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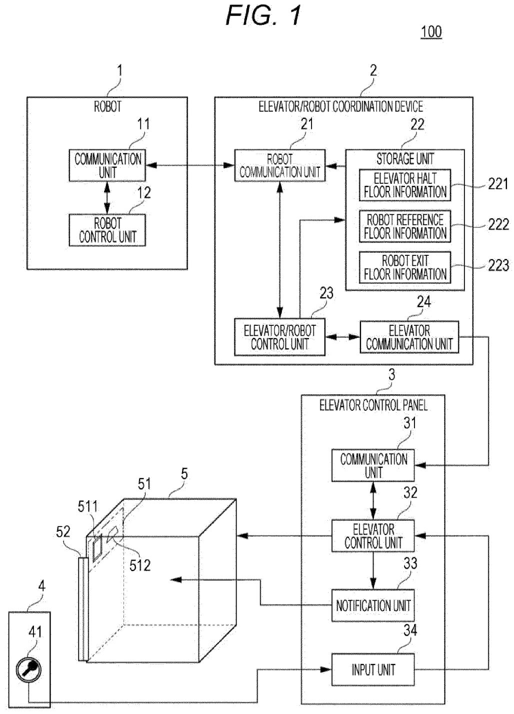
(54) **ROBOT, CONTROL DEVICE, ELEVATOR SYSTEM, AND CONTROL METHOD**

(57) The present invention enables a robot (1) to move to a robot standby floor when an elevator transitions to a halt operation. An elevator/robot control unit (23) of an elevator/robot coordination device (2) of an elevator system (100) according to an aspect of the present invention, upon reception of information indicating that the elevator transitions to the halt operation from an elevator control panel 3 and when a robot exit floor and a robot standby floor are different, transmits an execution command of a robot callback operation for returning a robot (1) to the robot standby floor to the elevator control panel 3. Then, the elevator/robot control unit (23) carries out control for causing the elevator halt operation to be executed after detecting the completion of the robot callback operation.

*FIG. 1*

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# Description

## Technical Field

**[0001]** The present invention relates to a control device, an elevator system, and a control method.

## Background Art

**[0002]** In recent years, an autonomous mobile body (hereinafter, also referred to as an autonomous mobile robot) that carries out operations such as cleaning inside a building, transporting loads, and guiding visitors of the building is being put into practical use. In a multiple-story structure like a building, it is essential for the autonomous mobile robot to use an elevator in order to cause the autonomous mobile robot to carry out the above-described operations.

**[0003]** For example, Patent Literature 1 discloses an elevator control device that, in a case where a dust bin of a cleaning robot is full, a robot is out of charge, or the like, carries out control to move the autonomous mobile robot in an elevator to a floor on which dust can be discarded or a floor on which charging is possible.

## Citation List

### Patent Literature

**[0004]** Patent Literature 1: Japanese Patent No. 6414026

## Summary of Invention

### Technical Problem

**[0005]** By the way, in the technology described in Patent Literature 1 cited above, for example, in a situation where the elevator cannot travel due to a parking (halt) operation or the like, the autonomous mobile robot cannot use the elevator and cannot move to a floor on which dust can be discarded or a floor on which charging is possible (robot standby floor).

**[0006]** The present invention has been made in view of the above circumstances, and an object of the present invention is to provide a technique for enabling a robot to move to a robot standby floor when an elevator transitions to a halt operation.

### Solution to Problem

**[0007]** A control device according to an aspect of the present invention carries out control by communicating with each of an elevator control device that controls an operation of an elevator and a robot that moves in a building using the elevator. The control device according to an aspect of the present invention includes an elevator/robot coordination unit that, when information indicating that the elevator transitions to a halt operation is received from the elevator control device, compares a robot exit floor which is a floor on which the robot exits the elevator and a robot standby floor which is a floor on which the robot stands by, transmits an execution command of a callback operation for returning the robot to the robot standby floor to the elevator control device when the floors are different.

### Advantageous Effects of Invention

**[0008]** According to at least one aspect of the present invention, when the elevator transitions to the halt operation, the robot can move to the robot standby floor.

**[0009]** Problems, configurations, and effects other than those described above will be clarified by the following description of embodiments.

## Brief Description of Drawings

**[0010]**

Fig. 1 is a diagram illustrating a schematic configuration example of an elevator system according to an embodiment of the present invention.

Fig. 2 is a block diagram illustrating a hardware configuration example of each device constituting the elevator system according to an embodiment of the present invention.

Fig. 3 is a flowchart illustrating an example of a processing procedure of the elevator system at the time of operation of the robot according to an embodiment of the present invention.

Fig. 4 is a flowchart illustrating an example of a processing procedure of the elevator system at the time of transitioning to the halt operation of the robot according to an embodiment of the present invention.

Fig. 5 is a flowchart illustrating an example of a procedure of a robot callback operation control process according to an embodiment of the present invention.

Fig. 6 is a flowchart illustrating an example of a procedure of a halt operation control process according to an embodiment of the present invention.

Fig. 7 is a flowchart illustrating an example of a processing procedure of the elevator system at the time of transitioning to the halt operation of the robot according to a modification.

## Description of Embodiments

**[0011]** Hereinafter, examples of modes for carrying out the present invention (hereinafter, referred to as "embodiments".) will be described with reference to the accompanying drawings. The present invention is not limited to the embodiments, and various numerical values and the like in the embodiment are examples. In the present specification and the drawings, the same components or components having substantially the same function are denoted by the same reference numerals, and redundant description is omitted.

<Schematic Configuration of Elevator System>

**[0012]** First, a configuration of an elevator system 100 according to an embodiment of the present invention will be described with reference to Fig. 1. Fig. 1 is a diagram illustrating a schematic configuration example of the elevator system 100.

**[0013]** As illustrated in Fig. 1, the elevator system 100 includes a robot 1, an elevator/robot coordination device 2, an elevator control panel 3, a landing 4, and a car 5.

[Robot]

**[0014]** The robot 1 is an autonomous mobile robot that can move autonomously using wheels (not illustrated) and the like, and includes a communication unit 11 and a robot control unit 12. The communication unit 11 communicates with the robot communication unit 21 of the elevator/robot coordination device 2. The robot control unit 12 (an example of the robot control device) controls the operation of the robot 1.

**[0015]** For example, the robot control unit 12 generates a command for causing the robot 1 to carry out various tasks on the basis of a predetermined schedule or the like, and transmits the command to the robot 1 via the robot communication unit 21. The schedule information may be stored in a storage unit (not illustrated) or the like of the robot 1, or may be transmitted from the elevator/robot coordination device 2.

**[0016]** In addition, when a floor on which the robot 1 carries out operations (hereinafter, also referred to as a robot working floor) is different from the robot reference floor (an example of a robot standby floor) which is a floor on which the robot 1 stands by, the robot control unit 12 carries out control to generate a car call for moving the robot 1 to the robot working floor and transmit the car call to the elevator/robot coordination device 2 via the communication unit 11. The robot reference floor is, for example, a floor on which a charging stand (an example of a charger) capable of charging the robot 1 is installed.

**[0017]** Further, when the execution command of the robot callback operation is transmitted from the elevator/robot coordination device 2, the robot control unit 12 carries out control to generate a car call for moving the robot 1 from the robot exit floor to the robot reference floor and transmit the generated car call to the elevator/robot coordination device 2 via the communication unit 11.

**[0018]** In the present embodiment, an example in which the robot control unit 12 is provided inside the robot 1 has been described; however, the present invention is not limited thereto. The robot control unit 12 may be provided, for example, in an external device such as a communication device provided on each floor in a building.

**[0019]** The elevator/robot coordination device 2 (an example of the control device) is provided, for example, in a server (not illustrated) or an on-premises server on a cloud, and transmits a command to each of the robot 1 and the car 5 to control respective operations of the robot 1 and the car 5. Note that the elevator/robot coordination device 2 may be provided in the robot 1, the elevator control panel 3, or the like.

**[0020]** The elevator/robot coordination device 2 includes a robot communication unit 21, a storage unit 22, an elevator/robot control unit 23, and an elevator communication unit 24.

**[0021]** The robot communication unit 21 communicates with the communication unit 11 of the robot 1. The storage unit 22 stores elevator halt floor information 221, robot reference floor information 222, robot exit floor information 223, and the like.

**[0022]** Information on the floor at which the car 5 stops during the elevator halt operation is written in the elevator halt floor information 221. In the robot reference floor information 222, information on the robot reference floor is written. Note that the robot reference floor may be set to a floor other than the floor where the charging stand is installed, such as a floor where there is a garbage dump where the robot 1, which is for cleaning, discards collected dust.

**[0023]** In the robot exit floor information 223, information on the floor on which the robot 1 exits the car 5 in order to carry out work such as cleaning or carrying baggage (robot exit floor) is written. The information on the robot exit floor is transmitted from the communication unit 31 of the elevator control panel 3.

**[0024]** The elevator/robot control unit 23 (an example of the elevator/robot coordination unit) generates a command for controlling the operation of the robot 1 on the basis of the information received from the robot 1 via the robot communication unit 21, and outputs the command to the robot communication unit 21. In addition, the elevator/robot control unit 23 generates a command for controlling the operation of the car 5 on the basis of the information received from the elevator control panel 3 via the elevator communication unit 24, and outputs the command to the elevator communication unit 24.

**[0025]** For example, the elevator/robot control unit 23 moves the robot 1 from the robot standby position to the work place in the robot working floor on the basis of a predetermined schedule or the like, generates a command for causing the operation to be executed, and transmits the command to the robot 1 via the robot communication unit 21. In addition, the elevator/robot control unit 23 generates a car call for moving the robot 1 from the robot reference floor to the robot working floor, and transmits the car call to the elevator control panel 3. Then, after confirmation of exit of the robot 1, the elevator/robot control unit 23 writes the information of the robot exit floor in the robot exit floor information 223 in the storage unit 22.

[0026] Further, upon receiving a signal (hereinafter, also referred to as a parking-switch-ON signal) indicating that the parking switch 41 provided at the landing 4 is turned on from the elevator control panel 3, the elevator/robot control unit 23 reads the robot exit floor information 223 and the robot reference floor information 222 from the storage unit 22, and compares the floors indicated by both pieces of information. Then, when the robot exit floor does not match the robot reference floor, the elevator/robot control unit 23 transmits an execution command of the robot callback operation to each of the robot 1 and the elevator control panel 3.

[0027] Specifically, the elevator/robot control unit 23 generates and transmits a robot callback command to the robot 1 as an execution command of the robot callback operation. The robot callback command is a command to cause the robot 1 to stop working, move to the position of the elevator (car 5), get on the arrived car 5, move to the elevator reference floor, exit the car 5, and move to the standby position for the robot 1.

[0028] In addition, the elevator/robot control unit 23 generates and transmits a car call for moving the car 5 to the robot exit floor to the elevator control panel 3 as an execution command of the robot callback operation. Then, after confirmation of exit of the robot 1, the elevator/robot control unit 23 executes the halt operation of the elevator to move the car 5 to the elevator halt floor, generates a command to stop the elevator, and transmits the command to the elevator control panel 3. Note that, during the execution of the robot callback operation, the elevator/robot control unit 23 also carries out control to cause the elevator control panel 3 not to receive either the landing call or the car call.

[0029] Further, before the execution of the robot callback operation, the elevator/robot control unit 23 transmits, to the elevator control panel 3, a notification command for notifying the passenger that the operation transitions to the halt operation after the execution of the robot callback operation.

[0030] The elevator communication unit 24 communicates with the communication unit 31 of the elevator control panel 3.

[0031] The elevator control panel 3 (an example of the elevator control device) is provided inside a machine room or a hoistway of an elevator (not illustrated) and controls the operation of the car 5. The elevator control panel 3 includes a communication unit 31, an elevator control unit 32, a notification unit 33, and an input unit 34.

[0032] The communication unit 31 communicates with the elevator communication unit 24 of the elevator/robot coordination device 2. The elevator control unit 32 controls a hoisting operation of the car 5 on the basis of a car call input from an in-car destination floor registration device (not illustrated) in the car 5, a landing call input from a landing destination floor registration device (not illustrated) in the landing 4, or the like.

[0033] For example, the elevator control unit 32 carries out control to move the car 5 from the robot reference floor to the robot working floor on the basis of the car call transmitted from the elevator communication unit 24 of the elevator/robot coordination device 2. In addition, for example, the elevator control unit 32 carries out control to move the car 5 to the robot exit floor and move the robot 1 having boarded the car 5 to the robot reference floor on the basis of the car call transmitted from the elevator/robot coordination device 2 at the time of executing the robot callback operation. In addition, for example, the elevator control unit 32 carries out control to stop the elevator by moving the car 5 from the robot reference floor to the elevator halt floor after the end of the robot callback operation.

[0034] Furthermore, the elevator control unit 32 carries out control to open and close the door 52 on the basis of detection signals by various sensors (not illustrated) in the car 5, detection results of pressing operation of an open button or a close button (not illustrated), and the like.

[0035] The notification unit 33 carries out control to cause the speaker 512 of the notification device 51 in the car 5 to emit an announcement indicating that the operation transitions to the halt operation after the execution of the robot callback operation on the basis of the notification command transmitted from the elevator/robot coordination device 2. Alternatively, the notification unit 33 carries out control to cause the display device 511 of the notification device 51 to display a message indicating that the operation transitions to the halt operation after execution of the robot callback operation. The announcement and the message may be simultaneously notified, or only one of them may be notified.

[0036] The input unit 34 receives the parking-switch-ON signal or the parking-switch-OFF signal indicating that the parking switch 41 is turned OFF, and outputs the received signals to the elevator control unit 32. Then, the elevator control unit 32 transmits each received signal to the elevator/robot coordination device 2 via the communication unit 31.

[0037] The parking switch 41 provided at the landing 4 is a switch that enables switching between ON and OFF of parking operation by receiving input of an operation of inserting a key (not illustrated) and turning the key clockwise or counterclockwise. When detecting the input of such an operation, the parking switch 41 generates a parking-switch-ON signal or a parking-switch-OFF signal and transmits the parking-switch-ON signal or the parking-switch-OFF signal to the elevator control panel 3.

[0038] In the present embodiment, a mode in which the parking operation is switched between ON and OFF by turning ON or OFF the parking switch 41 has been described as an example, but the present invention is not limited thereto. The parking operation may be turned ON or OFF by, for example, an operation on a mobile terminal carried by a maintenance person or an operation on a terminal device installed in a monitoring center (not illustrated).

[0039] The car 5 is mounted with a passenger, the robot 1, a load, or the like (not illustrated) and performs the hoisting operation in the hoistway (not illustrated). The car 5 includes a notification device 51 and a door 52. The notification device 51 includes a display device 511 including a liquid crystal panel, an organic electroluminescence panel, or the like, and a speaker 512.

<Hardware Configuration Example of Computer>

**[0040]** Next, a configuration (hardware configuration) of a control system of each device (the robot 1, the elevator/robot coordination device 2, the elevator control panel 3) constituting the elevator system 100 illustrated in Fig. 1 will be described with reference to Fig. 2.

**[0041]** Fig. 2 is a block diagram illustrating a hardware configuration example of each device constituting the elevator system 100. The computer 200 illustrated in Fig. 2 is hardware used as a so-called computer.

**[0042]** The computer 200 includes a central processing unit (CPU) 201, a read only memory (ROM) 202, a random access memory (RAM) 203, a nonvolatile storage 204, and a communication interface (I/F) 205, each connected to a bus B.

**[0043]** The CPU 201 reads a program code of software for realizing each function according to the present embodiment from the ROM 202, develops the program code in the RAM 203, and executes the program code. Alternatively, the CPU 201 directly reads the program code from the ROM 202 and executes the program. Note that the computer 200 may include a processing device such as a micro-processing unit (MPU) instead of the CPU 201. Variables, parameters, and the like generated during arithmetic processing by the CPU 201 are temporarily written to the RAM 203.

**[0044]** Each function of the robot control unit 12 of the robot 1, the elevator/robot control unit 23 of the elevator/robot coordination device 2, and the elevator control unit 32, the notification unit 33, and the input unit 34 of the elevator control panel 3 is realized by the CPU 201 reading and executing a program for realizing each function from the ROM 202.

**[0045]** As the nonvolatile storage 204, for example, a hard disk drive (HDD), a solid state drive (SSD), a flexible disk, an optical disk, a magneto-optical disk, a CD-ROM, a CD-R, a nonvolatile memory card, or the like can be used. In addition to an operating system (OS) and various parameters, a program for causing the computer 200 to function, and the like are recorded in the nonvolatile storage 204. The function of the storage unit 22 of the elevator/robot coordination device 2 is realized by the nonvolatile storage 204.

**[0046]** The program may also be stored in the ROM 202. The program is stored in the form of a computer-readable program code, and the CPU 201 sequentially executes an operation according to the program code. That is, the ROM 202 or the nonvolatile storage 204 is used as an example of a computer-readable non-transitory recording medium storing a program to be executed by a computer.

**[0047]** The communication I/F 205 includes a communication device or the like that controls communication with another device. The network in which the communication I/F 205 carries out communication control includes, for example, serial communication in a multi-drop mode such as RS-485 and a communication path providing a plurality of topologies such as Ethernet (registered trademark). Communication paths that provide a plurality of topologies include a local area network (LAN) and a wide area network (WAN) that are wired communication paths, a radio area network (RAN) that is a wireless communication path, and the like.

**[0048]** Furthermore, examples of the network on which the communication I/F 205 carries out communication control include a wireless network such as Wi-Fi (registered trademark) and a wireless network in a wireless communication infrastructure. The functions of the communication unit 11 of the robot 1, the elevator communication unit 24 of the elevator/robot coordination device 2, and the communication unit 31 of the elevator control panel 3 are realized by the communication I/F 205.

<Processing of Elevator System during Robot Operation>

**[0049]** Next, processing of the elevator system 100 during operation of the robot 1 will be described with reference to Fig. 3. Fig. 3 is a flowchart illustrating an example of a processing procedure of the elevator system 100 at the time of operation of the robot 1.

**[0050]** First, the robot control unit 12 of the robot 1 generates a car call for moving the robot 1 to the robot working floor on the basis of a predetermined schedule or the like, and transmits the car call to the elevator/robot coordination device 2 (step S1). The car call may be generated not by the robot 1 but by the elevator/robot coordination device 2.

**[0051]** Next, the robot communication unit 21 of the elevator/robot coordination device 2 outputs the received car call to the elevator/robot control unit 23 (step S2). Next, the elevator/robot control unit 23 transmits the input car call to the elevator control panel 3 via the elevator communication unit 24 (step S3).

**[0052]** Next, the communication unit 31 of the elevator control panel 3 outputs the received car call to the elevator control unit 32 (step S4). Next, the elevator control unit 32 moves the car 5 to the robot reference floor on the basis of the input car call, and carries out control to open the door 52 of the car 5 after arriving at the robot reference floor (step S5). For example, in a case where the robot reference floor is the first floor and the car 5 is located on the second floor, the car 5 moves from the second floor to the first floor through the control in step S5, and the door 52 of the car 5 opens after arriving at the first floor.

**[0053]** Next, after confirming that the robot 1 has boarded the car 5, the elevator control unit 32 carries out control to close the door 52 of the car 5, move the car 5 to the robot working floor, and open the door 52 of the car 5 after arriving at the robot working floor (step S6). For example, in a case where the robot working floor is the third floor, by carrying out the control of step S6, the car moves from the first floor to the third floor, and the door 52 of the car 5 opens after arriving at the third floor.

**[0054]** Next, after confirming that the robot 1 has exited the car 5, the elevator control unit 32 carries out control to close the door of the car 5 (step S7). Next, the elevator control unit 32 transmits information of the robot exit floor (the third floor in this example), which is the floor where the robot 1 exits, to the elevator/robot coordination device 2 via the communication unit 31 (step S8).

**[0055]** Next, the elevator communication unit 24 of the elevator/robot coordination device 2 outputs the received information of the robot exit floor to the elevator/robot control unit 23 (step S9). Next, the elevator/robot control unit 23 stores the input information of the robot exit floor to the storage unit 22 (writes the information to the robot exit floor information 223) (step S10). After the processing of step S10, the processing of the elevator system 100 at the time of the operation of the robot 1 ends.

<Processing of Elevator System at Time of Transition to Halt Operation>

**[0056]** Next, processing of the elevator system 100 at the time of transition to the halt operation of the elevator will be described with reference to Fig. 4. Fig. 4 is a flowchart illustrating an example of a processing procedure of the elevator system 100 at the time of transition to the halt operation of the robot 1.

**[0057]** First, the input unit 34 of the elevator control panel 3 determines whether the parking switch 41 has been turned ON (whether the parking-switch-ON signal has been input) (step S11). When it is determined in step S11 that the parking switch 41 has not been turned on (NO in step S11), the input unit 34 continues the determination in step S11.

**[0058]** On the other hand, when it is determined in step S11 that the parking switch 41 is turned ON (YES in step S11), the input unit 34 outputs a parking-switch-ON signal to the elevator control unit 32 (step S12). Next, the elevator control unit 32 transmits the input parking-switch-ON signal to the elevator/robot coordination device 2 via the communication unit 31 (step S13). Next, the elevator communication unit 24 of the elevator/robot coordination device 2 outputs the received parking-switch-ON signal to the elevator/robot control unit 23 (step S14).

**[0059]** Next, the elevator/robot control unit 23 determines whether or not the robot exit floor matches the robot reference floor (step S15). The process in step S15 can be carried out by the elevator/robot control unit 23 comparing the information of the robot exit floor read from the storage unit 22 with the information of the robot reference floor.

**[0060]** In a case where it has been determined in step S15 that the robot exit floor and the robot reference floor are the same floor (if step S15 is YES), the elevator/robot coordination device 2 and the elevator control panel 3 carry out a halt operation control process (step S16). The halt operation control process will be described in detail with reference to Fig. 6 described later. After the processing in step S16, the elevator system 100 ends the robot callback operation control process.

**[0061]** On the other hand, in a case where it has been determined in step S15 that the robot exit floor and the robot reference floor are not the same (NO in step S15), the elevator/robot control unit 23 generates a call acceptance stop command and transmits the call acceptance stop command to the elevator control panel 3 via the elevator communication unit 24 (step S17). The call acceptance stop command is a command for instructing stop of acceptance of both a landing call from a landing destination floor registration device (not illustrated) in the landing 4 and a car call from an in-car destination floor registration device (not illustrated) in the car 5. The elevator control panel 3 having received this command carries out control to stop accepting both the landing call and the car call.

**[0062]** Next, the elevator/robot control unit 23 generates a notification execution command and transmits the command to the elevator control panel 3 via the elevator communication unit 24 (step S18). The notification execution command generated and transmitted in step S18 is a command for notifying the passenger in the car 5 that the elevator transitions to the elevator halt operation after the end of the robot callback operation.

**[0063]** Next, the communication unit 31 of the elevator control panel 3 outputs the received notification execution command to the elevator control unit 32 (step S19). Next, the elevator control unit 32 outputs the input notification execution command to the notification unit 33 (step S20). Next, the notification unit 33 carries out control to cause the notification device 51 (the display device 511 and/or the speaker 512) in the car 5 to notify the passengers in the car 5 of an announcement or a message indicating that the elevator transitions to the halt operation after the end of the robot callback operation (step S21).

**[0064]** Next, a robot callback operation control process is carried out (step S22). The robot callback operation control process in step S22 will be described in detail with reference to Fig. 5. Next, the elevator halt operation control process in step S16 is carried out by the elevator control panel 3.

<Robot Callback Operation Control Process>

**[0065]** Next, with reference to Fig. 5, a robot callback operation control process in step S21 in Fig. 4 will be described. Fig. 5 is a flowchart illustrating an example of a procedure of a robot callback operation control process according to the present embodiment.

**[0066]** First, the elevator/robot control unit 23 of the elevator/robot coordination device 2 generates a robot callback operation execution command that instructs execution of a callback operation of the elevator, and transmits the robot callback operation execution command to the elevator control panel 3 via the elevator communication unit 24 (step S31). Next, the communication unit 31 of the elevator control panel 3 outputs the received robot callback operation execution command to the elevator control unit 32 (step S32).

**[0067]** Next, the elevator control unit 32 carries out control to move the car 5 to the robot exit floor and open the door 52 of the car 5 after arriving at the robot exit floor on the basis of the input robot callback operation execution instruction (step S33).

**[0068]** Next, after confirming that the robot 1 has boarded the car 5, the elevator control unit 32 carries out control to close the door 52 of the car 5, move the car 5 to the robot reference floor, and open the door 52 of the car 5 after arriving at the robot reference floor (step S34).

**[0069]** Next, after confirming that the robot 1 has exited the car 5, the elevator control unit 32 carries out control to close the door 52 of the car 5 (step S35). Next, the elevator control unit 32 transmits the completion of the callback operation of the robot 1 to the elevator/robot coordination device 2 via the communication unit 31 (step S36). After the processing in step S36, the robot callback operation control process ends.

<Elevator Halt Operation Control Process>

**[0070]** Next, the elevator halt operation control process in step S16 of Fig. 4 will be described with reference to Fig. 6. Fig. 6 is a flowchart illustrating an example of a procedure of an elevator halt operation control process according to the present embodiment. First, the elevator/robot control unit 23 generates a halt operation transition command that instructs transition to the elevator halt operation, and transmits the command to the elevator control panel 3 via the elevator communication unit 24 (step S41).

**[0071]** Next, the communication unit 31 of the elevator control panel 3 outputs the received halt operation transition command to the elevator control unit 32 (step S42). Next, the elevator control unit 32 executes the halt operation to move the car 5 to the elevator halt floor (for example, the first floor or the like), and carries out control to halt the elevator (step S43). After the process in step S43, the halt operation control process of the elevator ends.

**[0072]** In the embodiment described above, the elevator/robot control unit 23 of the elevator/robot coordination device 2 compares the robot exit floor with the robot standby floor upon acceptance of information (parking-switch-ON signal) indicating that the elevator transitions to the halt operation from the elevator control panel 3, and transmits an execution command of the robot callback operation for returning the robot 1 to the robot standby floor to the elevator control panel 3 when the floors are different. Then, the elevator/robot control unit 23 causes the elevator halt operation to be executed after detecting the completion of the robot callback operation. Therefore, according to the present embodiment, since the callback operation is executed before the execution of the halt operation, it is possible to prevent the robot 1 from being left on a floor other than the robot reference floor during the elevator halt operation.

**[0073]** In the embodiment described above, the elevator/robot control unit 23 transmits a call acceptance stop command for stopping acceptance of both the landing call and the car call to the elevator control panel 3 via the elevator communication unit 24 during the execution of the robot callback operation. Therefore, according to the present embodiment, it is possible to prevent the car 5 from moving to the robot exit floor or the floor other than the robot reference floor in response to the landing call or the car call during the callback operation of the robot 1.

**[0074]** In addition, in the embodiment described above, when an execution command of the robot callback operation is transmitted from the elevator/robot control unit 23, the notification unit 33 of the elevator control panel 3 carries out control to cause the notification device 51 in the car 5 to notify that the operation transitions to the elevator halt operation after the execution of the robot callback operation. Therefore, according to the present embodiment, the passenger who is in the car 5 of the elevator where the robot callback operation is carried out can comprehend in advance that the callback operation, the elevator halt operation, or the like of the robot 1 is carried out.

**[0075]** Note that control may be carried out, without performing the above notification, to transition to the callback operation of the robot 1 after it is detected that all the passengers of the car 5 to which the robot callback operation is carried out have exited.

**[0076]** In addition, in the above-described embodiment, the robot reference floor is a floor on which a charging stand (charger) (not illustrated) of the robot 1 is installed. Therefore, according to the present embodiment, since the robot 1 is movable to the robot reference floor having the charging stand before transitioning to the elevator halt operation, it is possible to prevent the robot 1 from being left on another floor having no charging stand and running out of charge.

<Modification>

**[0077]** Note that, when the operator of the parking switch 41 (the instructor of the halt operation) gives an instruction not to execute the robot callback operation before transitioning to the halt operation, control may be carried out to transition to the elevator halt operation without carrying out the robot callback operation. Fig. 7 is a flowchart illustrating an example of a procedure of processing of the elevator system 100 at the time of transitioning to the halt operation according to the modification.

**[0078]** Since the processing from step S51 to step S61 in Fig. 7 is the same as the processing from step S11 to step S21 in Fig. 4, the description of these processing is omitted herein.

**[0079]** In step S61, after the notification unit 33 carries out control to notify the passengers in the car 5 by the notification device 51 in the car 5, the elevator/robot control unit 23 of the elevator/robot coordination device 2 determines whether or not a signal of refusal of execution of the robot callback operation (command of refusal of callback operation) has been input (step S62).

**[0080]** When the parking switch 41 is turned off once and then turned on again, the signal of refusal of execution of the robot callback operation is input to the input unit 34 of the elevator control panel 3. Note that the signal of refusal of execution of the robot callback operation may be generated on the basis of another operation on the parking switch 41, an operation on a mobile terminal carried by a maintenance engineer, or the like.

**[0081]** Thereafter, the signal of refusal of execution of the robot callback operation is transmitted to the elevator/robot coordination device 2 by the elevator control unit 32 via the communication unit 31, and is output from the elevator communication unit 24 of the elevator/robot coordination device 2 to the elevator/robot control unit 23.

**[0082]** When it is determined in step S62 that the signal of refusal of execution of the robot callback operation has not been input (NO in step S62), the robot callback operation control process is executed (step S63). Next, an elevator halt operation control process is executed (step S56). After the process of step S56, the process of the elevator system 100 at the time of transitioning to the halt operation according to the modification ends.

**[0083]** On the other hand, when it is determined in step S62 that the signal of refusal of execution of the robot callback operation has been input (YES in step S62), the elevator halt operation control process is carried out (step S56). That is, when the signal of refusal of execution of the robot callback operation is input, the operation transitions to the elevator halt operation without executing the robot callback operation.

**[0084]** According to the present modification, when the instructor of the elevator halt operation does not choose the execution of the callback operation of the robot 1 before the execution of the elevator halt operation, the operation transitions to the halt operation without executing the robot callback operation. Therefore, it is possible to operate the elevator in a mode that meets the demand of the instructor of the halt operation.

**[0085]** In addition, the above-described embodiments have described the configurations of the device and the system specifically and in detail for the sake of easy understanding of the present invention, and are not necessarily limited to those provided with all the described configurations.

**[0086]** In addition, control lines or information lines indicated by solid double-headed arrows or single-headed arrows shown in Fig. 1 are only those considered necessary for description, and not necessarily all the control lines and the information lines in the product are shown. In practice, it may be considered that almost all the configurations are connected to each other.

**[0087]** Furthermore, in the present specification, the processing steps describing the time-series processing include not only processing carried out in time series according to the described order, but also processing executed in parallel or individually (for example, parallel processing or processing by an object) even if the processing is not necessarily carried out in time series.

**[0088]** Furthermore, each component of the elevator system according to the embodiment of the present invention described above may be implemented in any hardware as long as the hardware can transmit and receive information to and from each other via a network. Furthermore, the processing carried out by a certain processing unit may be realized by one piece of hardware or may be realized by distributed processing by a plurality of pieces of hardware.

Reference Signs List

**[0089]**

| | |
|---|---|
| 1 | Robot |
| 2 | Elevator/robot coordination device |
| 3 | Elevator control panel |
| 5 | Car |
| 12 | Robot control unit |
| 22 | Storage unit |
| 23 | Elevator/robot control unit |
| 32 | Elevator control unit |
| 33 | Notification unit |
| 34 | Input unit |
| 41 | Parking switch |
| 51 | Notification device |
| 100 | Elevator system |

## Claims

**1.** A control device that carries out control by communicating with each of an elevator control device that controls an operation of an elevator and a robot (1) that moves in a building using the elevator, **characterized by** comprising
an elevator/robot coordination unit that, when information indicating that the elevator transitions to a halt operation is received from the elevator control device, compares a robot exit floor which is a floor on which the robot (1) exits the elevator and a robot standby floor which is a floor on which the robot (1) stands by, transmits an execution command of a robot callback operation for returning the robot (1) to the robot standby floor to the elevator control device when the floors are different, and transmits an execution command of the halt operation to the elevator

control device after detection of completion of the robot callback operation.

2. The control device according to claim 1, **characterized in that** the execution command of the robot callback operation is a command for moving a car (5) of the elevator to the robot exit floor to cause the robot (1) to board, and then moving the car (5) to the robot standby floor.

3. The control device according to claim 2, **characterized in that** the elevator/robot coordination unit transmits, to the elevator control device, a command for stopping acceptance of both a landing call registered from a destination floor registration device in a landing and a car call registered from an in-car destination floor registration device in the car (5) during execution of the robot callback operation.

4. The control device according to claim 3, **characterized in that** when the elevator/robot coordination unit receives information indicating refusal of execution of the robot callback operation before transitioning to the halt operation, the elevator/robot coordination unit carries out control to cause the halt operation to be executed without executing the robot callback operation.

5. The control device according to claim 4, **characterized in that** when the execution command of the robot callback operation is to be transmitted, the elevator/robot coordination unit carries out control to cause a notification unit (33), which controls a notification operation of a notification device (51) provided in the car (5) of the elevator, to notify from the notification device (51) that the operation transitions to the halt operation after the execution of the robot callback operation.

6. The control device according to any one of claims 1 to 5, **characterized in that** the robot standby floor is a floor on which a charger for the robot (1) is installed.

7. An elevator system (100) comprising: an elevator control device that controls an operation of an elevator; a robot control device that controls an operation of a robot (1) that moves in a building using the elevator; and a control device that carries out control by communicating with each of the elevator control device and the robot control device, **characterized in that**
the control device includes an elevator/robot coordination unit that, when information indicating that the elevator transitions to a halt operation is received from the elevator control device, compares a robot exit floor which is a floor on which the robot (1) exits the elevator and a robot standby floor which is a floor on which the robot (1) stands by, transmits an execution command of a robot callback operation for returning the robot (1) to the robot standby floor to the elevator control device when the floors are different, and transmits an execution command of the halt operation to the elevator control device after detection of completion of the robot callback operation.

8. A control method executed by a control device that carries out control by communicating with each of an elevator control device that controls an operation of an elevator and a robot (1) that moves in a building using the elevator, **characterized by** comprising,
when information indicating that the elevator transitions to a halt operation is received from the elevator control device, comparing a robot exit floor which is a floor on which the robot (1) exits the elevator and a robot standby floor which is a floor on which the robot (1) stands by, transmitting an execution command of a robot callback operation for returning the robot (1) to the robot standby floor to the elevator control device when the floors are different, and transmitting an execution command of the halt operation to the elevator control device after detection of completion of the robot callback operation.

FIG. 1

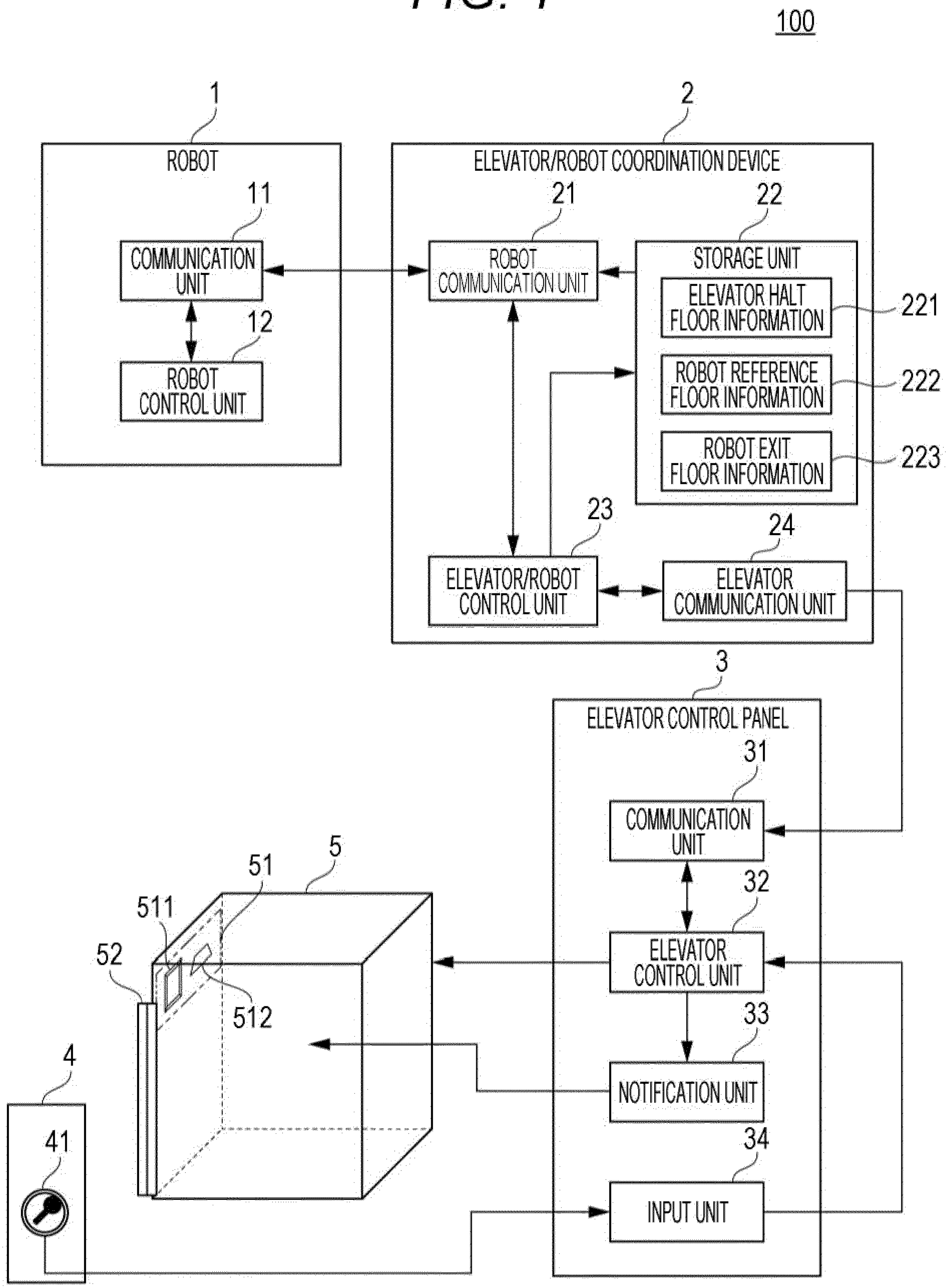

100
1
ROBOT
11
COMMUNICATION UNIT
12
ROBOT CONTROL UNIT
2
ELEVATOR/ROBOT COORDINATION DEVICE
21
ROBOT COMMUNICATION UNIT
22
STORAGE UNIT
ELEVATOR HALT FLOOR INFORMATION
221
ROBOT REFERENCE FLOOR INFORMATION
222
ROBOT EXIT FLOOR INFORMATION
223
23
ELEVATOR/ROBOT CONTROL UNIT
24
ELEVATOR COMMUNICATION UNIT
3
ELEVATOR CONTROL PANEL
31
COMMUNICATION UNIT
32
ELEVATOR CONTROL UNIT
33
NOTIFICATION UNIT
34
INPUT UNIT
5
51
511
52
512
4
41

FIG. 2

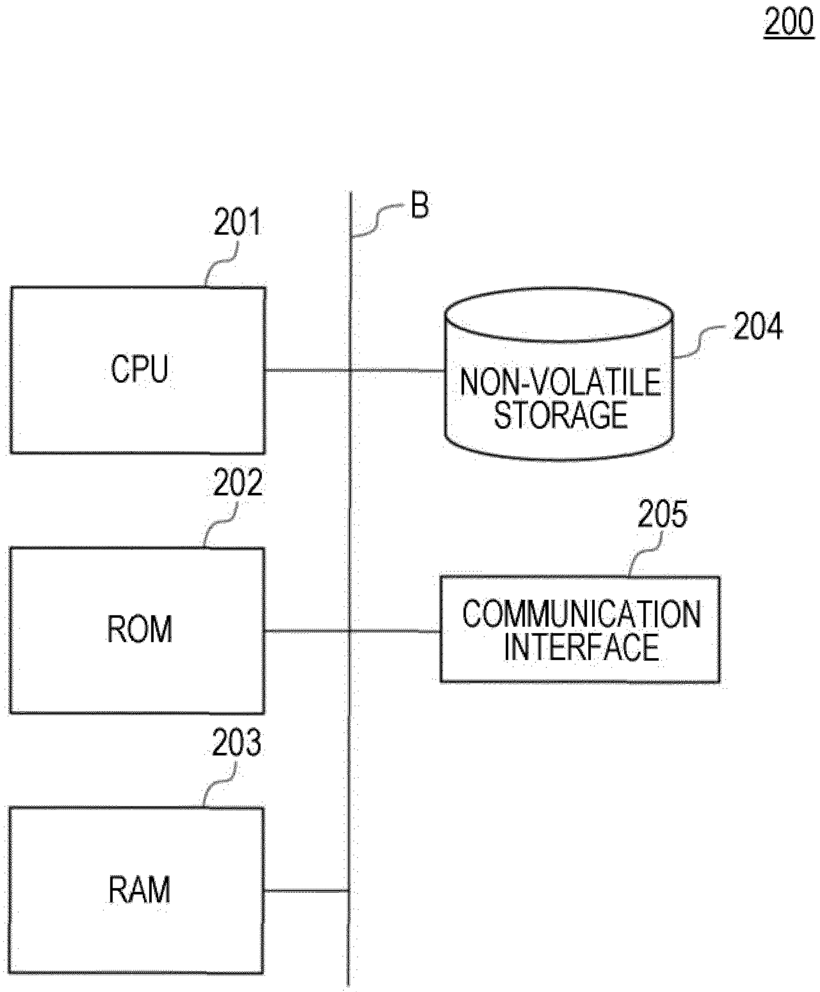

200
B
201
CPU
202
ROM
203
RAM
204
NON-VOLATILE STORAGE
205
COMMUNICATION INTERFACE

FIG. 3

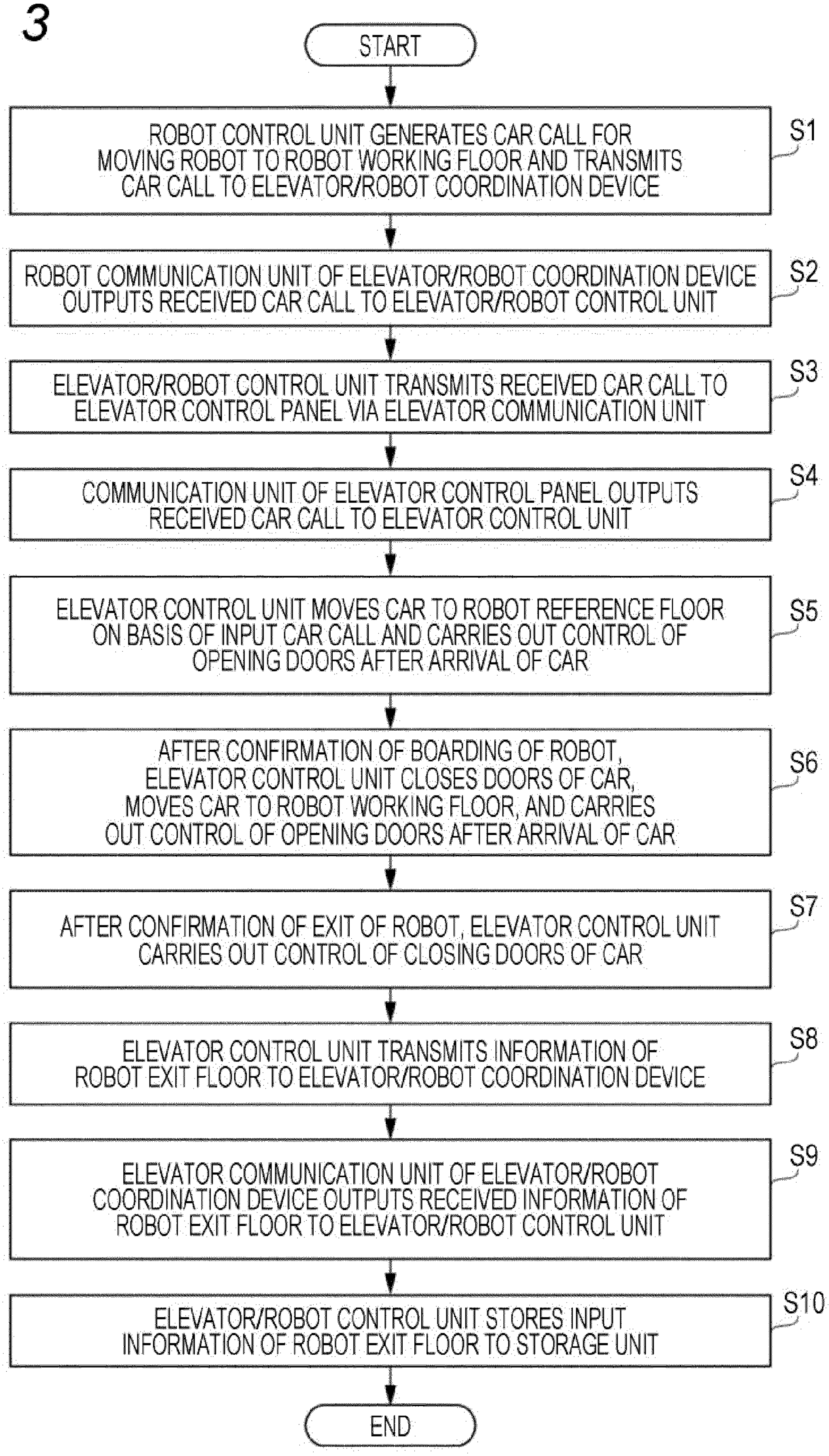

START
ROBOT CONTROL UNIT GENERATES CAR CALL FOR MOVING ROBOT TO ROBOT WORKING FLOOR AND TRANSMITS CAR CALL TO ELEVATOR/ROBOT COORDINATION DEVICE
S1
ROBOT COMMUNICATION UNIT OF ELEVATOR/ROBOT COORDINATION DEVICE OUTPUTS RECEIVED CAR CALL TO ELEVATOR/ROBOT CONTROL UNIT
S2
ELEVATOR/ROBOT CONTROL UNIT TRANSMITS RECEIVED CAR CALL TO ELEVATOR CONTROL PANEL VIA ELEVATOR COMMUNICATION UNIT
S3
COMMUNICATION UNIT OF ELEVATOR CONTROL PANEL OUTPUTS RECEIVED CAR CALL TO ELEVATOR CONTROL UNIT
S4
ELEVATOR CONTROL UNIT MOVES CAR TO ROBOT REFERENCE FLOOR ON BASIS OF INPUT CAR CALL AND CARRIES OUT CONTROL OF OPENING DOORS AFTER ARRIVAL OF CAR
S5
AFTER CONFIRMATION OF BOARDING OF ROBOT, ELEVATOR CONTROL UNIT CLOSES DOORS OF CAR, MOVES CAR TO ROBOT WORKING FLOOR, AND CARRIES OUT CONTROL OF OPENING DOORS AFTER ARRIVAL OF CAR
S6
AFTER CONFIRMATION OF EXIT OF ROBOT, ELEVATOR CONTROL UNIT CARRIES OUT CONTROL OF CLOSING DOORS OF CAR
S7
ELEVATOR CONTROL UNIT TRANSMITS INFORMATION OF ROBOT EXIT FLOOR TO ELEVATOR/ROBOT COORDINATION DEVICE
S8
ELEVATOR COMMUNICATION UNIT OF ELEVATOR/ROBOT COORDINATION DEVICE OUTPUTS RECEIVED INFORMATION OF ROBOT EXIT FLOOR TO ELEVATOR/ROBOT CONTROL UNIT
S9
ELEVATOR/ROBOT CONTROL UNIT STORES INPUT INFORMATION OF ROBOT EXIT FLOOR TO STORAGE UNIT
S10
END

FIG. 4

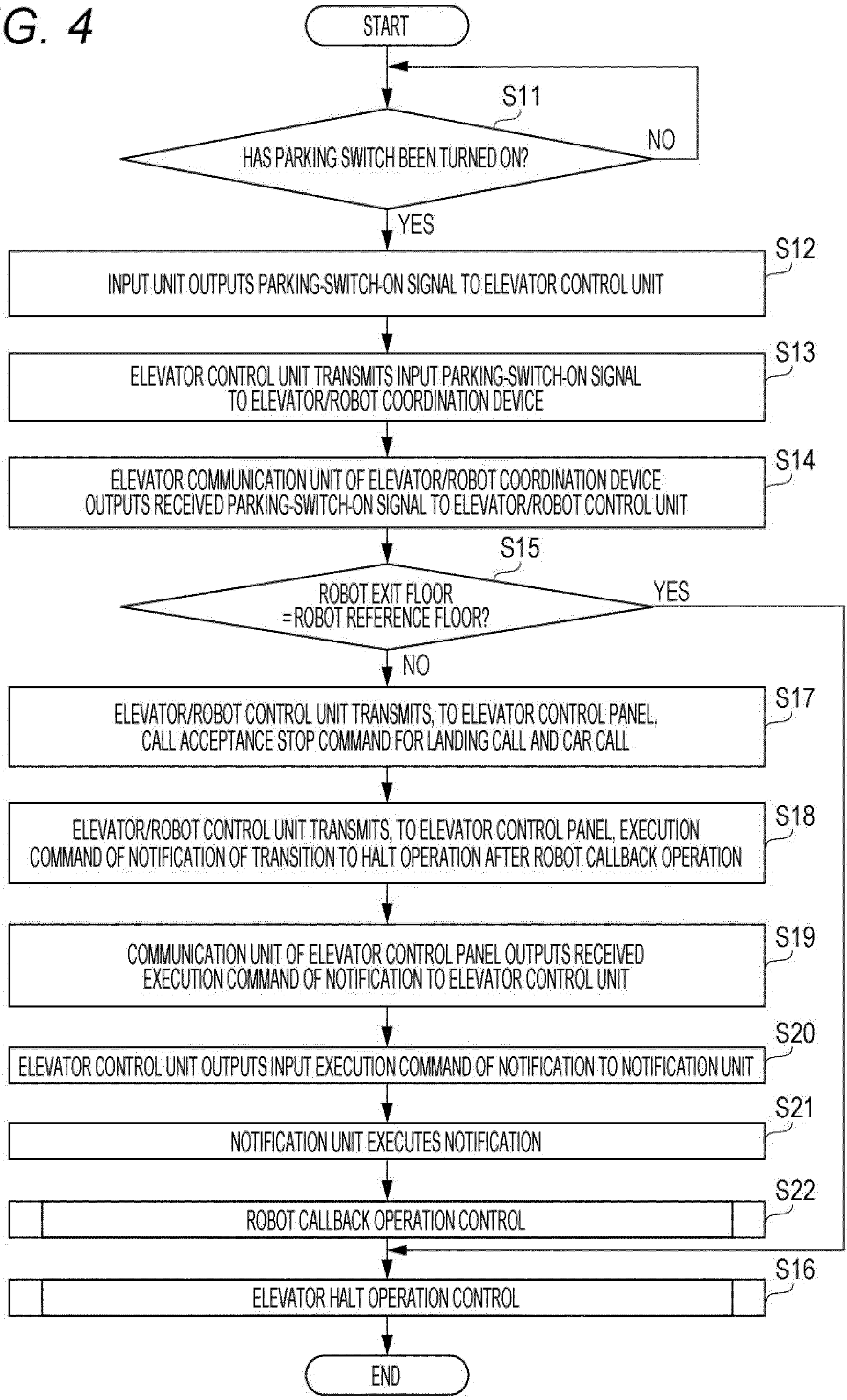

START
S11
HAS PARKING SWITCH BEEN TURNED ON?
NO
YES
S12
INPUT UNIT OUTPUTS PARKING-SWITCH-ON SIGNAL TO ELEVATOR CONTROL UNIT
S13
ELEVATOR CONTROL UNIT TRANSMITS INPUT PARKING-SWITCH-ON SIGNAL TO ELEVATOR/ROBOT COORDINATION DEVICE
S14
ELEVATOR COMMUNICATION UNIT OF ELEVATOR/ROBOT COORDINATION DEVICE OUTPUTS RECEIVED PARKING-SWITCH-ON SIGNAL TO ELEVATOR/ROBOT CONTROL UNIT
S15
ROBOT EXIT FLOOR = ROBOT REFERENCE FLOOR?
YES
NO
S17
ELEVATOR/ROBOT CONTROL UNIT TRANSMITS, TO ELEVATOR CONTROL PANEL, CALL ACCEPTANCE STOP COMMAND FOR LANDING CALL AND CAR CALL
S18
ELEVATOR/ROBOT CONTROL UNIT TRANSMITS, TO ELEVATOR CONTROL PANEL, EXECUTION COMMAND OF NOTIFICATION OF TRANSITION TO HALT OPERATION AFTER ROBOT CALLBACK OPERATION
S19
COMMUNICATION UNIT OF ELEVATOR CONTROL PANEL OUTPUTS RECEIVED EXECUTION COMMAND OF NOTIFICATION TO ELEVATOR CONTROL UNIT
S20
ELEVATOR CONTROL UNIT OUTPUTS INPUT EXECUTION COMMAND OF NOTIFICATION TO NOTIFICATION UNIT
S21
NOTIFICATION UNIT EXECUTES NOTIFICATION
S22
ROBOT CALLBACK OPERATION CONTROL
S16
ELEVATOR HALT OPERATION CONTROL
END

FIG. 5

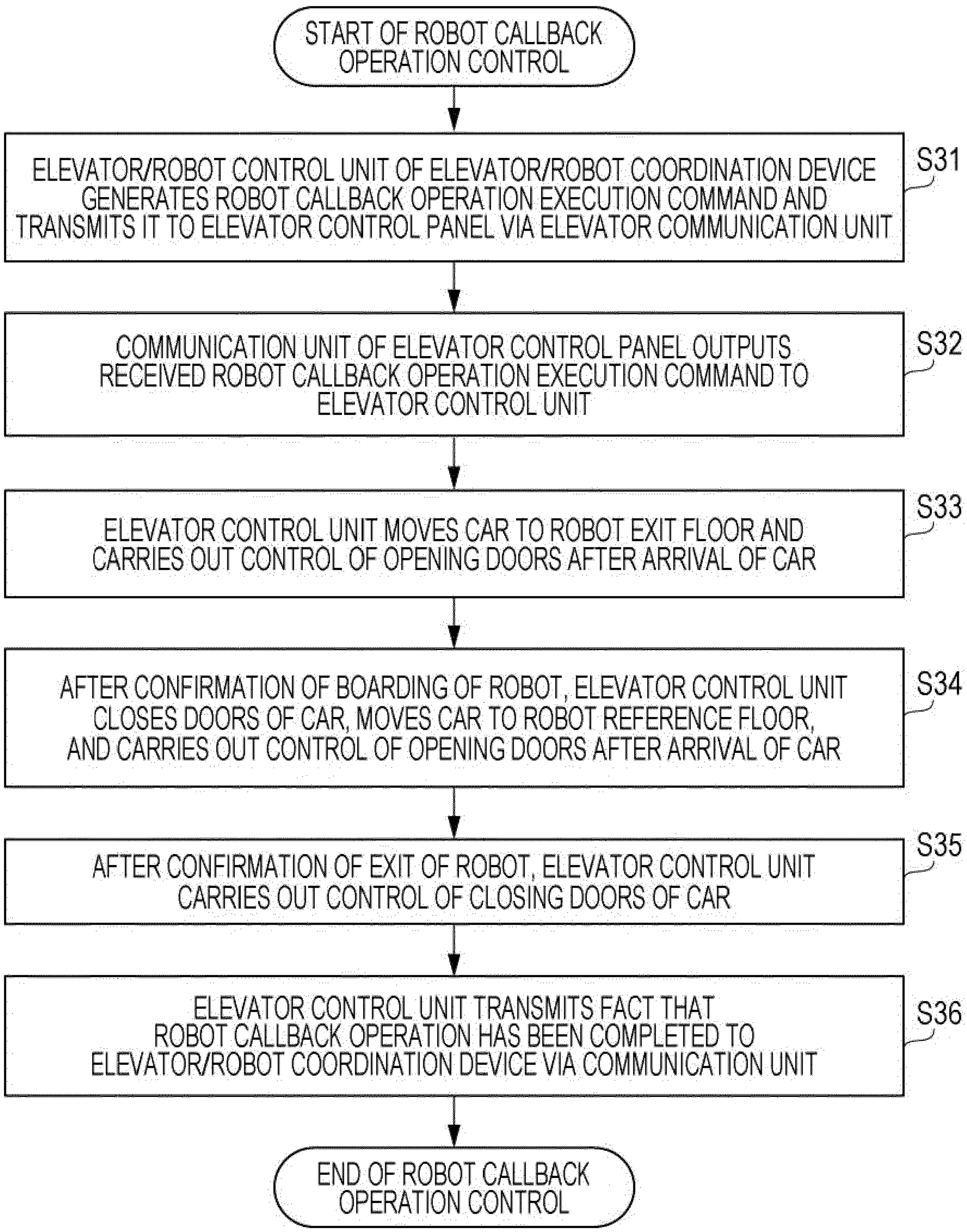

START OF ROBOT CALLBACK OPERATION CONTROL
ELEVATOR/ROBOT CONTROL UNIT OF ELEVATOR/ROBOT COORDINATION DEVICE GENERATES ROBOT CALLBACK OPERATION EXECUTION COMMAND AND TRANSMITS IT TO ELEVATOR CONTROL PANEL VIA ELEVATOR COMMUNICATION UNIT
S31
COMMUNICATION UNIT OF ELEVATOR CONTROL PANEL OUTPUTS RECEIVED ROBOT CALLBACK OPERATION EXECUTION COMMAND TO ELEVATOR CONTROL UNIT
S32
ELEVATOR CONTROL UNIT MOVES CAR TO ROBOT EXIT FLOOR AND CARRIES OUT CONTROL OF OPENING DOORS AFTER ARRIVAL OF CAR
S33
AFTER CONFIRMATION OF BOARDING OF ROBOT, ELEVATOR CONTROL UNIT CLOSES DOORS OF CAR, MOVES CAR TO ROBOT REFERENCE FLOOR, AND CARRIES OUT CONTROL OF OPENING DOORS AFTER ARRIVAL OF CAR
S34
AFTER CONFIRMATION OF EXIT OF ROBOT, ELEVATOR CONTROL UNIT CARRIES OUT CONTROL OF CLOSING DOORS OF CAR
S35
ELEVATOR CONTROL UNIT TRANSMITS FACT THAT ROBOT CALLBACK OPERATION HAS BEEN COMPLETED TO ELEVATOR/ROBOT COORDINATION DEVICE VIA COMMUNICATION UNIT
S36
END OF ROBOT CALLBACK OPERATION CONTROL

FIG. 6

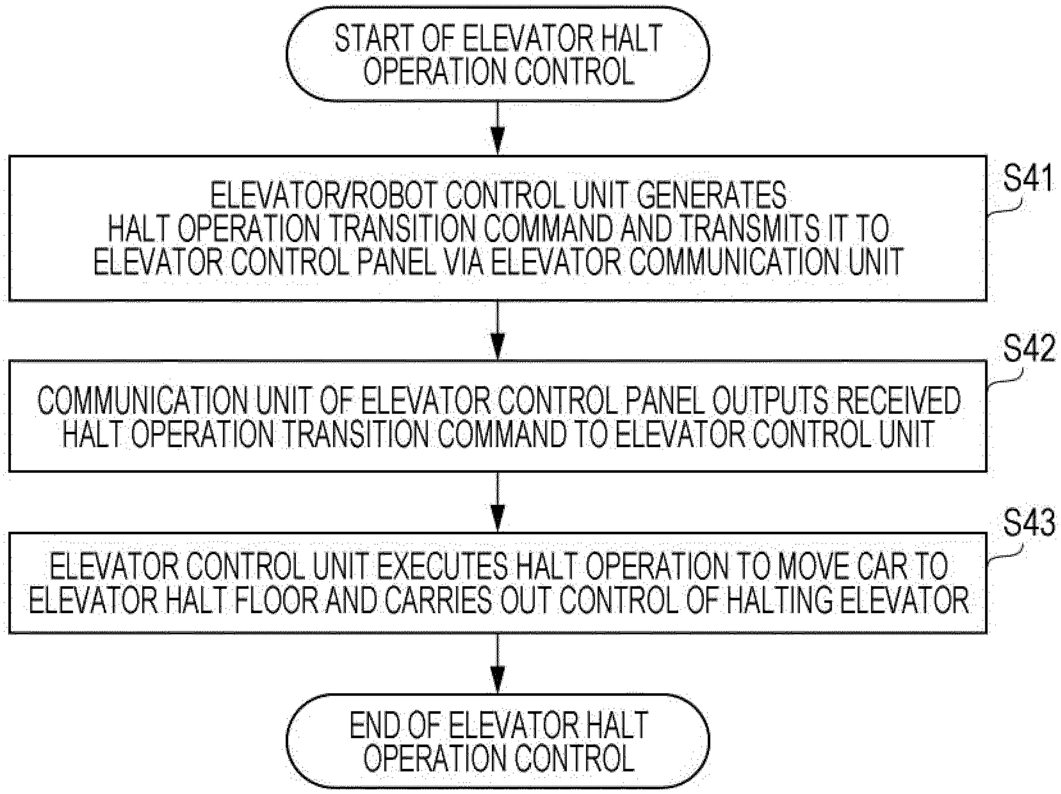
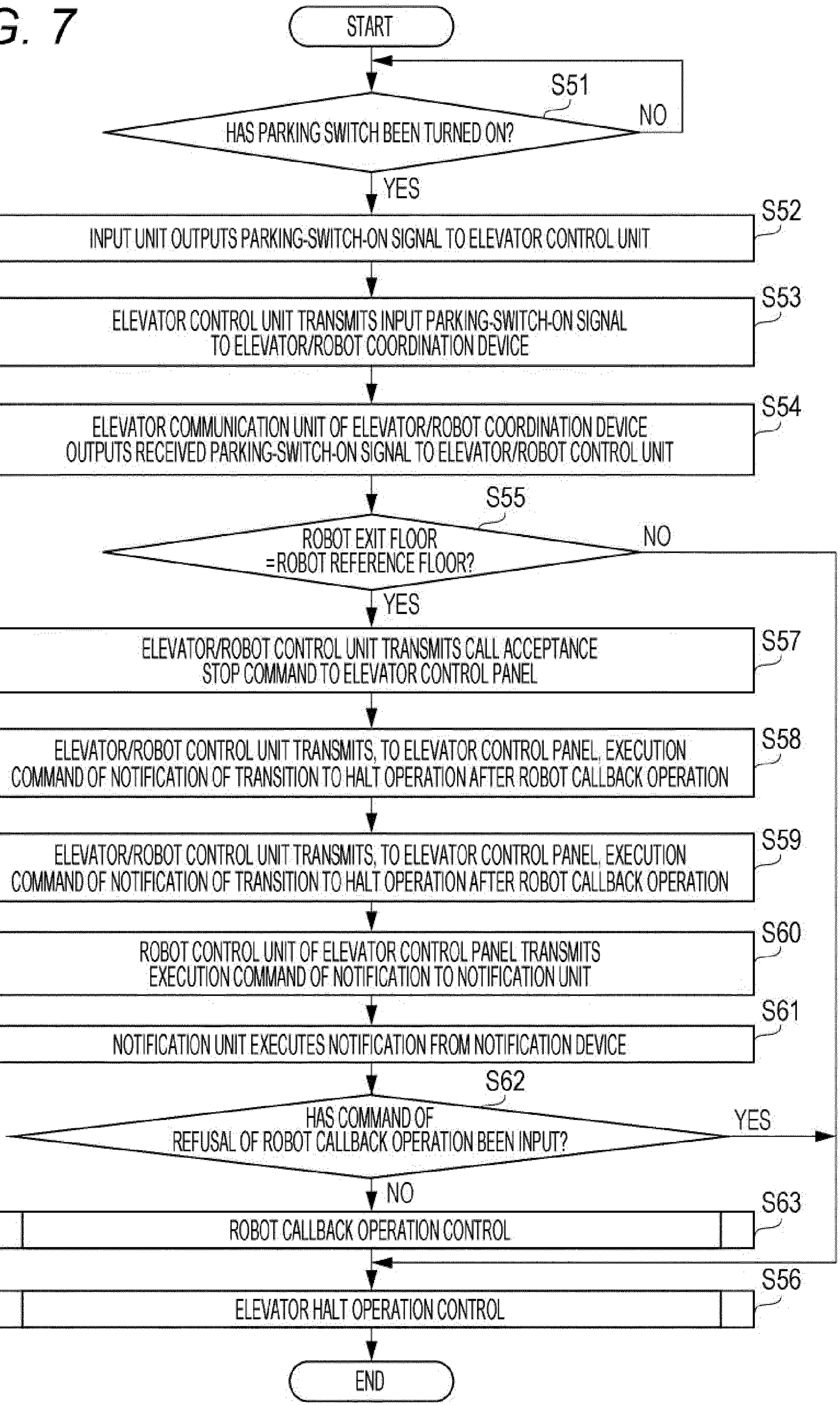

START OF ELEVATOR HALT OPERATION CONTROL
ELEVATOR/ROBOT CONTROL UNIT GENERATES HALT OPERATION TRANSITION COMMAND AND TRANSMITS IT TO ELEVATOR CONTROL PANEL VIA ELEVATOR COMMUNICATION UNIT
S41
COMMUNICATION UNIT OF ELEVATOR CONTROL PANEL OUTPUTS RECEIVED HALT OPERATION TRANSITION COMMAND TO ELEVATOR CONTROL UNIT
S42
ELEVATOR CONTROL UNIT EXECUTES HALT OPERATION TO MOVE CAR TO ELEVATOR HALT FLOOR AND CARRIES OUT CONTROL OF HALTING ELEVATOR
S43
END OF ELEVATOR HALT OPERATION CONTROL

FIG. 7


START
S51
HAS PARKING SWITCH BEEN TURNED ON?
NO
YES
S52
INPUT UNIT OUTPUTS PARKING-SWITCH-ON SIGNAL TO ELEVATOR CONTROL UNIT
S53
ELEVATOR CONTROL UNIT TRANSMITS INPUT PARKING-SWITCH-ON SIGNAL TO ELEVATOR/ROBOT COORDINATION DEVICE
S54
ELEVATOR COMMUNICATION UNIT OF ELEVATOR/ROBOT COORDINATION DEVICE OUTPUTS RECEIVED PARKING-SWITCH-ON SIGNAL TO ELEVATOR/ROBOT CONTROL UNIT
S55
ROBOT EXIT FLOOR =ROBOT REFERENCE FLOOR?
NO
YES
S57
ELEVATOR/ROBOT CONTROL UNIT TRANSMITS CALL ACCEPTANCE STOP COMMAND TO ELEVATOR CONTROL PANEL
S58
ELEVATOR/ROBOT CONTROL UNIT TRANSMITS, TO ELEVATOR CONTROL PANEL, EXECUTION COMMAND OF NOTIFICATION OF TRANSITION TO HALT OPERATION AFTER ROBOT CALLBACK OPERATION
S59
ELEVATOR/ROBOT CONTROL UNIT TRANSMITS, TO ELEVATOR CONTROL PANEL, EXECUTION COMMAND OF NOTIFICATION OF TRANSITION TO HALT OPERATION AFTER ROBOT CALLBACK OPERATION
S60
ROBOT CONTROL UNIT OF ELEVATOR CONTROL PANEL TRANSMITS EXECUTION COMMAND OF NOTIFICATION TO NOTIFICATION UNIT
S61
NOTIFICATION UNIT EXECUTES NOTIFICATION FROM NOTIFICATION DEVICE
S62
HAS COMMAND OF REFUSAL OF ROBOT CALLBACK OPERATION BEEN INPUT?
YES
NO
S63
ROBOT CALLBACK OPERATION CONTROL
S56
ELEVATOR HALT OPERATION CONTROL
END

Europäisches Patentamt
European Patent Office
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# EUROPEAN SEARCH REPORT

Application Number
EP 23 16 9608

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X | JP 2020 111409 A (TOSHIBA ELEVATOR CO LTD) 27 July 2020 (2020-07-27)<br>* abstract *<br>* paragraphs [0073] - [0086] *<br>* figures 1, 2, 7 *<br>----- | 1-8 | INV.<br>B66B1/24<br>B66B5/00 |
| X<br><br>A | JP H07 286870 A (TOSHIBA ENGINEERING CO; TOSHIBA CORP) 31 October 1995 (1995-10-31)<br>* abstract *<br>* paragraphs [0034] - [0054] *<br>* figures 1 - 4 *<br>----- | 1,2,4-8<br><br>3 | |

TECHNICAL FIELDS SEARCHED (IPC)

B66B

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| The Hague | 21 September 2023 | Dogantan, Umut H. |

3

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 16 9608

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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21-09-2023

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| JP 2020111409 A | 27-07-2020 | JP 6614600 B1 | 04-12-2019 |
| | | JP 2020111409 A | 27-07-2020 |
| JP H07286870 A | 31-10-1995 | JP 3434566 B2 | 11-08-2003 |
| | | JP H07286870 A | 31-10-1995 |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

## REFERENCES CITED IN THE DESCRIPTION



### Patent documents cited in the description

- JP 6414026 B **[0004]**