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

(11) **EP 3 421 405 A1**

(12) # EUROPEAN PATENT APPLICATION

published in accordance with Art. 153(4) EPC

(43) Date of publication:
02.01.2019 Bulletin 2019/01

(21) Application number: **17756166.9**

(22) Date of filing: **06.02.2017**

(51) Int Cl.:
B66B 5/02 *(2006.01)*

(86) International application number:
PCT/JP2017/004192

(87) International publication number:
WO 2017/145725 (31.08.2017 Gazette 2017/35)

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

(30) Priority: **26.02.2016 JP 2016035025**

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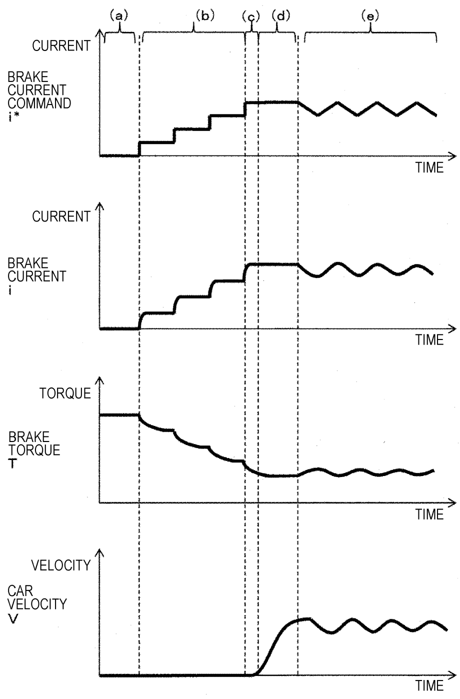
(54) ## ELEVATOR AND RESCUE OPERATION CONTROL METHOD

(57) Sudden acceleration of a passenger car is prevented at a time of starting to move during brake release operation. An elevator according to the present invention includes: a passenger car; a solenoid coil, a brake device which brakes the movement of the passenger car; a brake power supply; a moving velocity detection means which detects the moving velocity of the passenger car; and a controller which controls a current supplied by the brake power supply according the moving velocity of the passenger car detected by the moving velocity detection means, in which the controller transmits, to the brake power supply, a command for increasing a current (brake current i) supplied to the solenoid coil of the brake device by a predetermined value every time a predetermined time elapses when the passenger car is stopped, and transmits, to the brake power supply, a command for stopping increasing the current (brake current i) supplied to the solenoid coil of the brake device when a velocity change of the passenger car is detected by the moving velocity detection means.

FIG. 3



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Description

Technical Field

[0001] The present invention relates to an elevator and a rescue operation control method.

Background Art

[0002] A conventional elevator enables a car connected to a rope to move up and down by rotating an electric motor from an electric power converter and moving the rope in the vertical direction through a sheave coupled with the electric motor. When part of a drive system, such as this electric power converter, this electric motor or an encoder connected to the electric motor, fails, the elevator stops. When the position where the car of the elevator stopped is between the floors and a passenger is in the car at this time, a state in which the passenger is trapped in the car occurs. Since the car does not move in this state, the safety of the passenger is guaranteed, but the passenger experiences discomfort.

[0003] A method for rescuing the passenger trapped by such failure of the drive system is generally performed by a maintenance worker. In particular, when the weight in the car is not balanced with a counterweight, the passenger is rescued by moving the car to the nearest floor by releasing the brake manually and using the imbalance between the car and the counterweight.

[0004] On the other hand, since the above method is performed after waiting for the arrival of the maintenance worker, a waiting time occurs for rescuing the passenger. As a method for solving this problem, PTL 1 discloses a method for rescuing early by using a dedicated terminal which automatically releases a brake.

Citation List

Patent Literature

[0005] PTL 1: WO 2009/013821

Summary of Invention

Technical Problem

[0006] PTL 1 suggests that the voltage at the starting time is linearly increased until the movement of the car is detected. However, if the responsiveness of a coil used for the brake is low, a voltage command reaches a value, at which the brake can be sufficiently opened, when the brake starts to open and the car moves. Thus, there is a possibility of causing a sudden velocity increase of the car.

[0007] In light of the above circumstances, the present invention provides an elevator and a rescue operation method for the elevator capable of preventing sudden acceleration of a passenger car at a time of starting to move during brake release operation.

Solution to Problem

[0008] In order to solve the above-mentioned problems, the present invention provides an elevator including: a passenger car; a rope whose one end is connected to the passenger car; a counterweight connected to another end of the rope; a sheave around which the rope is wound; a solenoid coil which weakens a braking force as a current supplied increases; a brake device which brakes movement of the passenger car by applying the braking force to the sheave; a brake power supply which supplies the current to the solenoid coil; a moving velocity detection means which detects a moving velocity of the passenger car; and a controller which controls the current supplied by the brake power supply according to the moving velocity of the passenger car detected by the moving velocity detection means, in which the controller moves the passenger car by an imbalance of weights between the passenger car and the counterweight while the braking force is generated by the brake device, by transmitting, to the brake power supply, a command for increasing the current supplied to the solenoid coil by a predetermined value every time a predetermined time elapses when the passenger car is stopped and by transmitting, to the brake power supply, a command for stopping increasing the current supplied to the solenoid coil when a velocity change of the passenger car is detected by the moving velocity detection means.

[0009] Moreover, the present invention provides a rescue operation control method for an elevator including: a passenger car; a rope whose one end is connected to the passenger car; a counterweight connected to an other end of the rope; a sheave around which the rope is wound; a solenoid coil which weakens a braking force as a current supplied increases; and a brake device which brakes movement of the passenger car by applying the braking force to the sheave, includes: increasing the current supplied to the solenoid coil by a predetermined value every time a predetermined time elapses when the passenger car is stopped in emergency and a passenger is in the passenger car; and moving the passenger car to a floor where the passenger can get off by an imbalance of weights between the passenger car and the counterweight while the braking force is generated by the brake device, by stopping increasing the current supplied to the solenoid coil when a velocity change of the passenger car is detected.

Advantageous Effects of Invention

[0010] According to the present invention, it is possible to prevent sudden acceleration of the passenger car at the time of starting to move during the brake release operation.

Brief Description of Drawings

[0011]

[FIG. 1] FIG. 1 is a block diagram showing the entire configuration of an elevator according to the present invention.

[FIG. 2] FIG. 2 is a block diagram showing the a series of processing of the braking force control unit 20 in FIG. 1.

[FIG. 3] FIG. 3 is a timing chart showing one example of the outline of the behavior of the elevator according to the present invention.

[FIG. 4] FIG. 4 is a timing chart showing another example of the outline of the behavior of the elevator according to the present invention.

[FIG. 5] FIG. 5 is a flow diagram showing a rescue operation control method for the elevator according to the present invention.

Description of Embodiments

[0012] Hereinafter, embodiments of the present invention will be described in detail with reference to the drawings.

Examples

[0013] FIG. 1 is a block diagram showing the entire configuration of an elevator according to an example. The movement of a car 104 of the elevator is controlled by an elevator controller 100. The elevator controller 100 includes a braking force control unit 20 in addition to an elevator control unit 2 which controls the operation of the elevator.

[0014] The car 104 moves in a hoistway formed in the building across a plurality of floors. Although not shown in FIG. 1, the car 104 is connected to a counterweight for balancing with the car 104 through a rope. The car 104 is provided with a passenger car side door (not shown) which engages a riding side door (now shown) to open and close. The movement of the car 104 is performed by a sheave being driven by an electric motor 103. Electric power for the driving is supplied to the electric motor 103 by an electric power converter 101. The electric power converter 101 outputs electric power for controlling the electric motor according to a car position control command of the elevator controller 100. Moreover, a pulse generator such as an encoder is attached, and the elevator controller 100 counts the pulses generated by the rotation of the electric motor 103, thereby calculating the velocity of the electric motor 103, the hoistway moving direction, the position and the moving distance of the car 104, and the like. To brake the passenger car, the elevator controller 100 outputs a brake power supply stop command and a motive power supply stop command. When received these stop commands, a brake power supply actuates a brake device 102 and a motive power supply cuts off the power supply to the electric power converter 101 to brake the car 104. The brake power supply and the motive power supply are circuits constituted by electromagnetic contactors called contactors.

[0015] The brake device 102 is constituted by a brake pad for braking the sheave by frictional sliding, a solenoid coil for pulling up the brake pad to secure a gap between the sheave and the brake pad, and an iron core (core). Normally, when electric power is supplied to the solenoid coil, the brake pad is pulled up by electromagnetic force, and the sheave becomes free from the constraint by the brake pad and freely rotatable. Power is supplied to the solenoid coil through a relay from the brake power supply. Moreover, the brake device 102 is constituted so as to be capable of changing the braking force by a circuit which controls a current (brake current) flowing to the solenoid coil by a brake current control circuit 21.

[0016] The brake current control circuit 21 is constituted by a converter, such as an inverter circuit or a chopper circuit, which controls the current or the voltage, a hall CT which detects the brake current, and a controller for controlling the brake current, receives, from the elevator controller 100, a command value (brake current command) of the current flowing to the solenoid coil, and controls the brake current to that command value. Note that, in the present example, as one example for changing the braking force, the brake mechanism which changes the braking force according to the current by using the solenoid coil has been exemplified. However, for example, a brake, which changes the braking force according to the distance by using a direct acting type actuator, or a brake (shoe brake or the like), which changes the braking force according to the rotation angle by using a rotation mechanism, may be used. In general, the type of the brake does not matter as long as the braking force of the brake is changed according to a certain command.

[0017] A scale sensor 4 is used to detect the number of passengers in the car. The scale sensor 4 is used to calculate the torque necessary to compensate for the weight difference between the car and the counterweight during normal operation. When the car floor surface is metal, the scale sensor uses a method for estimating the weight from the amount of deflection of the car floor surface with a proximity sensor or the like provided to the car frame.

[0018] A position sensor 5 is a door zone sensor which detects whether or not the elevator is at a position where the door can be opened by detecting a detection plate 6.

[0019] A safety controller 1 is a controller constituting a safety system, which brakes the car 104 by shutting off the brake power supply and the motive power supply independently from the elevator controller 100. The safety controller 1 is mainly constituted by a central processing unit (CPU) which executes a series of processing, and additionally has a watchdog timer for detecting abnormality of the CPU and a circuit for monitoring power supply abnormality. Moreover, to detect processing abnormality of the CPU, the safety controller 1 may have the constitution which performs mutual comparison by duplicating the CPU in some cases.

[0020] The inputs of the safety controller 1 are constituted by a means 7 for detecting the position, velocity and acceleration of the car and a means which detects the actuation of a safety device of the elevator. The means 7 for detecting the position, velocity and acceleration of the car is, for example, a pulse generator which outputs pulses according to the position of the car. In this example, one with an encoder attached to a governor is shown in the drawing. Besides that, this means 7 only needs to be a means which can detect an absolute or relative position of the car, such as a type which detects the movement of the passenger car by directly pressing a roller against a guide rail, or a type which magnetizes a rail for the detection.

[0021] The outputs of the safety controller 1 are constituted by a brake power supply shut-off output 9, a motive power supply shut-off output 10, and a car position and velocity information output 23 detected by the safety controller 1. The brake power supply shut-off output 9 is an output for shutting off the brake power supply to actuate the brake device 102. Similarly, the motive power supply shut-off output 10 is also an output for stopping the electric motor 103 by shutting off the electric power source of the electric power converter 101. All the outputs are used to brake the car.

[0022] FIG. 2 is a block diagram showing the series of processing of the braking force control unit 20 in FIG. 1, and the outline of the series of processing of the braking force control unit 20 will be described with reference to this drawing. A rescue operation start detection processing unit 30 is a processing unit which detects a rescue operation start command transmitted from the elevator control unit 2 of the elevator controller 100, and transmits the start or stop of the rescue operation identified by the rescue operation start command to a brake current command creation processing unit 32. A car velocity detection processing unit 31 receives the car position and velocity information output 23 inputted from the safety controller 1, detects the current car velocity of the self-equipment in the hoistway, and outputs the detected car velocity. Based on the rescue operation start command outputted from the rescue operation start detection processing unit 30, the brake current command creation processing unit 32 creates a brake current command and outputs the created brake current command to the brake current control circuit 21. The brake current command creation processing unit 32 also changes the brake current command based on the car velocity outputted from the car velocity detection processing unit 31. To create a brake command, the brake current command creation processing unit 32 acquires different adjustment parameters depending on the type of brake from a model information database (DB) 33. Specifically, these adjustment parameters include a time for stopping the increase of the current command value for a certain period of time after the current is increased to a certain value to wait for the change in the magnetic flux. The change in the magnetic flux which changes the brake torque is delayed from the change in the current command. Thus, in consideration of that, a time for stopping the increase of the current command value for a certain period of time after the current is increased to a certain value is provided to wait for the change in the magnetic flux. Since the change in the current command value and the delay in the magnetic flux change are different depending on the structure and size of the brake, this information is acquired from the model information database (DB).

[0023] FIG. 3 is a timing chart showing one example of the outline of the behavior of the elevator according to Example 1. Specifically, FIG. 3 shows the relationships among the brake current command i* created by the brake current command creation processing unit 32, the brake current i flowing to the solenoid coil, the brake torque T acting between the brake pad and the sheave, and the car velocity with the horizontal axes as time. Also, for convenience of explanation, the time axis is divided into five sections from (a) to (e). Hereinafter, the basic behavior method will be described in order from the section (a) .

[0024] In the section (a), the brake current command i* is in a state of zero, the brake torque T is in a state in which sufficient torque is given to constrain the sheave, and the car velocity is zero.

[0025] In the section (b), the brake current command i* is increased stepwise, and the brake current i flowing to the solenoid coil also increases accordingly. Herein, the purpose of increasing the brake current command i* (or the brake current i) is to weaken the brake torque T, which is the braking force of the brake, by increasing the brake current i, and set the torque generated from the imbalance between the car and the counterweight and the braking force of the brake into an equilibrium state. In the section (b), the behavior is that, as the brake current i increases, an electromagnetic force is generated in the solenoid coil, and the brake torque T is weakened. In this state, the brake torque T is in a state of being greater than the torque generated by the imbalance between the car and the counterweight so that the car does not move and the car velocity V remains at zero. Moreover, the command is made stepwise at this time because the responsiveness of the brake is taken into consideration. Normally, the actuator such as the brake device 102 is constituted by an iron core and a coil. However, since the magnetic permeability of the iron core is low, the change in the magnetic flux is slower than the change in the current. As a result, the brake device 102, which is the actuator, behaves in a direction to open with a delay to the current command. For this reason, as shown in the section (b) in FIG. 3, the increase of the current is stopped for a certain period of time after the current is increased to a certain value to wait for the change in the magnetic flux. The time to stop the increase of the current is equal to or greater than the delay time of the magnetic flux change from the change in the current. Thus, the current command can be easily followed.

[0026] On the contrary, if the current command is not made stepwise but given with a certain inclination, the response delay of the magnetic flux change is long from the change in the current command. Thus, the behavior of the actuator cannot follow the current command and behaves with a delay from the current command. When the actuator behaves in this way, the current command is in a state of being further applied a large value at the timing the car starts to move. As a result, there is a possibility that the brake device 102 further opens and sudden acceleration occurs.

[0027] The section (c) is the timing from increasing the brake current command i* until the car moves and the car velocity V is detected. As previously mentioned, there is a response delay of the magnetic flux change from the change in the current command. Thus, there is a time as this section (c) from that the brake torque T changes until the car velocity V is detected.

[0028] The section (d) shows a state in which the brake current command i* is fixed at the timing the car velocity V is detected. The detection of the car velocity V indicates a state in which the brake torque T is less than the torque generated from the imbalance between the car and the counterweight. By fixing the brake current command at this time, it is possible to create a state in which the car is accelerated by the difference between the brake torque T, which is the braking force of the brake, and the torque generated from the imbalance between the car and the counterweight. Moreover, it is possible to increase the velocity of the car with a smaller acceleration than in a state in which the brake is completely released.

[0029] The section (e) shows a state in which the brake torque T, which is the braking force of the brake, is continuously controlled by continuously changing the brake current command as a square wave without suddenly increasing the change amount per unit time according to the detected car velocity V, and the car is being controlled at a constant velocity. In a conventional method for controlling the car velocity by opening and closing the brake, the brake torque is repeatedly applied as a square wave, and the change amount of the brake torque T per unit time becomes large. As a result, the velocity change of the car per unit time becomes also large, and vibration occurs in the car. In contrast, in the method of the present example, the brake current is continuously controlled, and the brake torque T is continuously changed. Thus, the change amount of the brake torque T becomes small so that it is possible to prevent sudden acceleration of the passenger car at the time of starting to move and to reduce the vibration of the car.

[0030] FIG. 4 is a timing chart showing another example of the outline of the behavior of the elevator according to the present invention, showing the operation method for decelerating the velocity in the section (d) in FIG. 3 to once stop the car and repeating again from the section (a). The feature of this mode is that the brake torque is changed according to the brake current. Not only the constant velocity operation, but also the operation may be repeated again after stopping once every time in this way. The merit of behaving in this way is that it is not necessary to consider the influence on the brake pad when running continuously. As shown in Fig. 3, when the constant velocity operation is applied to the elevator for long distance, the brake pad continuously wears out during the constant velocity running. In particular, since there is concern that the temperature of the brake pad portion will rise during a long-time running, there is a possibility that the friction characteristics change and braking may not be secured. Therefore, by once stopping and completing the operation, it is possible to suppress the temperature rise of the brake pad portion and to continue the main operation while the braking force of the brake is secured.

[0031] Note that control for stopping once when the brake is released several times in combination with the series of processing in FIGS. 3 and 4 may be performed. FIG. 5 is a flow diagram showing one example of a rescue operation method for the elevator according to the present invention and shows a flowchart of a series of processing executed by the brake current command creation processing unit 32. In Step S101, the brake current command creation processing unit 32 judges ON (start)/OFF (stop) of the rescue operation start command outputted from the rescue operation start detection processing unit 30. When the rescue operation start command is OFF, the processing ends. When the rescue operation start command is ON, the processing proceeds to Step S102. The condition under which the rescue operation start command is ON is normally set to when a passenger is trapped in the car and the motor or the like cannot be driven due to some abnormality, or the like. Note that, as a behaving condition at this time, it is also necessary for the brake to behave normally. The condition under which the rescue operation start command is OFF is set to when the car reaches the door openable position on the nearest floor during usual operation or during carrying out the rescue operation.

[0032] In Step S102, the brake current command creation processing unit 32 decides whether or not the car velocity V is zero. When the car velocity V is zero, the car is in a stopped state by the brake so that the processing proceeds to step S103. Then, the brake current i is increased to weaken the brake torque T, which is the braking force of the brake, and the brake current command i* is increased to bring the torque generated from the imbalance between the car and the counterweight and the braking force of the brake into an equilibrium state. Moreover, by staying for a predetermined time, the influence of the portion due to the response delay of the brake is eliminated. After staying for a predetermined time, the processing returns to Step S101. When the car velocity V is not zero, the processing proceeds to Step S104. Note that the value for increasing the brake current command i* is determined according to the resolution for controlling the brake. In Step S104, the brake current command i* is fixed. By fixing the brake current command i* in a situation where the car velocity is not zero, it is possible to secure a slipping state in which the brake pad and the sheave frictionally move without completely releasing the brake.

[0033] In Step S105, whether or not the car velocity V is greater than a target car velocity V* is decided. Note that the target car velocity V* is normally set to the maintenance operation velocity or lower velocity, but may be set to the rated velocity. When the car velocity V is greater than the target car velocity V*, the current command is continuously decreased to decelerate the car by the brake torque (Step S106).

[0034] In Step S107, whether or not the car velocity V is less than the target car velocity V* is decided. When the car velocity V is less than the target car velocity V*, the current command is continuously increased to reduce the brake torque to increase the velocity of the car.

[0035] According to the above constitution, when the controller transmits a command to change the braking force to the brake from the state in which the passenger car is stopped and the movement of the passenger car is detected by the movement detection means, the controller controls the braking force of the brake. By doing so, the braking force of the brake is changed from the state in which the brake is actuated to keep the passenger car, and the passenger car starts to move when the braking force of the brake becomes less than the torque generated from the imbalance between the passenger car and the counterweight. Moreover, by further controlling the braking force of the brake after the passenger car starts to move, it is possible to move the passenger car at low velocity and with low vibration.

[0036] In the present example, the model information database (DB) shown in FIG. 2 is used to refer to the time for stopping the increase of the current command value for a certain period of time after the current is increased to a certain value in order to wait for the change in the magnetic flux. However, without providing the database, a fixed value may be set according to the type of brake having the slowest response. There are various types of brakes, such as drum type, internal type, and shoe type, and responsiveness differs according to the type of brake. For this reason, when the car is moved by intermittently releasing the brake with the technique disclosed in PTL 1, the minimum time for opening and closing the brake differs depending on the type of the brake. Thus, it is necessary to separately adjust the control. When the fixed value is set according to the type of brake having the slowest response, the rescue operation can be performed by releasing the brake without depending on the type of brake.

[0037] Since the conventional rescue operation technique as disclosed in PTL 1 moves to the car to the nearest floor by intermittently releasing the brake, vibration occurs in the passenger car by being applied the braking force accompanying the intermittent release of the brake. In particular, when the response speed of the mechanical portion of the brake or the relay which shuts off the voltage applied to the brake is slow, the velocity-increased state caused by the imbalance between the passenger car and the counterweight must be braked. Thus, not only the vibration occurred in the passenger car becomes large, but also the velocity of the passenger car becomes difficult to be kept constant. Moreover, in the elevator of long distance, the masses of the passenger car, the counterweight, the sheave, and the rope increase. Thus, the resonance point of the mechanical system is shifted to the lower frequency side. Since the low frequency vibration is difficult to attenuate in the mechanical structure as compared with the radio frequency vibration, it is known that the ride feeling experienced by the passenger is deteriorated. In particular, in a case where a voltage is applied to the brake at the time of start, when a voltage for releasing the brake is directly applied, not only the velocity increases by opening the brake, but also an impact due to the acceleration change occurs at the time of start. Furthermore, PTL 1 describes that linearly changing the voltage at the time of start enables the start without detecting the imbalance by a scale device of the car. However, if the responsiveness of the coil used for the brake is low, the voltage command reaches a value, at which the brake can be sufficiently opened, when the brake starts to open and the car moves. Thus, there is a possibility of causing a sudden velocity increase of the car. In particular, in the actuator, such as the brake, constituted by the coil and the iron core, since the magnetic permeability of the iron core is low, the responsiveness of the change in the magnetic flux to the change in the current is low, causing such a possibility.

[0038] As described above, according to the present invention, it has been shown that it is possible to provide the elevator device and the rescue operation control method for the elevator capable of preventing sudden acceleration of the passenger car at the time of starting to move during the brake release operation.

[0039] Note that the present invention is not limited to the above examples and includes various modification examples. For example, the detailed description of the above examples has been made so that the present invention can be easily understood, and the present invention is not necessarily limited to those including all the constitutions which have been described. Moreover, part of the constitution of one example can be replaced with the configurations of other examples, and the constitutions of other examples can be added to the constitution of one example. Furthermore, addition, deletion and replacement of other constitutions can be made to part of the constitution of each example.

Reference Signs List

[0040]

1 safety controller
2 elevator control unit

4 scale sensor
5 position sensor
7 means for detecting position, velocity and acceleration of car
20 braking force control unit

Claims

1. An elevator, comprising: a passenger car; a rope whose one end is connected to the passenger car; a counterweight connected to an other end of the rope; a sheave around which the rope is wound; a solenoid coil which weakens a braking force as a current supplied increases; a brake device which brakes movement of the passenger car by applying the braking force to the sheave; a brake power supply which supplies the current to the solenoid coil; a moving velocity detection means which detects a moving velocity of the passenger car; and a controller which controls the current supplied by the brake power supply according to the moving velocity of the passenger car detected by the moving velocity detection means, wherein the controller moves the passenger car by an imbalance of weights between the passenger car and the counterweight while the braking force is generated by the brake device, by transmitting, to the brake power supply, a command for increasing the current supplied to the solenoid coil by a predetermined value every time a predetermined time elapses when the passenger car is stopped and by transmitting, to the brake power supply, a command for stopping increasing the current supplied to the solenoid coil when a velocity change of the passenger car is detected by the moving velocity detection means.

2. The elevator according to claim 1, wherein the controller transmits, to the brake power supply, a command for continuously decreasing the current supplied to the solenoid coil with time to stop the passenger car when the passenger car is moving and a velocity of the passenger car exceeding a specified velocity is detected by the moving velocity detection means.

3. The elevator according to claim 1, wherein the controller transmits, to the brake power supply, a command for linearly decreasing the current supplied to the solenoid coil with time to stop the passenger car when the passenger car is moving and a velocity of the passenger car exceeding a specified velocity is detected by the moving velocity detection means.

4. The elevator according to any one of claims 1 to 3, wherein the predetermined time is longer than a time taking from when the controller transmits, to the brake power supply, the command for increasing the current supplied to the solenoid coil until when a change in the braking force of the brake device stops.

5. The elevator according to any one of claims 1 to 3, wherein the controller comprises a model information database in which information on the predetermined time necessary for each model is stored, and the controller determines the predetermined time according to the information recorded in the model information database.

6. The elevator according to any one of claims 1 to 3, wherein the moving velocity detection means is an encoder provided to a governor.

7. The elevator according to any one of claims 1 to 3, wherein the controller transmits, to the brake power supply, a command for changing the current supplied to the solenoid coil based on detection information of the moving velocity detection means to move the passenger car to a floor where a passenger can get off, when the passenger car is stopped in emergency in a situation in which the passenger is in the passenger car, and a rescue operation signal is inputted into the controller.

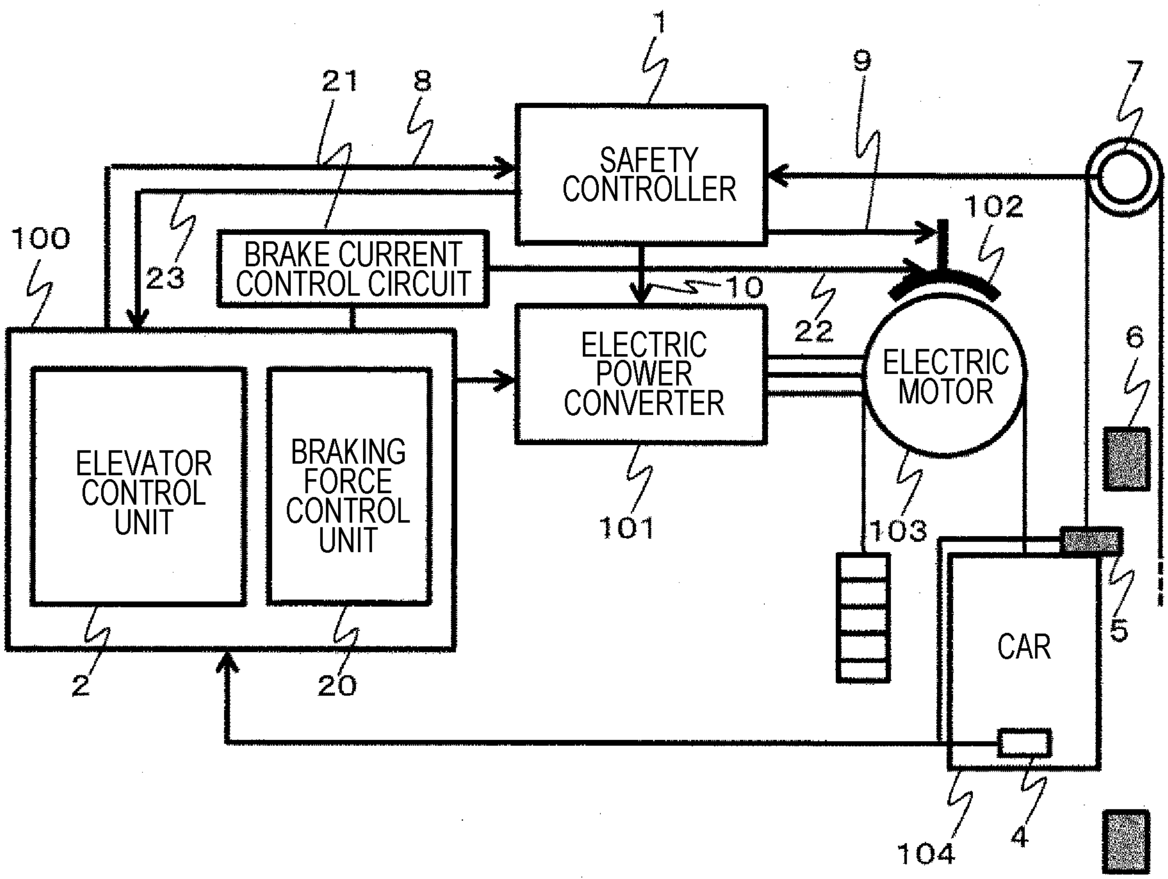
8. The elevator according to claim 6, comprising an external terminal which receives a status and an operating state of the passenger car and transmits the rescue operation signal to the controller, wherein the controller receives the rescue operation signal from the external terminal.

9. A rescue operation control method for an elevator comprising: a passenger car; a rope whose one end is connected to the passenger car; a counterweight connected to an other end of the rope; a sheave around which the rope is wound; a solenoid coil which weakens a braking force as a current supplied increases; and a brake device which brakes movement of the passenger car by applying the braking force to the sheave, comprising:

   increasing the current supplied to the solenoid coil by a predetermined value every time a predetermined time elapses when the passenger car is stopped in emergency and a passenger is in the passenger car; and
   moving the passenger car to a floor where the passenger can get off by an imbalance of weights between the passenger car and the counterweight while the braking force is generated by the brake device, by stopping increasing

the current supplied to the solenoid coil when a velocity change of the passenger car is detected.

FIG. 1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21
8
9
7
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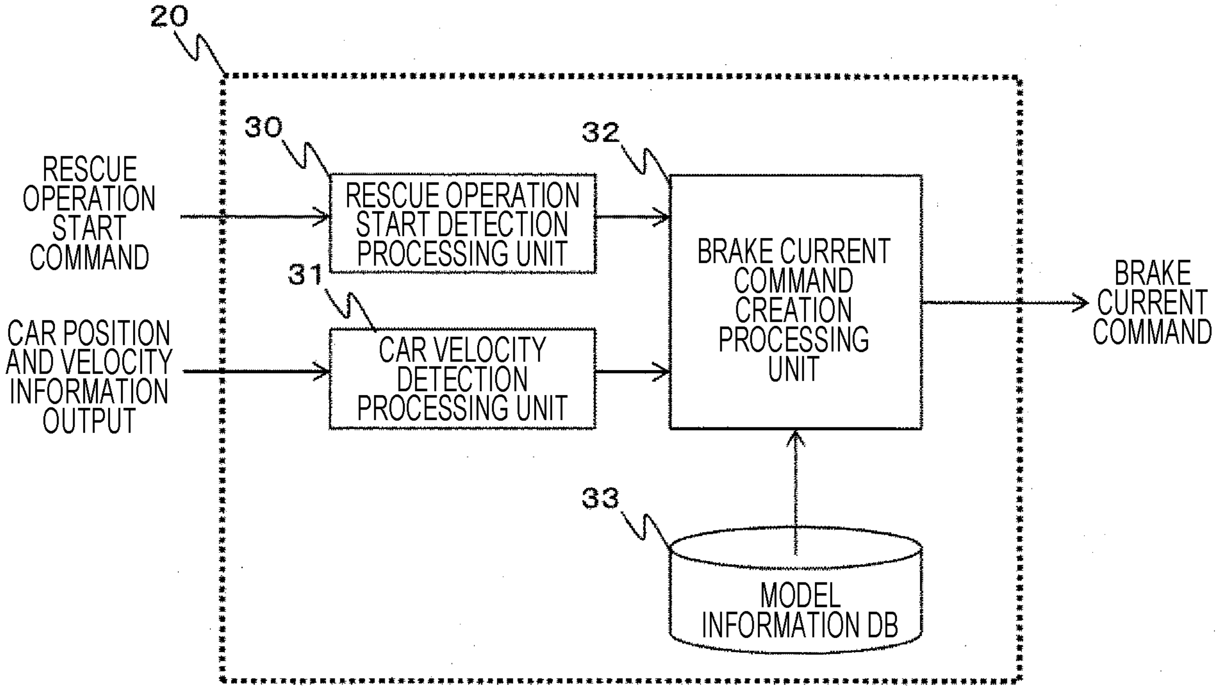
102
100
23
BRAKE CURRENT CONTROL CIRCUIT
10
22
ELECTRIC POWER CONVERTER
ELECTRIC MOTOR
6
ELEVATOR CONTROL UNIT
BRAKING FORCE CONTROL UNIT
101
103
CAR
5
2
20
104
4

FIG. 2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31
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32
BRAKE CURRENT COMMAND CREATION PROCESSING UNIT
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MODEL INFORMATION DB
RESCUE OPERATION START COMMAND
CAR POSITION AND VELOCITY INFORMATION OUTPUT
BRAKE CURRENT COMMAND

FIG. 3

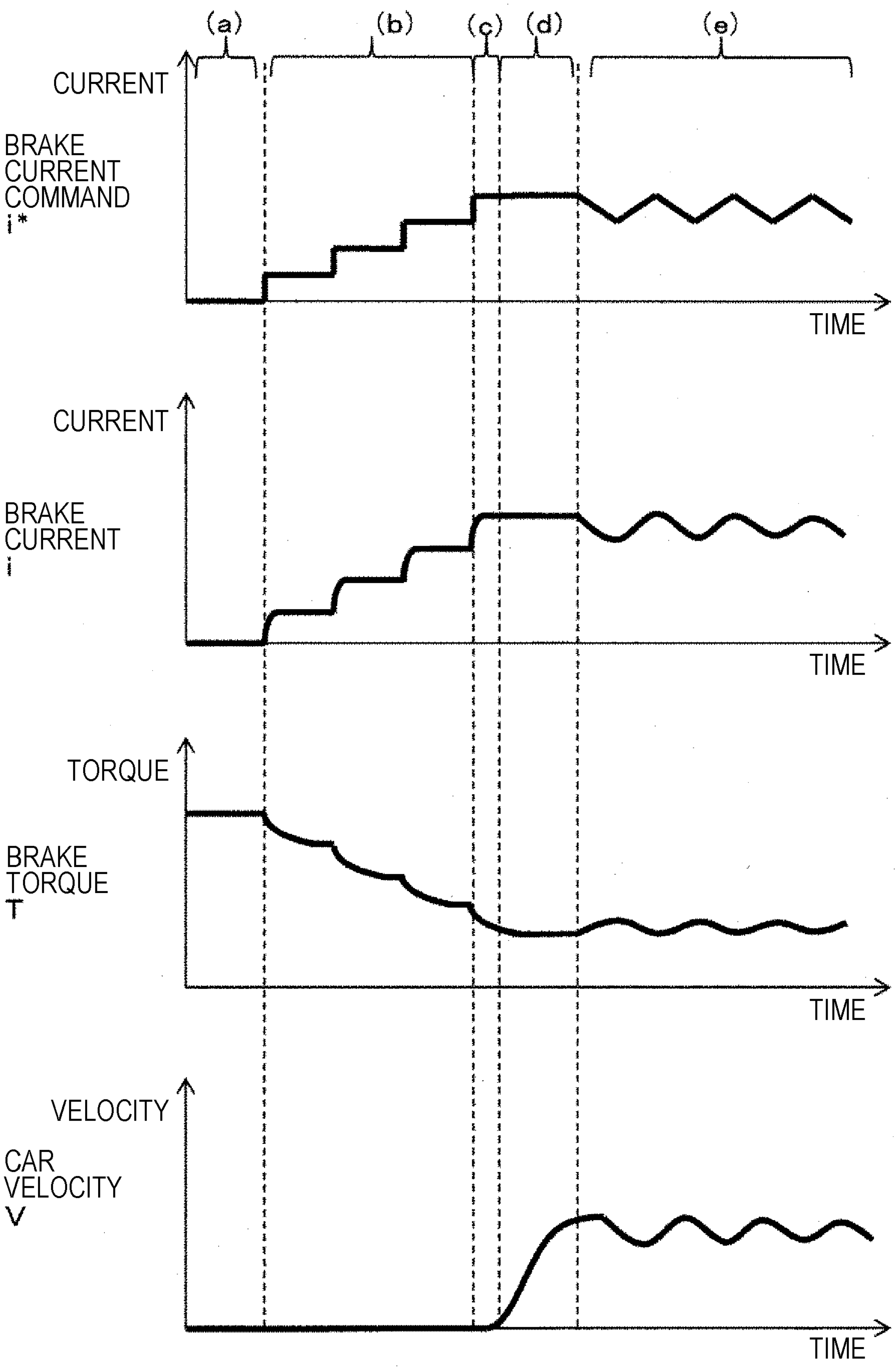

(a)
(b)
(c)
(d)
(e)
CURRENT
BRAKE CURRENT COMMAND i*
TIME
CURRENT
BRAKE CURRENT i
TIME
TORQUE
BRAKE TORQUE T
TIME
VELOCITY
CAR VELOCITY V
TIME

FIG. 4

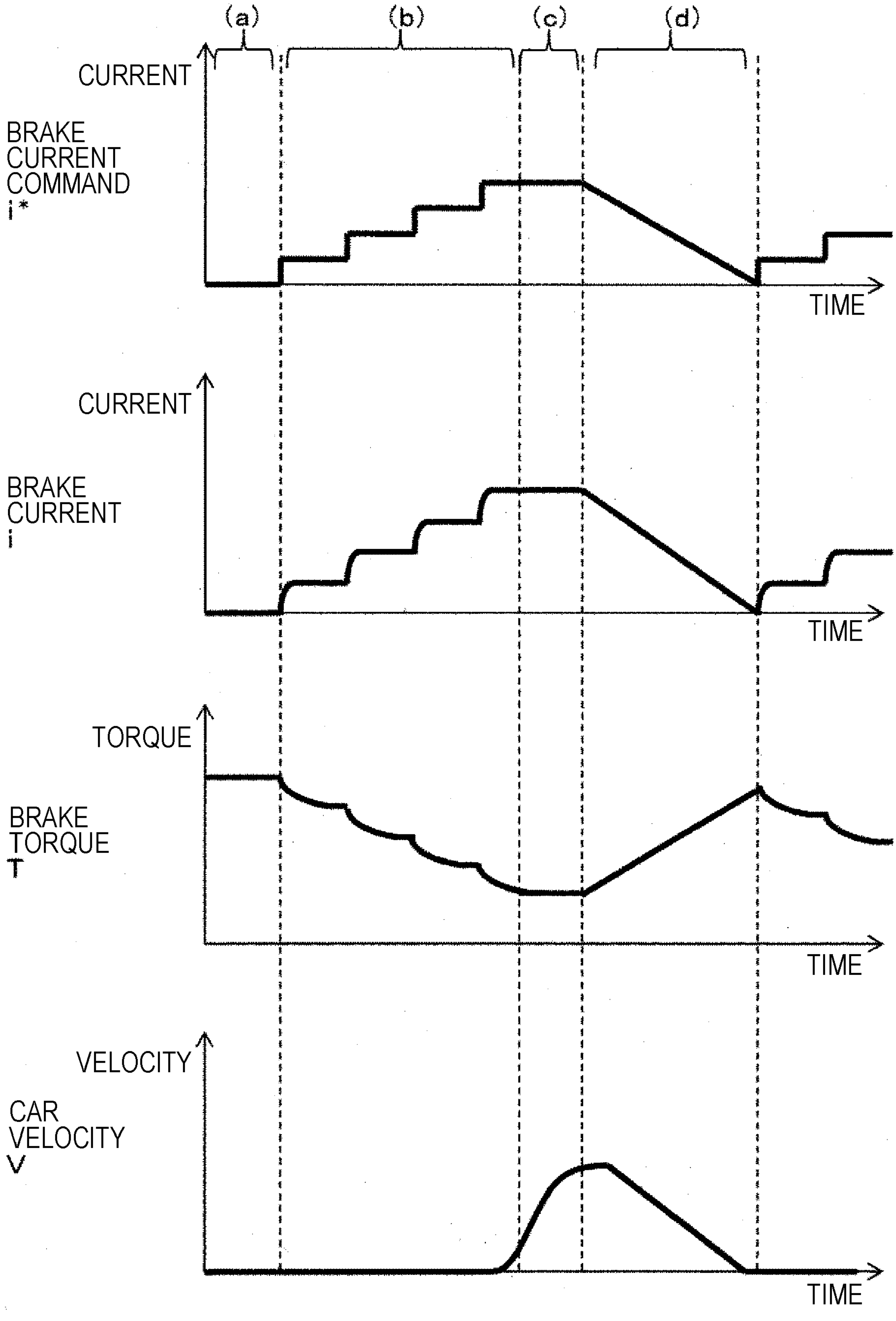
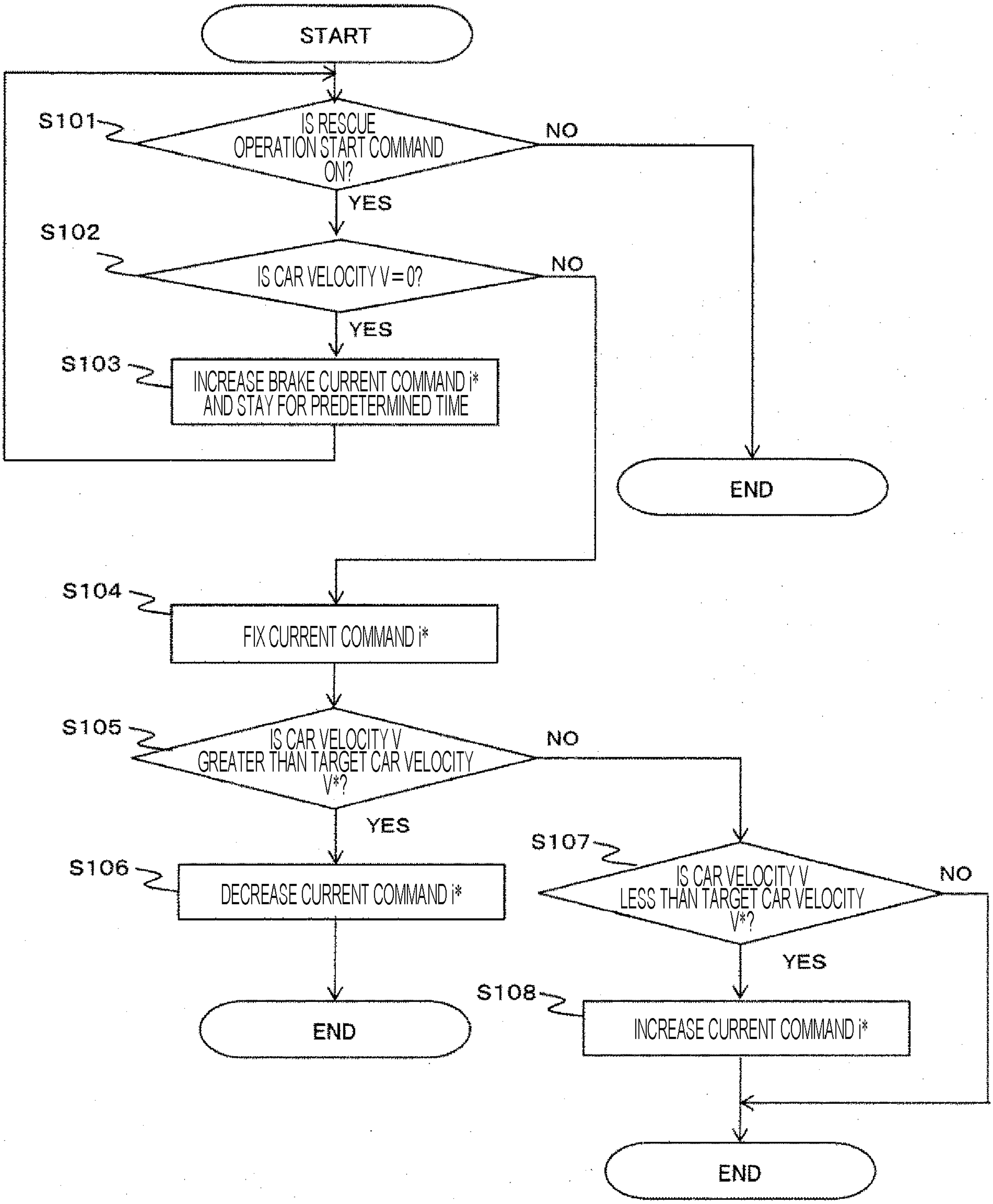

(a)
(b)
(c)
(d)
CURRENT
BRAKE
CURRENT
COMMAND
i*
TIME
CURRENT
BRAKE
CURRENT
i
TIME
TORQUE
BRAKE
TORQUE
T
TIME
VELOCITY
CAR
VELOCITY
V
TIME

FIG. 5


START
S101
IS RESCUE OPERATION START COMMAND ON?
NO
YES
S102
IS CAR VELOCITY V=0?
NO
YES
S103
INCREASE BRAKE CURRENT COMMAND i* AND STAY FOR PREDETERMINED TIME
END
S104
FIX CURRENT COMMAND i*
S105
IS CAR VELOCITY V GREATER THAN TARGET CAR VELOCITY V*?
NO
YES
S106
DECREASE CURRENT COMMAND i*
S107
IS CAR VELOCITY V LESS THAN TARGET CAR VELOCITY V*?
NO
YES
END
S108
INCREASE CURRENT COMMAND i*
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/004192

A. CLASSIFICATION OF SUBJECT MATTER
B66B5/02(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)
B66B5/02

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	WO 2009/013821 A1 (Mitsubishi Electric Corp.), 29 January 2009 (29.01.2009), paragraphs [0008] to [0017], [0034] to [0039]; fig. 1 to 2, 6 to 7 & US 2010/0170751 A1 paragraphs [0017] to [0025], [0043] to [0048]; fig. 1 to 2, 6 to 7 & EP 2168901 A1 & KR 10-2010-0022520 A & CN 101765557 A	1,5-7,9 8 2-4
Y	JP 2008-230757 A (Toshiba Elevator and Building Systems Corp.), 02 October 2008 (02.10.2008), paragraphs [0019], [0025]; fig. 1 to 2 (Family: none)	8

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 April 2017 (17.04.17)	09 May 2017 (09.05.17)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/004192

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 56-117970 A (Hitachi, Ltd.), 16 September 1981 (16.09.1981), (Family: none)	1-9
A	JP 2013-119436 A (Hitachi, Ltd.), 17 June 2013 (17.06.2013), (Family: none)	1-9
A	JP 7-242376 A (Toshiba Corp.), 19 September 1995 (19.09.1995), (Family: none)	1-9
A	US 2006/0201752 A1 (KONE CORP.), 14 September 2006 (14.09.2006), & WO 2006/096484 A2	1-9

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2009013821 A **[0005]**