (26) is subjected to the operation, no matter whether the operation mode is the enabling mode or the disabling mode.

[0060] The second aspect allows, no matter whether the operation mode of the electric lock system (10) is the enabling mode or the disabling mode, the entrance (4) to be unlocked from inside of the building (3) just by operating the second operating unit (26). In addition, this also eliminates the need of paying attention to the operation mode when the unlocking processing is performed from inside of the building (3), which is also beneficial. However, this is not a configuration essential to the electric lock system (10). Optionally, the second operating unit (26) may be omitted.

[0061] In an electric lock system (10) according to a third aspect, which may be implemented in conjunction with the first or second aspect, the decision unit (221) is configured to decide, if a predetermined condition is satisfied after the unlocking processing has been performed, that the key device (1) be currently located inside of the building (3), so that the mode selection unit (222) selects the disabling mode as the operation mode.

[0062] According to the third aspect, if the unlocking processing has been performed from outside of the building (3), it is presumed that the user (5) has entered the building (3). Thus, in that case, selecting the disabling mode as the operation mode reduces the chances of the entrance (4) of the building (3) being unlocked in an unauthorized manner from outside of the building (3). However, this is not a configuration essential to the electric lock system (10). That is to say, the electric lock system (10) does not have to be configured to select the disabling

mode as the operation mode even if the predetermined condition is satisfied after the unlocking processing has been performed from outside of the building (3).

[0063] In an electric lock system (10) according to a fourth aspect, which may be implemented in conjunction with any one of the first to third aspects, the operating unit serves as a first operating unit (25). The electric lock device (2) further includes a second operating unit (26) subjected to operation from inside of the building (3) when unlocking the entrance (4). The decision unit (221) is configured to decide, if a prescribed condition is satisfied after the entrance (4) has been unlocked in response to the operation done on the second operating unit (26), that the key device (1) be currently located outside of the building (3), so that the mode selection unit (222) selects the enabling mode as the operation mode.

[0064] According to the fourth aspect, if the entrance (4) has been unlocked from inside of the building (3), it is presumed that the user (5) is going to go out of the building (3). Thus, in that case, selecting the enabling mode as the operation mode allows the user (5) to perform the unlocking processing from outside of the building (3) when he or she comes home. However, this is not a configuration essential to the electric lock system (10). That is to say, the electric lock system (10) does not have to be configured to select the enabling mode as the operation mode even if the prescribed condition is satisfied after the unlocking processing has been performed from inside of the building (3).

[0065] An electric lock system (10) according to a fifth aspect, which may be implemented in conjunction with any one of the first to fourth aspects, includes a plurality of the key devices (1), and has a plurality of the operation modes. Each of the plurality of operation modes is associated one to one with any one of the plurality of the key devices (1).

[0066] The fifth aspect allows for setting operation modes for the respective key devices (1) on an individual basis. However, this is not a configuration essential to the electric lock system (10). Alternatively, the electric lock system (10) may also be configured so that a single operation mode is associated with the plurality of the key devices (1).

[0067] In an electric lock system (10) according to a sixth aspect, which may be implemented in conjunction with the fifth aspect, the mode selection unit (222) is configured to, if the plurality of the key-end communications units (11) are able to communicate with the lock-end communications unit (21), select the plurality of the operation modes collectively.

[0068] The sixth aspect allows, when a plurality of users (5) have entered the same building (3) altogether, a plurality of operation modes associated one to one with the plurality of key devices (1) to be the same as each other. This does not decrease the utility of this electric lock system (10), which is beneficial. However, this is not a configuration essential to the electric lock system (10). Alternatively, the electric lock system (10) does not have

to be configured to select a plurality of operation modes collectively in a situation where a plurality of key-end communications units (11) are able to communicate with the lock-end communications unit (21).

[0069] An electric lock device (2) according to a seventh aspect is configured to lock an entrance (4) of a building (3) by communicating with a key device (1) including a key-end communications unit (11). The electric lock device (2) includes an operating unit (first operating unit (25)), a lock-end communications unit (21), and an authentication unit (23). The operating unit is subjected to operation from outside of the building (3) when unlocking the entrance (4). The electric lock device (2) is configured to perform unlocking processing to unlock the entrance (4) in response to the operation done on the operating unit and based on a result of authentication. The authentication is carried out by the authentication unit (23) in accordance with authentication information of the key device (1). The authentication information is received at the lock-end communications unit (21) through communication between the lock-end communications unit (21) and the key-end communications unit (11). The electric lock device (2) further includes a decision unit (221) and a mode selection unit (222). The decision unit (221) determines whether the key device (1) is currently located inside or outside of the building (3). The mode selection unit (222) selects, in accordance with a decision made by the decision unit (221), either an enabling mode that enables the unlocking processing or a disabling mode that disables the unlocking processing, as an operation mode.

[0070] According to the seventh aspect, if the decision unit (221) has decided that the key device (1) be currently located inside of the building (3), the mode selection unit (222) selects the disabling mode, thus disabling the unlocking processing from outside of the building (3). This reduces the chances of the entrance (4) of the building (3) being unlocked in an unauthorized manner from outside of the building (3). In addition, this also allows the mode selection unit (222) to automatically select the operation mode in accordance with a decision made by the decision unit (221). This eliminates the chances of forgetting to select the operation mode and increases the degree of security.

Reference Signs List

[0071]

1	Key Device
2	Electric Lock Device
3	Building
4	Entrance
10	Electric Lock System
11	Key-End Communications Unit
12	Lock-End Communications Unit
23	Authentication Unit
25	First Operating Unit (Operating Unit)

26	Second Operating Unit
221	Decision Unit
222	Mode Selection Unit

Claims

1. An electric lock system comprising:

an electric lock device configured to lock an entrance of a building; and
a key device with the ability to communicate with the electric lock device,
the electric lock device including: an operating unit configured to be subjected to operation from outside of the building when unlocking the entrance; a lock-end communications unit; and an authentication unit,
the key device including a key-end communications unit configured to communicate with the lock-end communications unit,
the electric lock system being configured to perform unlocking processing to unlock the entrance in response to the operation done on the operating unit and based on a result of authentication, the authentication being carried out by the authentication unit in accordance with authentication information of the key device, the authentication information being received at the lock-end communications unit through communication between the lock-end communications unit and the key-end communications unit,
the electric lock system further comprising:

a decision unit configured to determine whether the key device is currently located inside or outside of the building; and
a mode selection unit configured to select, in accordance with a decision made by the decision unit, either an enabling mode that enables the unlocking processing or a disabling mode that disables the unlocking processing, as an operation mode.

2. The electric lock system of claim 1, wherein the operating unit serves as a first operating unit, the electric lock device further includes a second operating unit configured to be subjected to operation from inside of the building when unlocking the entrance, and
the electric lock device is configured to be able to unlock the entrance whenever the second operating unit is subjected to the operation, no matter whether the operation mode is the enabling mode or the disabling mode.
3. The electric lock system of claim 1 or 2, wherein the decision unit is configured to decide, if a prede-

terminated condition is satisfied after the unlocking processing has been performed, that the key device be currently located inside of the building, so that the mode selection unit selects the disabling mode as the operation mode.

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4. The electric lock system of any one of claims 1 to 3, wherein

the operating unit serves as a first operating unit, the electric lock device further includes a second operating unit configured to be subjected to operation from inside of the building when unlocking the entrance,

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the decision unit is configured to decide, if a prescribed condition is satisfied after the entrance has been unlocked in response to the operation done on the second operating unit, that the key device be currently located outside of the building, so that the mode selection unit selects the enabling mode as the operation mode.

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5. The electric lock system of any one of claims 1 to 4, wherein

the electric lock system includes a plurality of the key devices,

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the electric lock system has a plurality of the operation modes, and

each of the plurality of the operation modes being associated one to one with any one of the plurality of key devices.

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6. The electric lock system of claim 5, wherein the mode selection unit is configured to, if the plurality of key-end communications units are able to communicate with the lock-end communications unit, select the plurality of the operation modes collectively.

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7. An electric lock device configured to lock an entrance of a building by communicating with a key device including a key-end communications unit, the electric lock device comprising:

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an operating unit configured to be subjected to operation from outside of the building when unlocking the entrance;

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a lock-end communications unit; and

an authentication unit,

the electric lock device being configured to perform unlocking processing to unlock the entrance in response to the operation done on the operating unit and based on a result of authentication, the authentication being carried out by the authentication unit in accordance with authentication information of the key device, the authentication information being received at the lock-end communications unit through communication between the lock-end communications unit and the key-end communications unit,

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the electric lock device further comprising:

a decision unit configured to determine whether the key device is currently located inside or outside of the building; and
a mode selection unit configured to select, in accordance with a decision made by the decision unit, either an enabling mode that enables the unlocking processing or a disabling mode disables the unlocking processing, as an operation mode.

FIG. 1

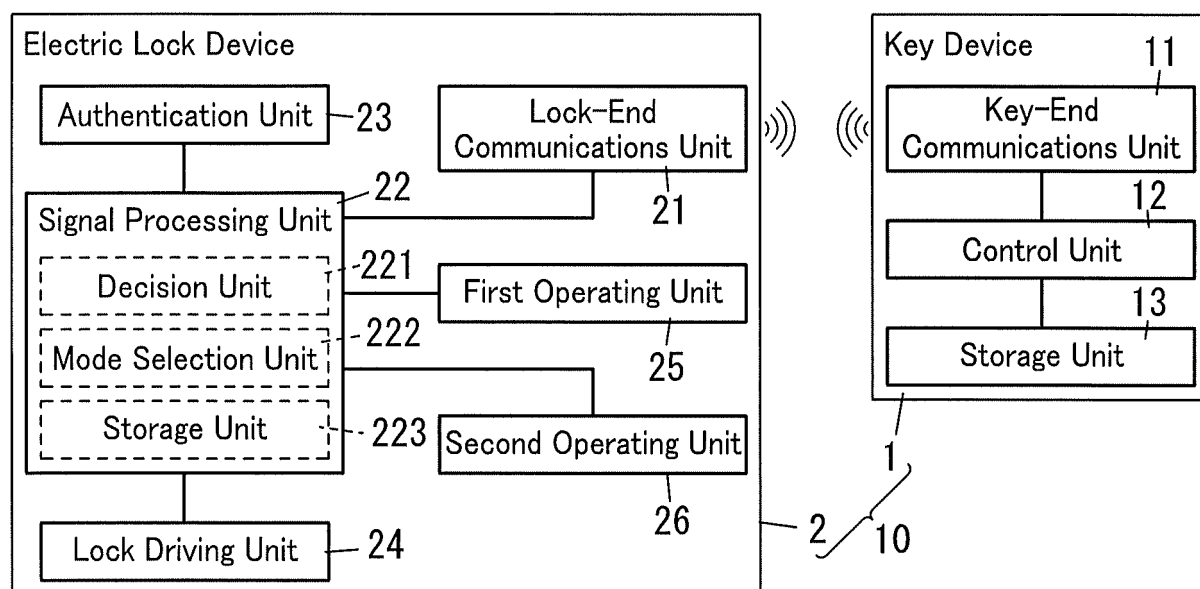


FIG. 2A

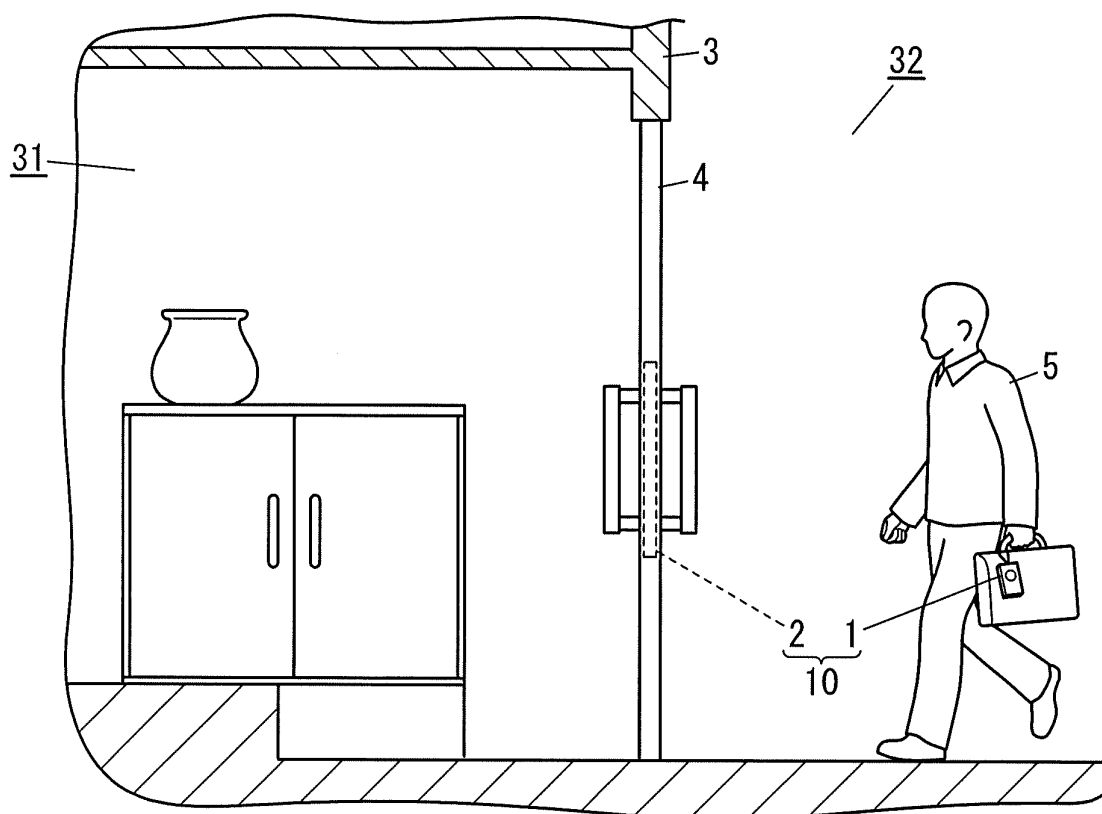


FIG. 2B

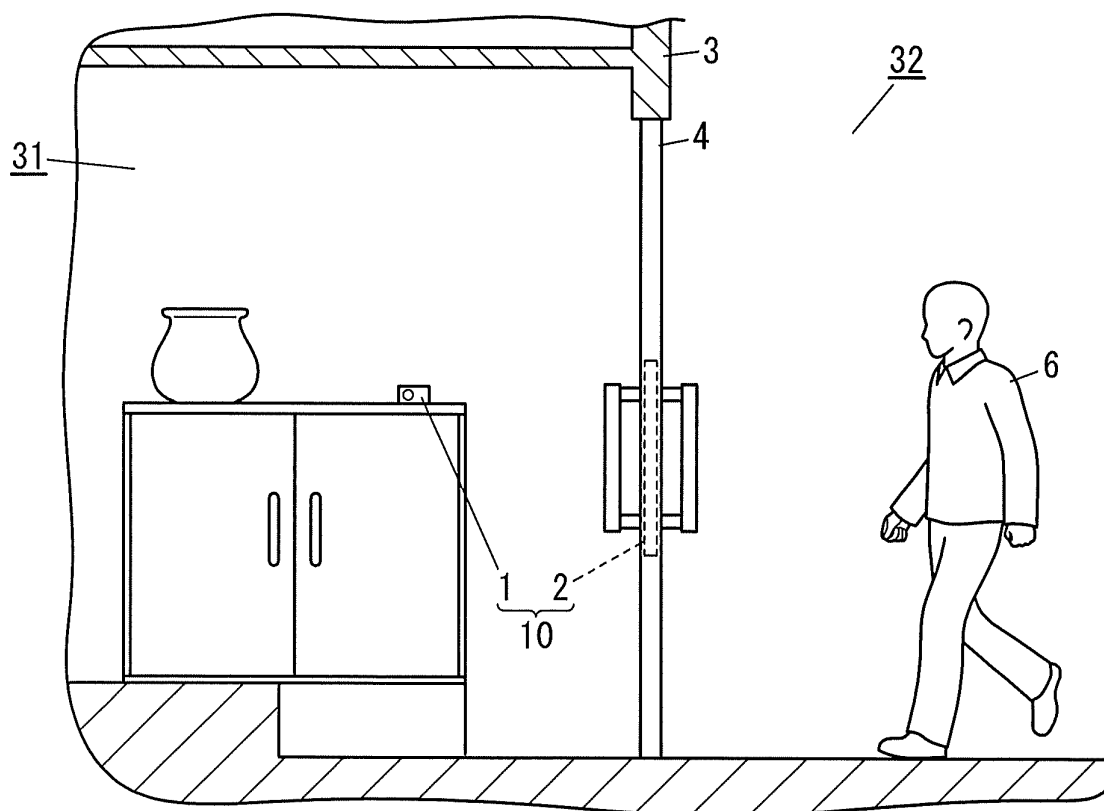
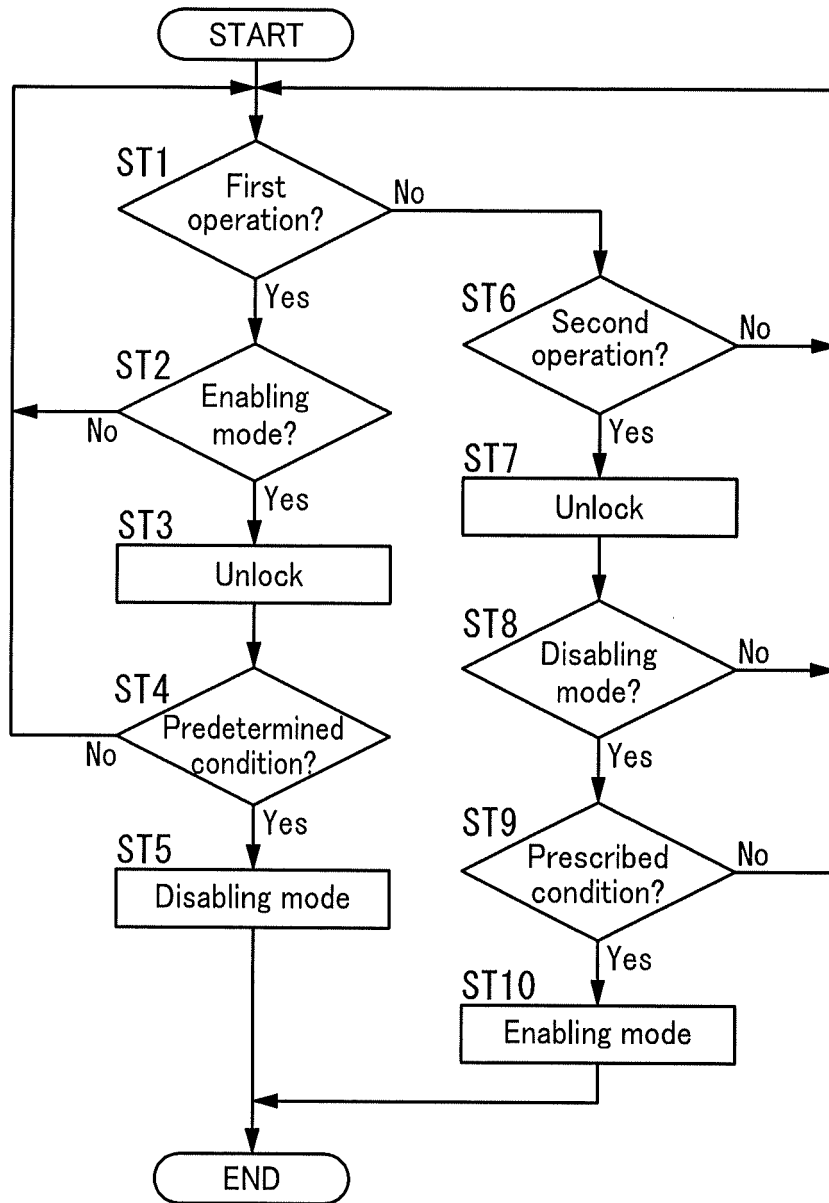


FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/019856

A. CLASSIFICATION OF SUBJECT MATTER

E05B49/00(2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E05B49/00

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017

Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2016-56503 A (Panasonic Intellectual Property Management Co., Ltd.), 21 April 2016 (21.04.2016), paragraphs [0058] to [0089]; fig. 1 to 9 & WO 2016/034930 A1	1-5, 7 6
Y A	JP 2007-1479 A (Mazda Motor Corp.), 11 January 2007 (11.01.2007), paragraphs [0039] to [0068]; fig. 5, 6 & US 2006/0279401 A1 paragraphs [0068] to [0107]; fig. 5, 6 & EP 1731390 A1	1-5, 7 6

☐ Further documents are listed in the continuation of Box C.
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"&" document member of the same patent family

Date of the actual completion of the international search

06 July 2017 (06.07.17)

Date of mailing of the international search report

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 3-4-3, Kasumigaseki, Chiyoda-ku,
 Tokyo 100-8915, Japan

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Telephone No.

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