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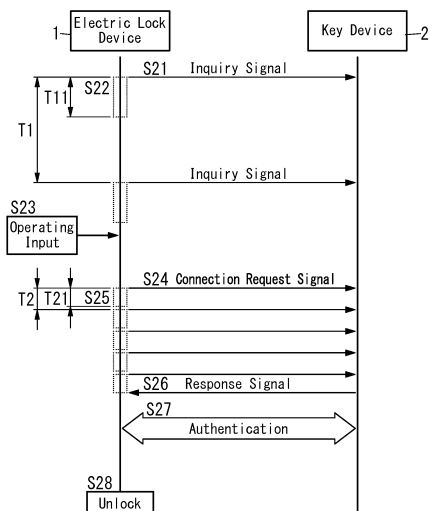
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(54) **ELECTRIC LOCK DEVICE AND ELECTRIC LOCK SYSTEM**

(57) An object of the present disclosure is to reduce power consumption by an electric lock device. An electric lock device (1) includes a lock-end communications unit (communications unit) (11), a lock-end operating unit (operating unit) (12), a lock driving unit (13), and a lock-end control unit (control unit) (14). The lock-end control unit (14) performs, when connected to the key device (2), authentication, and performs, when the authentication is done successfully, particular processing in accordance with either an operating input or a command from the key device (2). The lock-end control unit (14) operates in a first mode unless the operating input is accepted, and starts operating in a second mode when the operating input is accepted. The lock-end control unit (14) periodically performs, in the first mode, first transmission processing and first reception processing. The lock-end control unit (14) performs, in the second mode, second transmission processing and second reception processing irrespective of intervals of the first transmission processing and the first reception processing.

FIG. 4



Description

Technical Field

[0001] The present disclosure generally relates to an electric lock device and an electric lock system, and more particularly relates to an electric lock device and electric lock system for electrically shutting or opening a lock provided for an entrance of a building.

Background Art

[0002] Electric lock systems for electrically shutting or opening a lock provided for a building's entrance have been provided (see, for example, Patent Literature 1). The electric lock system disclosed in Patent Literature 1 includes an electric lock device and a mobile device. The electric lock device includes a first communications unit, a driving unit for driving a lock, a control unit, and a sensing unit for detecting the presence or absence of a human. The mobile device includes a memory and a second communications unit. The second communications unit establishes short-range wireless communication with the first communications unit via electromagnetic field or radio waves. 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 a mobile device authorized to shut or open the lock.

[0003] When the mobile device that stores the authentication information enters a communications range defined around the door, the first communications unit communicates wirelessly with the mobile device to acquire the authentication information from the mobile device. When the first communications unit successfully authenticates the mobile device with the authentication information acquired and the sensing unit detects the presence of a human, the control unit instructs the driving unit to open the lock.

[0004] Recently, there is an increasing demand for reducing the power consumption by the electric lock device in known electric lock systems like this.

Citation List

Patent Literature

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

Summary of Invention

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

[0007] An electric lock device according to an aspect of the present disclosure includes a communications unit,

an operating unit, a lock driving unit, and a control unit. The communications unit is configured to be able to communicate with a key device. The operating unit is configured to accept an operating input provided by a human.

5 The lock driving unit is configured to electrically shut or open a lock provided for an opening/closing member at a building's opening. The control unit is configured to control the communications unit and the lock driving unit. The control unit is configured to perform, when connected to the key device, authentication, and perform, when the authentication is done successfully, particular processing in accordance with either the operating input or a command from the key device. The control unit is configured to operate in a first mode unless the operating unit accepts the operating input and to start operating in a second mode when the operating unit accepts the operating input. The control unit is configured to periodically perform, in the first mode, first transmission processing and first reception processing. The first transmission processing includes making the communications unit transmit an inquiry signal to ask the key device if there is any command. The first reception processing includes controlling the communications unit such that the communications unit maintains a reception state of waiting for an incoming signal for a predetermined amount of time after having performed the first transmission processing. The control unit is configured to perform, in the second mode, second transmission processing and second reception processing irrespective of intervals of the first transmission processing and the first reception processing. The second transmission processing includes making the communications unit transmit a connection request signal, requesting connection to the key device. The second reception processing includes controlling the communications unit such that the communications unit maintains the reception state for a predetermined amount of time after having performed the second transmission processing.

[0008] An electric lock system according to another aspect of the present disclosure includes: the electric lock device described above; and the key device. The key device is configured to perform the authentication with the electric lock device by communicating with the electric lock device.

Brief Description of Drawings

[0009]

50 FIG. 1 is a block diagram illustrating an electric lock device and electric lock system according to a first embodiment of the present disclosure;
FIG. 2 is a schematic representation depicting an exemplary application of the electric lock device and electric lock system;
55 FIG. 3 is a sequence chart showing a first mode of the electric lock device in the electric lock system;
FIG. 4 is a sequence chart showing a second mode

of the electric lock device in the electric lock system; FIG. 5 is a sequence chart showing how the electric lock device finishes operating in the second mode in the electric lock system; and

FIG. 6 is a sequence chart showing a third mode of an electric lock device in an electric lock device and electric lock system according to a second embodiment of the present disclosure.

Description of Embodiments

(First embodiment)

(1) Overview

[0010] First of all, an overview of an electric lock system 100 according to a first embodiment will be described before an electric lock device 1 and electric lock system 100 according to the first embodiment are described. As shown in FIG. 1, the electric lock system 100 according to this embodiment includes an electric lock device 1 and a key device 2.

[0011] The electric lock device 1 is a device for locking an opening/closing member 4 provided at an opening (such as an entrance) of a building 3. As used herein, the "opening/closing member 4" 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 1 is installed on the opening/closing member 4. In this embodiment, the electric lock device 1 is configured to be able to communicate with the key device 2 and electrically switch the state of the opening/closing member 4 from a locked state into an unlocked state, and vice versa, by communicating with the key device 2.

[0012] The key device 2 has the capability of communicating with the electric lock device 1. In this embodiment, the method of communication between the electric lock device 1 and the key device 2 is wireless communication via radio waves. Also, in this embodiment, the electric lock device 1 and the key device 2 are both battery driven. Furthermore, in this embodiment, the key device 2 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. 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 who holds the key device 2.

[0013] In this electric lock system 100, the electric lock device 1 is allowed to lock or unlock the opening/closing member 4 by making the key device 2 transmit a terminal ID (identification), which is stored in advance in the key device 2, to the electric lock device 1. That is to say, successful authentication of the key device's 2 terminal ID through communication established between the electric lock device 1 and the key device 2 makes the electric

lock device 1 ready to lock or unlock the opening/closing member 4. In this embodiment, the electric lock device 1 lets the user 5 provide an operating input through either the electric lock device 1 or the key device 2 and then performs authentication. Then, once the authentication has been done successfully, the electric lock device 1 locks (or unlocks) the opening/closing member 4. Consequently, the electric lock device 1 performs the unlocking operation of switching from the locked state into the unlocked state or the locking operation of switching from the unlocked state into the locked state through communication with the key device 2.

(2) Configuration

[0014] Next, configurations of the electric lock device 1 and key device 2 in the electric lock system 100 according to this embodiment will be described in detail with reference to FIGS. 1 and 2.

[0015] The electric lock device 1 includes a lock-end communications unit 11, a lock-end operating unit 12, a lock driving unit 13, a lock-end control unit 14, and a battery 15 as shown in FIG. 1. The electric lock device 1 may be built in a door (such as a main entrance door) serving as an exemplary opening/closing member 4. The battery 15 is a secondary battery that supplies power to operate the electric lock device 1. The battery 15 may or may not be a constituent element of the electric lock device 1.

[0016] The lock-end communications unit 11 is configured to be able to communicate with (the key-end communications unit 21 of) the key device 2. The method of communication between the lock-end communications unit 11 and the key-end communications unit 21 may be, for example, a wireless communication via radio waves such as Bluetooth®. In this embodiment, the electric lock device 1 not only transmits a signal to the key device 2 but also receives a response signal such as an acknowledgement (ACK) signal from the key device 2. That is to say, the lock-end communications unit 11 has signal transmission and reception capabilities and is configured to communicate bidirectionally with the key-end communications unit 21.

[0017] The lock-end operating unit 12 has the function of accepting an operating input provided by the user 5 (i.e., a human). For example, the lock-end operating unit 12 may be implemented as a press button switch provided on both sides, facing the inside 31 and outside 32, of the opening/closing member 4. Alternatively, the lock-end operating unit 12 may also be configured as a door handle (handgrip) provided for the door as the opening/closing member 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. When the lock-end operating unit 12 accepts the operating input provided, an operating signal corresponding to the operating input provided is transmitted to the lock-end control unit 14.

[0018] The lock driving unit 13 is configured to electrically shut or open the lock (dead bolt) provided for the opening/closing member 4 of the building 3. Specifically, the lock driving unit 13 includes a drive motor to be controlled by the lock-end control unit 14. The lock driving unit 13 is configured to move the dead bolt by transmitting the driving force of the drive motor to the dead bolt. The dead bolt is locked when protruding at least partially from the door, and is unlocked when retracted entirely into the door.

[0019] In this embodiment, the lock-end control unit 14 is implemented as a microcomputer including, as its major components, a central processing unit (CPU) and a memory. In other words, since the lock-end control unit 14 is configured as a computer including a CPU and a memory, the computer functions as the lock-end control unit 14 by making the CPU execute a program stored in the memory. In this embodiment, the program 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.

[0020] At least one registration ID is registered with (or stored in) the memory of the lock-end control unit 14. The registration ID corresponds to the terminal ID of the key device 2. For example, if the building 3 houses multiple residents, each holding their own key device 2 individually (i.e., if the electric lock system 100 includes a plurality of key devices 2), then a plurality of registration IDs respectively corresponding to the terminal IDs of those key devices 2 are registered with the memory of the lock-end control unit 14.

[0021] The lock-end control unit 14 controls the lock-end communications unit 11 and the lock driving unit 13. In this embodiment, the lock-end control unit 14 is configured to operate in a first mode and a second mode by controlling the lock-end communications unit 11. The first mode is a mode of operation performed unless the lock-end operating unit 12 accepts an operating input provided. That is to say, the first mode of operation is always performed while the electric lock device 1 is operating, except a period during which the electric lock device 1 operates in the second mode. The second mode is a mode of operation that starts to be performed when the lock-end operating unit 12 accepts the operating input provided, i.e., a mode of operation triggered by the operating input provided. That is to say, the second mode of operation is performed only when the electric lock device 1 accepts the operating input provided by the user 5.

[0022] While operating in the first mode, the lock-end control unit 14 performs first transmission processing and first reception processing periodically. The first transmission processing includes making the lock-end communications unit 11 transmit an inquiry signal to ask the key device 2 if there is any command. As used herein, the "command" refers to a command to make the electric

lock device 1 perform a type of particular processing in accordance with the operating input provided by the user 5 at the key device 2. The first reception processing includes controlling the lock-end communications unit 11 such that the lock-end communications unit 11 maintains a reception state of waiting for an incoming signal for a predetermined amount of time after having performed the first transmission processing. Thus, while operating in the first mode, the lock-end control unit 14 periodically and repeatedly performs the processing of transmitting the inquiry signal and the processing of waiting for an incoming signal for a predetermined amount of time after having transmitted the inquiry signal. In this embodiment, the lock-end control unit 14 repeats the first transmission processing and the first reception processing every few seconds (e.g., every second) while operating in the first mode.

[0023] The lock-end control unit 14 performs, in the second mode, second transmission processing and second reception processing irrespective of intervals of the first transmission processing and the first reception processing. The second transmission processing includes making the lock-end communications unit 11 transmit a connection request signal, requesting connection to the key device 2. The second reception processing includes controlling the lock-end communications unit 11 such that the lock-end communications unit 11 maintains the reception state for a predetermined amount of time after having performed the second transmission processing. In this embodiment, the lock-end control unit 14 repeats the second transmission processing and the second reception processing every few ten ms (e.g., 20 ms) until the lock-end control unit 14 receives the response signal from the key device 2.

[0024] When the lock-end communications unit 11 receives, in the reception state, a response signal from the key device 2 to establish communication between the electric lock device 1 and the key device 2, the lock-end control unit 14 starts to operate in an authentication mode. In the authentication mode, the lock-end control unit 14 makes the lock-end communications unit 11 transmit an authentication request signal requesting the key device 2 to transmit its terminal ID. Next, when the lock-end communications unit 11 receives a response signal including the terminal ID from the key device 2, the lock-end control unit 14 collates the terminal ID included in the received signal with a registration ID stored in advance.

[0025] When the authentication is done successfully by finding a match between the terminal ID and the registration ID, the lock-end control unit 14 performs particular processing in accordance with either the operating input provided through the lock-end operating unit 12 or the command from the key device 2. In this embodiment, the type of particular processing performed by the lock-end control unit 14 is locking or unlocking the opening/closing member 4 by controlling the lock driving unit 13.

[0026] As shown in FIG. 1, the key device 2 includes a key-end communications unit 21, a key-end control unit 22, a key-end operating unit 23, and a battery 24, all of which are housed in a portable case. The battery 24 is a secondary battery that supplies power to operate the key device 2. The battery 24 may or may not be a constituent element of the key device 2.

[0027] The key-end communications unit 21 is configured to be able to communicate with the electric lock device 1. The lock-end communications unit 11 and the key-end communications unit 21 communicate with each other bidirectionally as described above, and therefore, the key-end communications unit 21 has signal transmission and reception capabilities.

[0028] When the key device 2 is present inside of the communication area 6 (see FIG. 2), i.e., when the user 5 carrying the key device 2 is present inside of the communication area 6, the key-end communications unit 21 is ready to communicate with the lock-end communications unit 11 of the electric lock device 1. As used herein, the "communication area 6" refers herein to an area, defined with respect to the electric lock device 1, where the electric lock device 1 is able to communicate with the key device 2, i.e., within the reach of radio waves for communications between the electric lock device 1 and the key device 2.

[0029] The key-end control unit 22 may be implemented as a microcomputer, for example, and controls the key-end communications unit 21. The memory of the key-end control unit 22 stores a terminal ID unique to the key device 2. When the key-end communications unit 21 receives an inquiry signal from the electric lock device 1 with the key-end operating unit 23 accepting an operating input provided, the key-end control unit 22 makes the key-end communications unit 21 transmit a response signal to the inquiry signal. On the other hand, when the key-end communications unit 21 receives an inquiry signal from the electric lock device 1 with the key-end operating unit 23 accepting no operating input provided, the key-end control unit 22 makes the key-end communications unit 21 transmit no response signals.

[0030] Also, when the key-end communications unit 21 receives a connection request signal from the electric lock device 1, the key-end control unit 22 makes the key-end communications unit 21 transmit a response signal to the connection request signal. Furthermore, when the key-end communications unit 21 receives an authentication request signal from the electric lock device 1, the key-end control unit 22 makes the key-end communications unit 21 transmit, as a response signal to the authentication request signal, a signal including the terminal ID stored in the memory.

[0031] The key-end operating unit 23 has the function of accepting an operating input provided by the user 5. For example, the key-end operating unit 23 may be implemented as a press button switch provided for the case of the key device 2. Alternatively, the key-end operating unit 23 may also be configured as a lever provided for

the case of the key device 2 or may also be configured as a touchscreen panel, for instance. When the key-end operating unit 23 accepts the operating input provided, an operating signal corresponding to the operating input provided is transmitted to the key-end control unit 22.

(3) Operation

[0032] Next, it will be described how the electric lock device 1 and electric lock system 100 according to this embodiment operate.

[0033] First of all, it will be described with reference to FIG. 3 how the user 5 unlocks the opening/closing member 4 by operating the key device 2. In the example illustrated in FIG. 3, no operating input is supposed to be provided through the electric lock device 1.

[0034] When the electric lock device 1 is powered, the lock-end control unit 14 starts operating in a first mode. Specifically, the lock-end control unit 14 repeatedly performs first transmission processing of transmitting an inquiry signal (Step S11) and first reception processing of waiting for an incoming signal for a predetermined amount of time T11 (Step S12) at regular intervals T1. It is not until the user 5 operates the key device 2 that the key device 2 responds to the inquiry signal, even if the key device 2 is present inside of the communication area 6.

[0035] When the user 5 operates the key device 2 (i.e., when the key-end operating unit 23 accepts an operating input) at an arbitrary timing, the key-end control unit 22 turns ON a flag indicating that the operating input has been accepted (in Step S13). When the key-end communications unit 21 receives the inquiry signal with the flag ON, the key-end control unit 22 makes the key-end communications unit 21 transmit a response signal to the inquiry signal (in Step S14). In this processing step, the response signal is transmitted from the key-end communications unit 21 at a timing determined by the timing of reception of the inquiry signal by the key-end communications unit 21. Therefore, while the lock-end control unit 14 is performing the first reception processing (Step S12), i.e., in the reception state, the lock-end communications unit 11 is able to receive the response signal.

[0036] When the lock-end communications unit 11 receives the response signal, the lock-end control unit 14 finishes operating in the first mode and starts operating in the authentication mode instead (in Step S15). In this embodiment, in the authentication mode, a command from the key device 2 is transmitted in the response signal to an authentication request signal. When the authentication is done successfully, the lock-end control unit 14 performs a type of particular processing in accordance with the command from the key device 2. In this example, the lock-end control unit 14 unlocks the opening/closing member 4 by controlling the lock driving unit 13 (in Step S16). After having performed the type of particular processing, the lock-end control unit 14 resumes operating in the first mode.

[0037] Next, it will be described with reference to FIG. 4 how the user 5 unlocks the opening/closing member 4 by operating the electric lock device 1. In the example illustrated in FIG. 4, no operating input is supposed to be provided through the key device 2.

[0038] When the electric lock device 1 is powered, the lock-end control unit 14 starts operating in a first mode. Specifically, the lock-end control unit 14 repeatedly performs first transmission processing of transmitting an inquiry signal (Step S21) and first reception processing of waiting for an incoming signal for a predetermined amount of time T11 (Step S22) at regular intervals T1.

[0039] When the user 5 operates the electric lock device 1 (i.e., when the lock-end operating unit 12 accepts an operating input) at an arbitrary timing (in Step S23), the lock-end control unit 14 finishes operating in the first mode and starts operating in the second mode instead. Specifically, the lock-end control unit 14 repeatedly performs second transmission processing of transmitting a connection request signal (Step S24) and second reception processing of waiting for an incoming signal for a predetermined amount of time T21 (Step S25) at regular intervals T2. In this case, the interval T2 of the second transmission processing and second reception processing is shorter than the interval T1 of the first transmission processing and the first reception processing.

[0040] In the key device 2 present inside of the communication area 6, when the key-end communications unit 21 receives the connection request signal, the key-end control unit 22 makes the key-end communications unit 21 transmit a response signal to the connection request signal (in Step S26). In this processing step, the response signal is transmitted from the key-end communications unit 21 at a timing determined by the timing of reception of the connection request signal by the key-end communications unit 21. Therefore, while the lock-end control unit 14 is performing the second reception processing (Step S25), i.e., in the reception state, the lock-end communications unit 11 is able to receive the response signal.

[0041] When the lock-end communications unit 11 receives the response signal, the lock-end control unit 14 finishes operating in the second mode and starts operating in the authentication mode instead (in Step S27). When the authentication is done successfully, the lock-end control unit 14 performs a type of particular processing in accordance with the operating input provided through the lock-end operating unit 12. In this example, the lock-end control unit 14 unlocks the opening/closing member 4 by controlling the lock driving unit 13 (in Step S28). After having performed the type of particular processing, the lock-end control unit 14 resumes operating in the first mode.

[0042] In the example described above, the user 5 unlocks the opening/closing member 4 by operating either the electric lock device 1 or the key device 2. The same statement applies to a situation where the user 5 locks the opening/closing member 4. In that case, when the

authentication is done successfully, the lock-end control unit 14 locks the opening/closing member 4 by controlling the lock driving unit 13.

5 (4) Advantages

[0043] In an electric lock system, no matter whether the user operates an electric lock device or a key device, the electric lock device normally needs to wait for an incoming signal, in order to receive a response signal from the key device. However, to make the electric lock device always ready to receive the signal (i.e., to keep the electric lock device in the reception state), its communications unit needs to be always kept activated, thus causing an increase in power consumption. The power consumption could be cut down by activating the communications unit intermittently. Nevertheless, in that case, a delay would be caused in the reception of a response signal from the key device, thus possibly causing a decline in responsiveness to the user's operating inputs.

[0044] Thus, in the electric lock device 1 according to this embodiment, the lock-end control unit (control unit) 14 is configured to start operating in the second mode upon receiving the operating input provided through the lock-end operating unit (operating unit) 12 but operate in the first mode all the time otherwise. That is to say, in the electric lock device 1 according to this embodiment, the lock-end communications unit (communications unit) 11 performs the intermittent reception by repeatedly performing the first transmission processing and the first reception processing at relatively long intervals. This allows the electric lock device 1 to wait for a command coming from the key device 2 while reducing its power consumption. In addition, in a situation where the user 5 has operated the electric lock device 1, starting operating in the second mode, irrespective of the intervals of the first transmission processing and the first reception processing, allows the electric lock device 1 to be connected to the key device 2 and also allows the key device 2 to be authenticated in a relatively short time. This allows the electric lock device 1 and electric lock system 100 according to this embodiment to cut down the power consumption of the electric lock device 1 and curb the decline in responsiveness to the user's operations.

[0045] In the electric lock system 100 according to this embodiment, extending the interval of intermittent reception by the lock-end communications unit (communications unit) 11 could cause some decrease in response speed to the user's 5 operating inputs at the key device 2. However, such a decrease would not pose a serious problem. The reason is that in the electric lock system 100 according to this embodiment, the key device 2 is supposed to be operated at some distance from the opening/closing member 4. In such a situation, it would take a relatively long amount of time for the user's 5 operating inputs to reach the opening/closing member 4 since the user 5 has operated the key device 2. Therefore, even if the response speed is somewhat slow compared to a

situation where the user has provided the operating input at the electric lock device 1, no significant decline would be caused in responsiveness.

<Variations>

[0046] In the embodiment described above, the inquiry signal may have higher signal strength than the connection request signal. In other words, the signal strength of the connection request signal may be reduced to a smaller value than the signal strength of the inquiry signal. This restricts the reach of the connection request signal, transmitted from the electric lock device 1, thus ensuring a higher degree of security. This reduces the chances of allowing the electric lock device 1, to which an operating input has been provided by somebody other than the user 5, to be accidentally connected to, and authenticate, the user's key device 2, which is located at a relatively long distance from the electric lock device 1. In addition, decreasing the output level of the connection request signal transmitted would reduce the power consumption by the electric lock device 1 as well, which is also beneficial.

[0047] Furthermore, in this embodiment, the lock-end control unit 14 of the electric lock device 1 may be configured to finish operating in the second mode unless the lock-end control unit 14 receives, from the key device 2, a response signal (i.e., a response signal to the connection request signal) before a predetermined period of time passes since the lock-end control unit 14 started operating in the second mode.

[0048] Next, a situation where no response signal is received from the key device 2 after the user 5 has operated the electric lock device 1 will be described with reference to FIG. 5. In the example illustrated in FIG. 5, the key device 2 is supposed to be present outside of the communication area 6. Such a situation could arise when the user 5 who has operated the electric lock device 1 does not carry the key device 2 with him or her.

[0049] When the electric lock device 1 is powered, the lock-end control unit 14 starts operating in the first mode. Specifically, the lock-end control unit 14 repeatedly performs first transmission processing of transmitting an inquiry signal (Step S31) and first reception processing of waiting for an incoming signal for a predetermined amount of time T11 (Step S32) at regular intervals T1.

[0050] When the user 5 operates the electric lock device 1 (i.e., when the lock-end operating unit 12 accepts an operating input) at an arbitrary timing (in Step S33), the lock-end control unit 14 finishes operating in the first mode and starts operating in the second mode instead. Specifically, the lock-end control unit 14 repeatedly performs second transmission processing of transmitting a connection request signal (Step S34) and second reception processing of waiting for an incoming signal for a predetermined amount of time T21 (Step S35) at regular intervals T2.

[0051] The lock-end control unit 14 repeatedly performs the second transmission processing and the sec-

ond reception processing until a predetermined period T22 passes since the start of the second mode. If no response signal has been received from the key device 2 when the predetermined period T22 passes, the lock-end control unit 14 finishes operating in the second mode. Then, the lock-end control unit 14 resumes operating in the first mode and repeatedly performs the first transmission processing (Step S31) and the first reception processing (Step S32) at regular intervals T1.

[0052] This configuration prevents, when the key device 2 is present outside of the communication area 6, unidirectional signal transmission from the electric lock device 1 from continuing in vain, thus reducing the power consumption by the electric lock device 1.

[0053] In this embodiment, the key device 2 is a tag device. However, this is only an example and should not be construed as limiting. The key device 2 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 or a personal digital assistant (PDA).

[0054] In the embodiment described above, the lock-end control unit 14 of the electric lock device 1 locks or unlocks the opening/closing member 4 in the same way, no matter whether the operating input is provided through the electric lock device 1 or the command is received from the key device 2. However, this is only an example and should not be construed as limiting. That is to say, among various types of particular processing, the type of particular processing performed by the lock-end control unit (control unit) 14 in accordance with the operating input provided through the electric lock device 1 may be different from the type of particular processing performed by the lock-end control unit 14 in accordance with the command from the key device 2.

[0055] Suppose the key device 2 is a general-purpose mobile telecommunications device such as a smartphone and includes a display. In that case, the lock-end control unit 14 of the electric lock device 1 may make, in accordance with the command from the key device 2, the lock-end communications unit 11 transmit information about the (locked or unlocked) state of the electric lock device 1 to the key device 2. Such a configuration allows the user 5 to confirm the state of the electric lock device 1 by checking the information on the display of the key device 2. Alternatively, the lock-end control unit 14 of the electric lock device 1 may also make, in accordance with the command from the key device 2, the lock-end communications unit 11 transmit information about the history of locking or unlocking of the electric lock device 1 to the key device 2. Such a configuration allows the user 5 to confirm the history of locking or unlocking of the electric lock device 1 by checking the information on the display of the key device 2.

[0056] Also, in this embodiment, the building 3 is a single-family dwelling house. However, this is only an example and should not be construed as limiting. Alterna-

tively, the building 3 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.

[0057] Furthermore, the method of communication between the electric lock device 1 and the key device 2 does not have to be compliant with the Bluetooth® standard as in the embodiment described above, 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.

[0058] Furthermore, the battery 15, 24 for use in each of the electric lock device 1 and the key device 2 does not have to be a secondary battery but may also be, for example, a primary battery or a solar battery as well.

[0059] Furthermore, in the embodiment described above, the lock-end control unit 14 collates, in the authentication mode, the terminal ID with the registration ID. Optionally, the lock-end control unit 14 may further collate pieces of key information with each other. As used herein, the key information is information issued by the electric lock device 1 and unique to the electric lock device 1. The key information is stored in advance in each of the electric lock device 1 and the key device 2 registered with the electric lock device 1. In that case, the lock-end control unit 14 requests, in the authentication mode, the key device 2 to provide not only the terminal ID but also the key information as well. Then, the lock-end control unit 14 collates the terminal ID with the registration ID and also collates the key information acquired from the key device 2 with the key information stored in advance. When a match is found between each of these two pairs, lock-end control unit 14 determines that the authentication is done successfully.

[0060] Furthermore, in the embodiment described above, the terminal ID is authenticated by the electric lock device 1. However, this is only an example and should not be construed as limiting. Alternatively, the terminal ID may also be authenticated by the key device 2, for example. Specifically, in that case, the lock-end control unit 14 of the electric lock device 1 makes the lock-end communications unit 11 transmit, in the authentication mode, the registration ID stored in advance to the key device 2. The key-end control unit 22 of the key device 2 collates the registration ID acquired with the terminal ID stored in advance (or collates pieces of key information of any other type), and transmits, when finding a match between them, the authentication signal from the key-end communications unit 21 to the electric lock device 1. Then, when the lock-end communications unit 11 receives the authentication signal from the key device 2, the lock-end control unit 14 of the electric lock device 1 performs a type of particular processing in accordance with the operating input provided through the lock-end operating unit 12 or the command from the key device 2.

[0061] In the embodiment described above, the command from the key device 2 is transmitted, in the authentication mode, in the response signal to the authentication request signal. However, this is only an example and should not be construed as limiting. Alternatively, the command from the key device 2 may also be transmitted in any other signal. For example, the command from the key device 2 may be transmitted in a response signal to the inquiry signal. Added to that, the command from the key device 2 may be transmitted after the authentication mode.

(Second embodiment)

[0062] Next, an electric lock device 1 and electric lock system 100 according to a second embodiment will be described. Note that as the electric lock device 1 and electric lock system 100 according to this embodiment have the same basic configuration as the electric lock device 1 and electric lock system 100 according to the first embodiment, description of their common features will be omitted. Optionally, any of the constituent elements to be described for this embodiment may be combined as appropriate with the configuration described for the first embodiment and its variations.

[0063] If the key device 2 is a general-purpose mobile telecommunications device such as a smartphone, the key device 2 sometimes enters a power saving state (suspended state) to reduce the power consumption of the battery 24. In that case, unless the key device 2 quickly returns from the power saving state to the activated state when the user 5 operates the electric lock device 1, the key-end communications unit 21 of the key device 2 may be unable to receive the connection request signal from the electric lock device 1. This causes a longer latency from a point in time when the operating input is entered through the electric lock device 1 through a point in time when the particular processing (such as locking or unlocking) is performed, thus possibly causing a significant decline in responsiveness to the user's operation on the electric lock device 1.

[0064] Thus, to avoid such a situation, the lock-end control unit (control unit) 14 is configured according to this embodiment to operate in not only the first and second modes but also a third mode as well. The third mode is a mode in which the lock-end communications unit (communications unit) 11 is made to transmit a startup signal for canceling the power saving state of the key device 2 at shorter intervals than the transmission interval of the inquiry signal. The startup signal may be any type of signal as long as the startup signal is transmitted unidirectionally from the electric lock device 1 toward the key device 2 to allow the key device 2 in the power saving state to cancel the power saving state in response to the signal. In the third mode, the lock-end control unit 14 transmits the startup signal every few hundred ms (e.g., at an interval of 100 ms) in parallel with the first mode or the second mode. The transmission interval of the startup signal is suitably shorter than the transmission interval of the inquiry signal and longer than the transmission

interval of the connection request signal.

[0065] Next, it will be described with reference to FIG. 6 how the user 5 unlocks the opening/closing member 4 by operating the electric lock device 1. In the example illustrated in FIG. 6, the sequence of the second and third modes is illustrated with the sequence of the first mode omitted. Also, in the example illustrated in FIG. 6, when the electric lock device 1 is powered, the key device 2 is supposed to be present outside of the communication area 6 and assume the power saving state.

[0066] When the electric lock device 1 is powered, the lock-end control unit 14 starts operating in the third mode in parallel with the first mode. That is to say, the lock-end control unit 14 repeatedly performs the processing of making the lock-end communications unit 11 transmit the startup signal at regular intervals T3 (Step S41). In this case, the key device 2 has not reached the communication area 6 yet, and therefore, the key-end communications unit 21 is unable to receive the startup signal. Thus, the key device 2 still remains in the power saving state.

[0067] When the key device 2 reaches the communication area 6 (Step S42), the key-end communications unit 21 is ready to receive the startup signal. Thus, the key-end communications unit's 21 receiving the startup signal after the key device 2 has reached the communication area 6 allows the key device 2 to return from the power saving state to the activated state (in Step S43).

[0068] Thereafter, when the user 5 operates the electric lock device 1 at an arbitrary timing, i.e., when the lock-end operating unit 12 accepts the operating input (in Step S44), the lock-end control unit 14 finishes operating in the first mode and starts operating in the second mode instead. Specifically, the lock-end control unit 14 repeatedly performs second transmission processing of transmitting the connection request signal (Step S45) and second reception processing of waiting for an incoming signal for a predetermined amount of time T21 (Step S46) at regular intervals T2.

[0069] Since the key device 2 has already returned to the activated state, the key-end communications unit 21 is able to receive the connection request signal. When the key-end communications unit 21 receives the connection request signal, the key-end control unit 22 makes the key-end communications unit 21 transmit a response signal to the connection request signal (in Step S47).

[0070] When the lock-end communications unit 11 receives the response signal, the lock-end control unit 14 finishes operating in the second mode and starts operating in the authentication mode instead (in Step S48). When the authentication is done successfully, the lock-end control unit 14 performs particular processing in accordance with the operating input provided through the lock-end operating unit 12. In this example, the lock-end control unit 14 unlocks the opening/closing member 4 by controlling the lock driving unit 13 (in Step S49). After having performed the particular processing, the lock-end control unit 14 resumes operating in the first mode.

[0071] Optionally, in this case, the lock-end control unit

14 may also be configured to make the lock-end communications unit 11 postpone transmitting the startup signal until the lock-end operating unit 12 accepts the operating input. According to such a configuration, however, it would take a lot of time for the key device 2 to return to the activated state from the power saving state, thus leaving some interval during which the key-end communications unit 21 is unable to receive the connection request signal. In that case, it would cause a longer latency from a point in time when the operating input is provided through the electric lock device 1 through a point in time when the particular processing starts to be performed. This would also cause a significant decline in responsiveness to user's operation on the electric lock device 1.

[0072] In this embodiment, the lock-end control unit 14 operates in the third mode in parallel with the first mode. Thus, according to this embodiment, when the key device 2 enters the reach of the startup signal (i.e., the communication area 6), the key device 2 is allowed to return to the activated state in advance before the lock-end operating unit 12 accepts the operating input provided. Therefore, this embodiment prevents, even if the key device 2 is a general-purpose mobile telecommunications device such as a smartphone, the interval between a point in time when the operating input is provided through the electric lock device 1 and a point in time when the particular processing is started from becoming too long. Consequently, this embodiment reduces the chances of causing a significant decline in responsiveness to the user's operation on the electric lock device 1.

[0073] As can be seen from the foregoing description, an electric lock device (1) according to a first aspect includes a lock-end communications unit (communications unit) (11), a lock-end operating unit (operating unit) (12), a lock driving unit (13), and a lock-end control unit (control unit) (14). The lock-end communications unit (11) is configured to be able to communicate with a key device (2). The lock-end operating unit (12) is configured to accept an operating input provided by a human. The lock driving unit (13) is configured to electrically shut or open a lock provided for an opening/closing member at a building's (3) entrance. The lock-end control unit (14) is configured to control the lock-end communications unit (11) and the lock driving unit (13). The lock-end control unit (14) is configured to perform, when connected to the key device (2), authentication, and perform, when the authentication is done successfully, particular processing in accordance with either the operating input or a command from the key device (2). The lock-end control unit (14) is configured to operate in a first mode unless the lock-end operating unit (12) accepts the operating input and to start operating in a second mode when the lock-end operating unit (12) accepts the operating input. The lock-end control unit (14) is configured to periodically perform, in the first mode, first transmission processing and first reception processing. The first transmission processing includes making the lock-end communications unit (11) transmit an inquiry signal to ask the key device (2) if there

is any command. The first reception processing includes controlling the lock-end communications unit (11) such that the lock-end communications unit (11) maintains a reception state of waiting for an incoming signal for a predetermined amount of time after having performed the first transmission processing. The lock-end control unit (14) is configured to perform, in the second mode, second transmission processing and second reception processing irrespective of intervals of the first transmission processing and the first reception processing. The second transmission processing includes making the lock-end communications unit (11) transmit a connection request signal requesting connection to the key device (2). The second reception processing includes controlling the lock-end communications unit (11) such that lock-end the communications unit (11) maintains the reception state for a predetermined amount of time after having performed the second transmission processing.

[0074] According to this configuration, the lock-end communications unit (11) performs intermittent communication by repeatedly performing the first transmission processing and the first reception processing at relatively long intervals, thus reducing the power consumption by the electric lock device (1). In addition, when the user (5) operates the electric lock device (1), the electric lock device (1) starts operating in the second mode irrespective of intervals of the first transmission processing and the first reception processing, thus curbing a decline in responsiveness to the user's (5) operating input.

[0075] In an electric lock device (1) according to a second aspect, which may be implemented in conjunction with the first aspect, the lock-end control unit (14) is configured to further operate in a third mode including making the lock-end communications unit (11) transmit a startup signal at an interval shorter than the inquiry signal's transmission interval. The startup signal is transmitted to cancel a power saving state of the key device (2).

[0076] This configuration prevents, even when the key device (2) is a general-purpose telecommunications device such as a smartphone, a long latency from being caused between a point in time when any operating input is provided for the electric lock device (1) and a point in time when the type of particular processing starts to be performed in response to the input.

[0077] In an electric lock device (1) according to a third aspect, which may be implemented in conjunction with the first or second aspect, the inquiry signal and the connection request signal are wireless signals, and the inquiry signal has higher signal strength than the connection request signal.

[0078] This configuration restricts the reach of the connection request signal, transmitted from the electric lock device (1), thus ensuring a higher degree of security.

[0079] In an electric lock device (1) according to a fourth aspect, which may be implemented in conjunction with any one of the first to third aspects, the lock-end control unit (14) is configured to perform, in the second mode, the second transmission processing and the sec-

ond reception processing periodically. The lock-end control unit (14) is configured to finish operating in the second mode unless the lock-end control unit (14) receives, from the key device (2), a response signal to the connection request signal before a predetermined period of time passes since the lock-end control unit's (14) start of operating in the second mode.

[0080] This configuration prevents, when the key device (2) falls outside of the communication area (6), unidirectional transmission of signals from the electric lock device (1) from continuing in vain, thus cutting down the power consumption by the electric lock device (1).

[0081] In an electric lock device (1) according to a fifth aspect, which may be implemented in conjunction with any one of the first to fourth aspects, the particular processing includes multiple different types of processing. The type of particular processing performed by the lock-end control unit (14) in accordance with the operating input from the lock-end operating unit (12) is different from the type of particular processing performed by the lock-end control unit (14) in accordance with the command from the key device (2).

[0082] This configuration provides multiple other types of operations to be performed with the key device (2), not just opening or shutting the opening/closing member (4), thus improving the user (5)-friendliness of this electric lock device (1).

[0083] An electric lock system (100) according to a sixth aspect includes the electric lock device (1) of any one of the first to fifth aspects; and the key device (2). The key device (2) is configured to perform the authentication with the electric lock device (1) by communicating with the electric lock device (1).

[0084] This configuration realizes an electric lock system (100) with the ability to cut down the power consumption by the electric lock device (1) and curb the decline in responsiveness to the user's (5) operating inputs.

[0085] First and second exemplary embodiments of an electric lock device (1) and electric lock system (100) are as described above. Note that these embodiments are only two exemplary ones of various embodiments of the present disclosure. Rather, any of those embodiments may be readily modified, depending on a design choice or any other factor, without departing from a true spirit and scope of the present disclosure.

Reference Signs List

[0086]

1	Electric Lock Device
11	Lock-End Communications Unit (Communications Unit)
12	Lock-End Operating Unit (Operating Unit)
13	Lock Driving Unit
14	Lock-End Control Unit (Control Unit)
15	Battery
2	Key Device

21 Key-End Communications Unit
 22 Key-End Control Unit
 23 Key-End Operating Unit
 24 Battery
 3 Building
 31 Inside
 32 Outside
 4 Opening/Closing Member
 5 User
 6 Communication Area
 100 Electric Lock System

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including controlling the communications unit such that the communications unit maintains the reception state for a predetermined amount of time after having performed the second transmission processing.

2. The electric lock device of claim 1, wherein the control unit is configured to further operate in a third mode including making the communications unit transmit a startup signal at an interval shorter than the inquiry signal's transmission interval, the startup signal being transmitted to cancel a power saving state of the key device.

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Claims

1. An electric lock device comprising:

a communications unit with the ability to communicate with a key device;
 an operating unit configured to accept an operating input provided by a human;
 a lock driving unit configured to electrically shut or open a lock provided for an opening/closing member at a building's opening; and
 a control unit configured to control the communications unit and the lock driving unit, the control unit being configured to perform, when connected to the key device, authentication, and perform, when the authentication is done successfully, particular processing in accordance with either the operating input or a command from the key device,
 the control unit being configured to operate in a first mode unless the operating unit accepts the operating input and to start operating in a second mode when the operating unit accepts the operating input,
 the control unit being configured to periodically perform, in the first mode, first transmission processing and first reception processing, the first transmission processing including making the communications unit transmit an inquiry signal to ask the key device if there is any command, the first reception processing including controlling the communications unit such that the communications unit maintains a reception state of waiting for an incoming signal for a predetermined amount of time after having performed the first transmission processing,
 the control unit being configured to perform, in the second mode, second transmission processing and second reception processing irrespective of intervals of the first transmission processing and the first reception processing, the second transmission processing including making the communications unit transmit a connection request signal requesting connection to the key device, the second reception processing

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3. The electric lock device of claim 1 or 2, wherein the inquiry signal and the connection request signal are wireless signals, and the inquiry signal has higher signal strength than the connection request signal.

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4. The electric lock device of any one of claims 1 to 3, wherein the control unit is configured to perform, in the second mode, the second transmission processing and the second reception processing periodically, and the control unit is configured to finish operating in the second mode unless the control unit receives, from the key device, a response signal to the connection request signal before a predetermined period of time passes since the control unit's start of operation in the second mode.

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5. The electric lock device of any one of claims 1 to 4, wherein the particular processing includes multiple different types of processing, and a type of the particular processing performed by the control unit in accordance with the operating input from the operating unit is different from a type of the particular processing performed by the control unit in accordance with the command from the key device.

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6. An electric lock system comprising:

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the electric lock device of any one of claims 1 to 5; and
 the key device configured to perform the authentication with the electric lock device by communicating with the electric lock device.

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FIG. 1

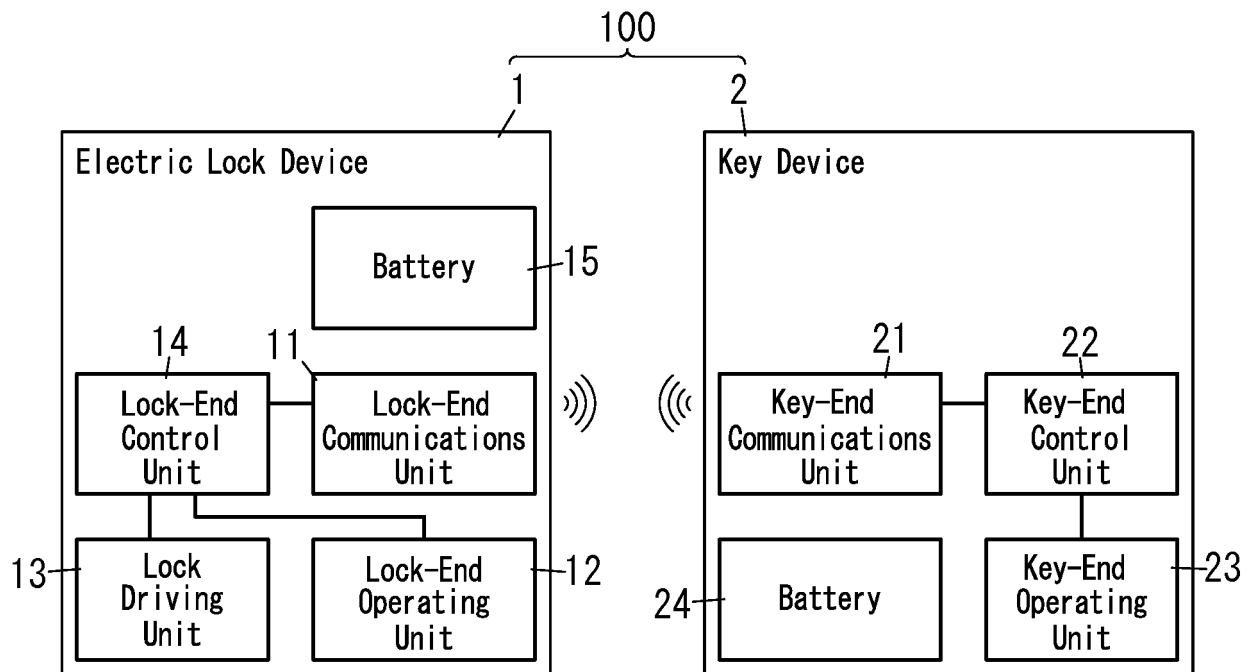


FIG. 2

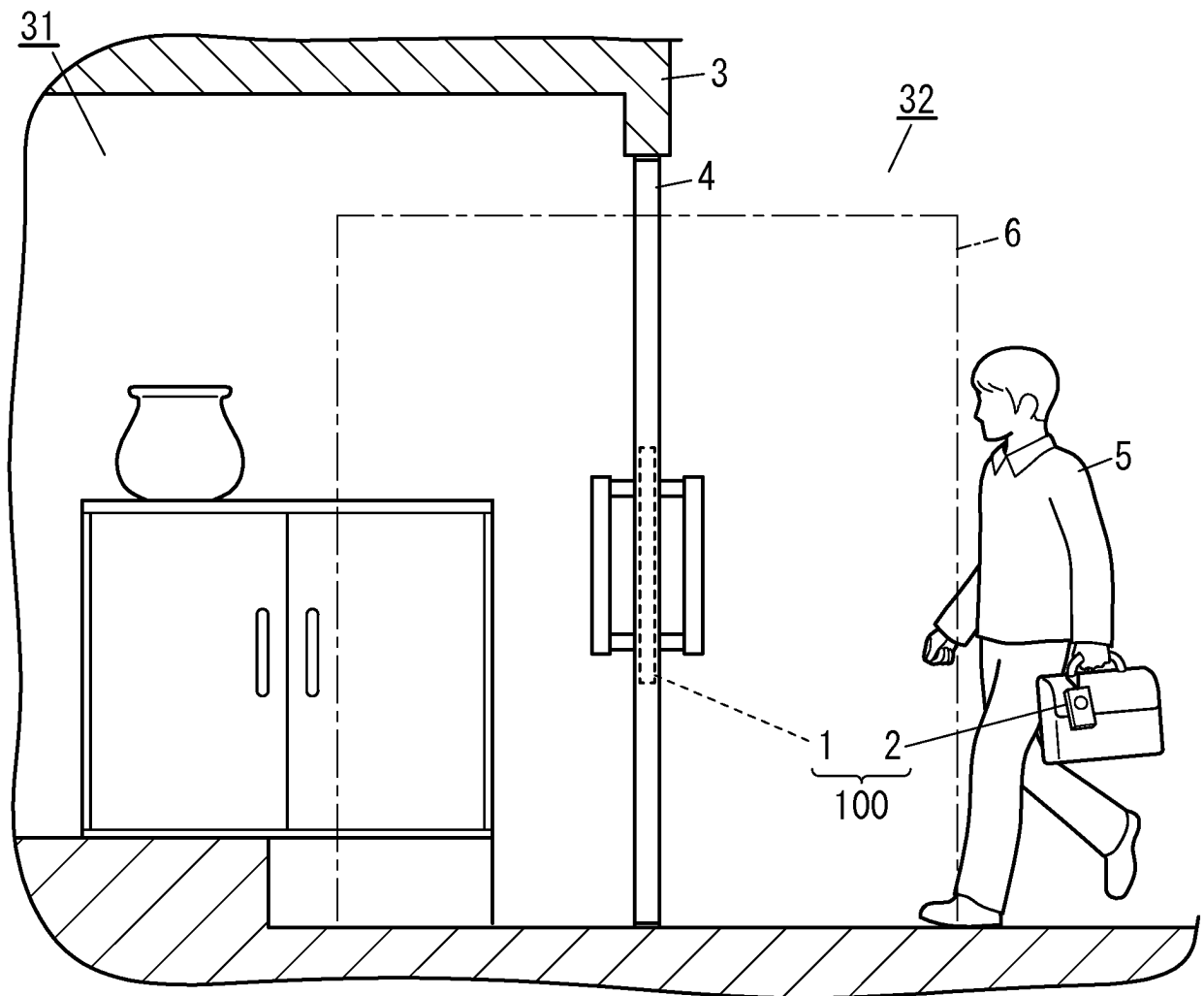


FIG. 3

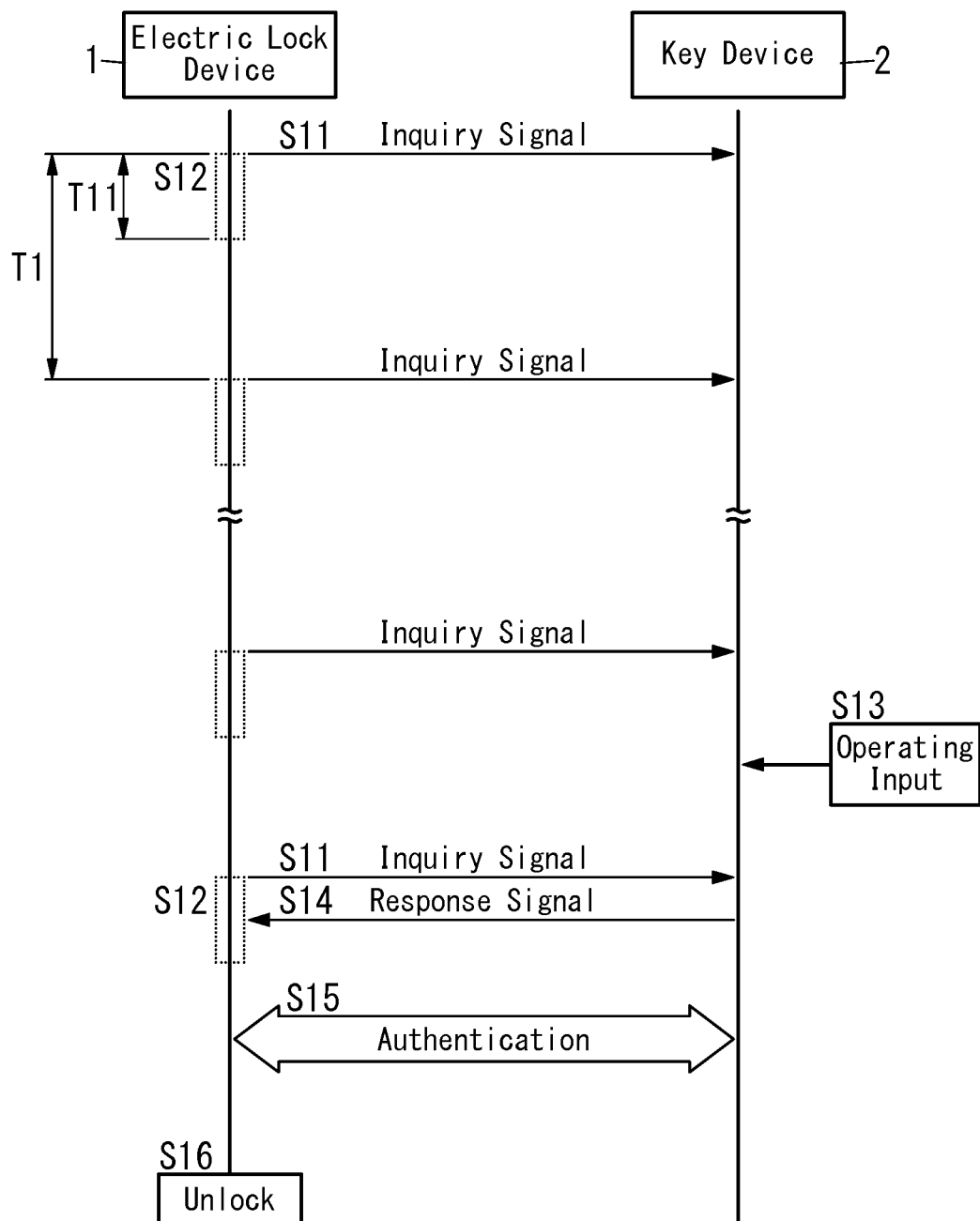


FIG. 4

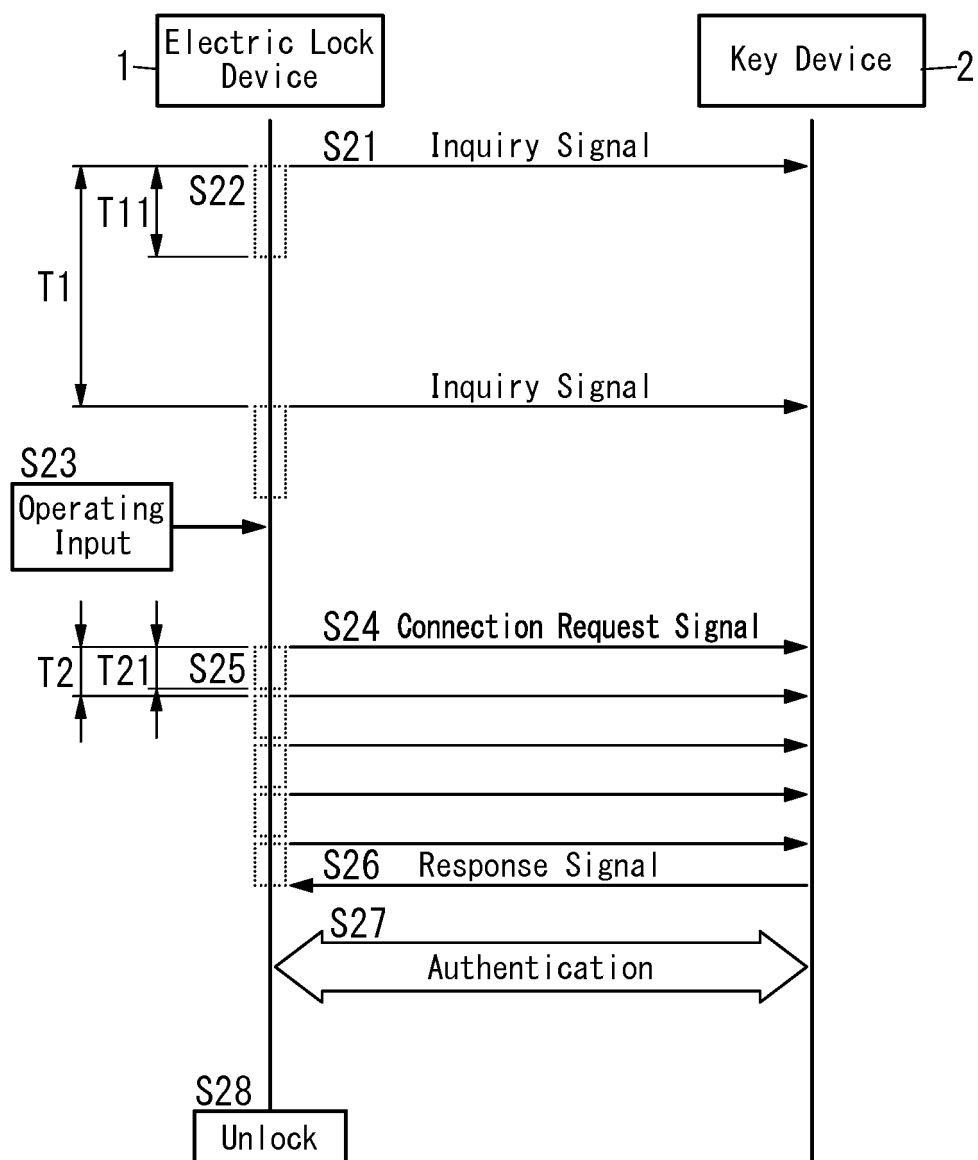


FIG. 5

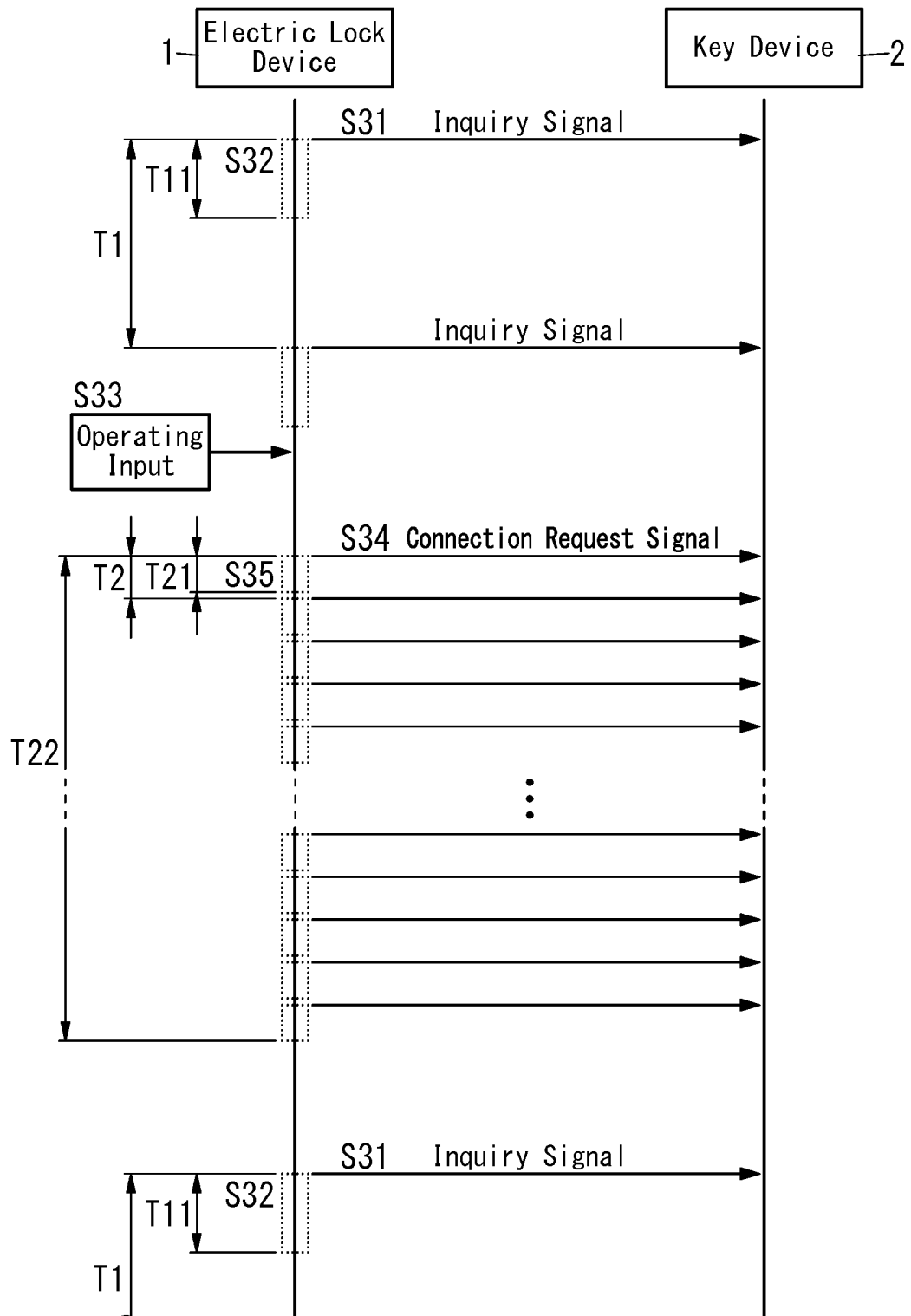
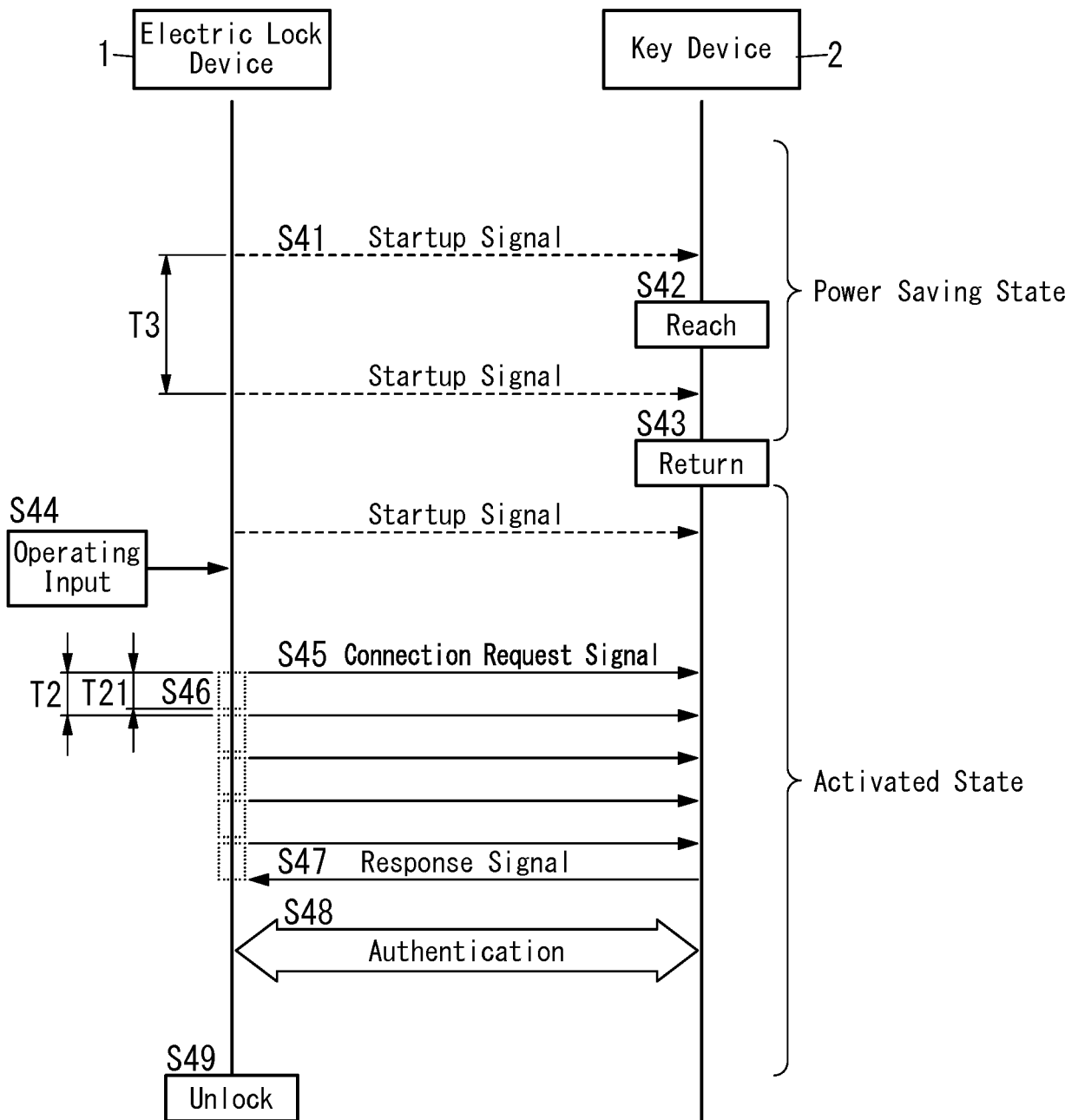


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/037479

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. 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)

Int.Cl. E05B49/00

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2017

Registered utility model specifications of Japan 1996-2017

Published registered utility model applications of Japan 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.
A	JP 4665649 B2 (PANASONIC CORP.) 06 April 2011, paragraph [0026] (Family: none)	1-6
A	JP 4484855 B2 (MITSUBISHI ELECTRIC CORP.) 16 June 2010, paragraph [0039] (Family: none)	1-6

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Further documents are listed in the continuation of Box C.

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See patent family annex.

* Special categories of cited documents:

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
20 December 2017 (20.12.2017)Date of mailing of the international search report
09 January 2018 (09.01.2018)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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

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Patent documents cited in the description

- JP 2016030894 A [0005]