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(54) **ELEVATOR**

AUFZUG

ASCENSEUR

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(56) References cited:
CN-A- 104 671 022 US-A- 5 247 140

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Description

BACKGROUND

[0001] The present invention relates to an elevator.

[0002] The elevator car is normally driven under control to allow the motor to output compensation torque corresponding to the difference between the car and the counterweight so as to maintain static state of the car while preventing its fall even in the transition from the stop state under the braking force to the state where the braking force is released. In order to determine the compensation torque upon activation, it is necessary to detect inside weight of the car by means of the weighing sensor attached to the bottom of the car or the thimble rod. Possible error of the weighing sensor may fail to accurately output the required compensation torque, which shakes the car upon starting at a magnitude corresponding to the error. Japanese Patent Application Laid-Open No. 2015-00796 discloses the method of calibrating the weighing sensor for the purpose of solving the above-described problem.

[0003] US5247140 discloses a brake control system for an elevator control apparatus according to the preamble of claim 1. Disclosed is a brake circuit that includes a current detector, a comparator for comparing the detected value with a dictated brake current pattern, and a switch which switches the brake current in accordance with the magnitude of the difference between the detected current value and the dictated value.

[0004] CN104671022 discloses an elevator control device and an elevator control method. In a state where a first torque command value is applied to a motor in the direction the same as the advancing direction of the elevator car in advance before the advancing of the elevator car, the braking force of the brake is released gradually to make the elevator car to start advancing. The braking force of the brake is diagnosed by checking the matching between the current value of a braking coil and the value of the unbalance torque at the time of advancing start.

SUMMARY

[0005] There may be the case that the car is shaken when starting the elevator if the weighing sensor fails, or high detection accuracy cannot be expected. As a result, the appropriate compensation torque cannot be output, thus shaking the car upon starting of the elevator.

[0006] According to the present invention there is provided an elevator as specified in claim 1.

[0007] It is an object of the present invention to lessen shaking of the car upon starting of the elevator.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a block diagram showing an overall structure

of an embodiment according to the present invention;

Fig. 2 is a block diagram showing the process flow executed by an elevator controller according to the embodiment;

Fig. 3 is a view schematically showing the operation of the embodiment; and

Fig. 4 is a flowchart representing process steps of generating the drive torque according to the embodiment.

DETAILED DESCRIPTION

[0009] An embodiment according to the present invention will be described referring to the drawings.

[0010] Fig. 1 is an overall view of an elevator system structure according to the present invention. An elevator controller 100 controls movement of a car 104 of the elevator. The elevator controller 100 includes a brake control unit 20 and a torque control unit 23 in addition to an elevator control unit 2 for operation control of the elevator.

[0011] The car 104 operated to move between floors of the building through the hoistway is connected to a weight or counterweight with a rope for balancing with the car 104. The car 104 includes a car door that is opened and closed in engagement with the door at the landing floor side. The car 104 is operated by a motor 103 which drives the sheave. A power converter 101 supplies drive power to the motor 103. The power converter 101 outputs power for controlling the motor in accordance with a car position control command from the elevator controller 100. A rotation sensor as the pulse generator such as an encoder is attached to the motor 103. The elevator controller 100 counts the pulse generated by rotation of the motor 103 so as to calculate speed of the motor 103, and moving direction, position, movement distance of the car 104 in the hoistway. The rotation sensor attached to the motor will be referred to as a machine encoder. The elevator controller outputs a brake power source stop command and a power supply stop command (not shown) for braking the car. In response to those stop commands, the brake power source actuates a brake 102, and the power supply interrupts power supply to the power converter 101 so as to brake the car 104. The brake power source and the power supply are circuits each constituted by an electromagnetic contactor called contactor.

[0012] The brake 102 includes a brake pad for braking the sheave through friction sliding operation, a solenoid coil for lifting the brake pad so as to generate the gap between the sheave and the brake pad, and a core. Generally, upon power supply to the solenoid coil, the brake pad is lifted under electromagnetic force so that the sheave released from restraint of the brake pad becomes freely rotatable. Power is supplied to the solenoid coil through relay from the brake power source. The brake 102 is connected to a brake current control circuit 21 as the circuit configured to control the current (brake current

22) applied to the solenoid coil and configured to make the braking force of the brake variable. The brake 102 is provided with a brake check switch 8 configured to mechanically detect whether the brake pad and the sheave are separated (uncontact state). The information detected by the brake check switch 8 indicating as to whether the brake and the sheave are separated (uncontact state) is output to the elevator control unit 2.

[0013] The brake current control circuit 21 is constituted by a converter for controlling current or voltage, for example, inverter circuit, chopper circuit or the like, a hall CT for detecting the brake current, and a control unit for controlling the brake current. In response to the current command value (brake current command) applied from the elevator controller 100 to the solenoid coil, the brake current 22 is controlled into the command value. This embodiment has been described by taking the brake mechanism for varying the braking force in accordance with the current using the solenoid coil as an example of varying the braking force. It is also possible to employ the brake configured to vary the braking force in accordance with the distance by utilizing the actuator of direct drive type, or the brake (shoe brake) configured to vary the braking force in accordance with the rotation angle by utilizing the rotation mechanism. Arbitrary type of brake may be employed so long as the braking force of the brake is variable in accordance with the specific command.

[0014] A position sensor 5 is a door zone sensor configured to detect a detection plate 6 so as to determine if the elevator is at the position where the door can be opened. A car speed sensor 7 for detecting the car speed may be formed as a rotation sensor attached to the governor, for example. The rotation sensor attached to the governor will be referred to as a governor encoder. It is also possible to directly attach the acceleration sensor to the car.

[0015] Fig. 2 is a block diagram representing correlation between the brake control unit 20 and the torque control unit 23 with respect to processing executed by those units. Upon reception of an operation start command input from the elevator control unit 2, a speed command output processing unit 30 issues a zero speed command. The difference between the zero speed command and a car speed feedback input from a car speed detection processing unit 31 is calculated for execution of target value follow-up control, for example, proportional integral control. Finally, the torque command is output. In other words, the torque command is output so that the car speed becomes zero. The car speed detection processing unit 31 detects a car speed feedback signal derived from the machine encoder so that the signal is output for speed command output processing.

[0016] A torque control processing unit 32 obtains the difference between the torque command input from the speed command output processing unit 30 and a torque feedback signal calculated from a motor current feedback signal, executes such process as proportional integral

control, and outputs the torque output command. The torque output command is input to the power converter 101 so that voltage is applied to a synchronous motor for generating the desired torque.

5 **[0017]** The brake control unit 20 includes a brake current command generation unit 33 and a type information database (DB) 34. Upon reception of an operation start command input from the elevator control unit 2, the brake current command generation unit 33 outputs the brake current command in reference to the type information DB 34 to be described later. The brake current command is input to the brake current control circuit 21, based on which the brake current control circuit 21 controls the brake current 22 to be applied to the brake solenoid coil.

10 **[0018]** Fig. 3 graphically represents the time-series correlation among waveforms generated upon start of the brake control unit 20 and the torque control unit 23. For convenience of explanation, the time axis is divided into four sections from (a) to (d). The basic operation process will be described with respect to the sections sequentially from the section (a).

15 **[0019]** In the section (a), the operation start command has not been input to the respective control units, and therefore, the brake current command is in the zero state. In other words, the car is kept under braking force by the brake, and accordingly, the car speed is also zero. Because of the braking force applied by the brake, the torque output command is also in the zero state.

20 **[0020]** In the section (b), the operation start command is input. Then the brake control unit 20 gradually increases the brake current command value so that the brake current output from the brake current control circuit 21 is applied to the solenoid for lifting the brake 102. Upon increase in the brake current command value, the brake 102 is lifted slowly so as to decrease the brake torque T. In the case that the unbalance torque between the car and the counterweight is made larger under the decreasing brake torque, the car is likely to move. At this time, the speed command output processing unit 30 has already output the zero speed command. Then the torque control processing unit 32 outputs the torque output command to the power converter 101 so that the car speed becomes zero. Then power is output to the motor 103 to output the torque in accordance with the torque output command to the power converter 101. Since the speed command output processing unit 30 has already output the zero speed command, the brake is lifted. As the unbalance torque is made relatively larger than the brake torque, the motor torque for maintaining the zero speed is increased as well as the output of the torque command. By releasing the brake slowly, the brake torque insufficient to bring the car into static state may be compensated in response to the torque output command. This may maintain the static state of the car. The gradient of the brake current command in the section (b) is determined in reference to the type information DB 34 in order to cope with the response which differs depending on the brake type. For example, in the case of brake torque re-

sponse delay to change in the brake current command, the gradient may be reduced or shaped into step-like form so as to facilitate the response following up to the command.

[0021] The section (c) represents the transitional change into the state that brings the brake torque into zero state as a result of separation of the brake pad from the sheave resulting from increasing brake current. At this time, the torque required for making the car into static state has been already output in the section (b). Therefore, shaking of the car owing to torque change rarely occurs even in the state that the brake is released.

[0022] The section (d) represents the state that the brake has been separated. The torque sufficient to bring the car into static state has been output in the section (c) so that the car is kept in the static state. At this time, the torque control processing unit 32 has output the torque output command to set the car speed to zero. Subsequently, the speed command is applied to start operation of the car.

[0023] Fig. 4 is a flowchart according to the present invention. In step S101, the elevator control unit 2 detects whether the operation start command has been input. If the operation start command is OFF, the process ends. If the operation start command is ON, the process proceeds to step S102. In step S102, the car speed detection processing unit 31 converts the machine encoder information or the information output from the car speed sensor 7, which has been input via the elevator control unit into the car speed. The speed command output processing unit 30 judges whether or not the car speed is zero. If the car speed is zero, the process proceeds to step S103 where the brake current command value is increased through the brake current command generation process. In step S104, the brake torque is reduced as the brake current varies. If it is judged in step S102 that the car speed is not zero, the process proceeds to step S105 where the speed command output processing unit outputs the torque control command to set the car speed to zero. In step S106, it is judged whether or not the brake pad has been separated. Separation of the brake pad may be detected by utilizing the brake check switch 8 for detecting the brake operation state. If the brake pad has not been separated, the process proceeds to the step prior to step S102. That is, when the brake pad is not separated at the speed other than zero, the control for increasing the brake current is executed while outputting the torque that approximates the speed to zero. If the brake pad is separated by decreasing the brake torque stepwise, the process proceeds to step S107 where the process is kept stand-by until the operation command is input while allowing the speed control unit to output the torque to set the car speed to zero. The current command generation increasing process executed by the brake current command generation unit 33 ends to terminate the series of process steps.

[0024] The above-described structure allows the unbalance torque corresponding to the difference between

the car and the counterweight to be gradually activated under the decreasing braking force resulting from the brake slowly released by the elevator control unit. The control unit subjects the torque command to the follow-up control, which allows slow follow-up to the unbalance torque without causing sharp torque change. This makes it possible to make the acceleration change owing to torque gentle. In the case of error in the weighing sensor and the rotation sensor, the resultant shaking may be suppressed.

[0025] The present invention is useful for the case that the magnetic pole position of the motor as the drive unit is estimated for driving operation. In particular, so called vector control is executed for the general torque control or speed control of the motor as the permanent magnet synchronous motor. As the above-described control needs detection of the magnetic pole position of the synchronous motor, the magnetic pole is detected by the rotation sensor. The detection error of the rotation sensor attached to the synchronous motor with respect to the magnetic pole position may influence the compensation torque. As a result, the large detection error and the error in estimation with respect to the magnetic pole position through sensor-less driving operation may cause shaking of the car.

[0026] The current value kept constant for the magnetic pole position estimation is output immediately after execution of step S101, and the brake is gradually released by the control unit to bring the unbalance torque as the difference between the car and the counterweight into activated state under the weakening braking force. At this time, the control unit subjects the torque command to the follow-up control to allow slow follow-up to the unbalance torque without causing sharp torque change. This makes it possible to make the acceleration change owing to torque gentle. In spite of torque inversion, large torque is not required, and shaking may be lessened without generating high acceleration under the active braking force. In the case of error in the weighing sensor and the rotation sensor, it is possible to lessen shaking of the car.

List of Reference Signs

[0027]

2 elevator control unit

Claims

1. An elevator comprising:

- a car (104);
- a drive unit (103) for moving the car (104) by rotating a rotary body connected to the car (104);
- a brake (102) for applying a braking force to the rotary body;
- an elevator control unit (2) for controlling an op-

- eration of the car (104); and
 a brake control unit (20) for changing a brake torque of the brake (102) stepwise for releasing upon reception of a start signal of the elevator from the elevator control unit (2);
 a torque control unit (23) configured for controlling a torque of the drive unit (103) so that the speed of the car (104) approaches zero, upon reception of the start signal of the elevator from the elevator control unit (2); and **characterized by** further comprising a
 a brake check switch (8) configured for detecting a contact state between the brake (102) and the rotary body, wherein the torque control unit (23) is configured to control the torque of the drive unit (103) so that the speed of the car (104) approaches zero following detection of separation of the brake (102) from the rotary body by the brake check switch (8), until reception of a movement command of the elevator.
2. The elevator according to claim 1, wherein in the case that the brake check switch (8) detects separation of the brake (102) from the rotary body, the brake control unit (20) fully releases the brake (102) from the rotary body.
 3. The elevator according to claim 1, wherein the brake control unit (20) determines a brake control process of gradually releasing the brake (102) from the rotary body based on information stored in a type information DB of the brake control unit (20).

Patentansprüche

1. Aufzug, der Folgendes umfasst:

eine Kabine (104);
 eine Antriebseinheit (103) zum Bewegen der Kabine (104) durch Drehen eines Drehkörpers, der mit der Kabine verbunden ist (104);
 eine Bremse (102) zum Aufbringen einer Bremskraft auf den Drehkörper;
 eine Aufzugsteuereinheit (2) zum Steuern eines Betriebs der Kabine (104); und
 eine Bremsensteereinheit (20) zum stufenweisen Ändern eines Bremsmoments der Bremse (102) zum Lösen bei Empfang eines Startsignals des Aufzugs von der Aufzugsteuereinheit (2);
 eine Drehmomentsteuereinheit (23), die ausgelegt ist, um ein Drehmoment der Antriebseinheit (103) zu steuern, so dass die Geschwindigkeit der Kabine (104) sich null annähert, wenn sie das Startsignal des Aufzugs von der Aufzugsteuereinheit (2) empfängt; und **dadurch gekennzeichnet, dass** er ferner

einen Bremsenüberprüfungsschalter (8) umfasst, der ausgelegt ist, um einen Kontaktzustand zwischen der Bremse (102) und dem Drehkörper zu detektieren, wobei die Drehmomentsteuereinheit (23) ausgelegt ist, um das Drehmoment der Antriebseinheit (103) so zu steuern, dass die Geschwindigkeit der Kabine (104) sich null annähert, nachdem durch den Bremsenüberprüfungsschalter (8) detektiert wurde, dass die Bremse (102) von dem Drehkörper getrennt ist, bis ein Bewegungsbefehl des Aufzugs empfangen wird.

2. Aufzug nach Anspruch 1, wobei in dem Fall, dass der Bremsenüberprüfungsschalter (8) detektiert, dass die Bremse (102) von dem Drehkörper getrennt ist, die Bremsensteereinheit (20) die Bremse (102) vollständig von dem Drehkörper löst.
3. Aufzug nach Anspruch 1, wobei die Bremsensteereinheit (20) einen Bremsensteuerungsprozess eines allmählichen Lösens der Bremsen (102) von dem Drehkörper auf der Grundlage von Informationen, die in einer Typinformationen-Datenbank der Bremsensteereinheit (20) gespeichert sind, bestimmt.

Revendications

1. Ascenseur comprenant :

une cabine (104) ;
 une unité d'entraînement (103) pour déplacer la cabine (104) en faisant tourner un corps rotatif relié à la cabine (104) ;
 un frein (102) pour appliquer une force de freinage au corps rotatif ;
 une unité de commande d'ascenseur (2) pour commander un fonctionnement de la cabine (104) ; et
 une unité de commande de frein (20) pour modifier un couple de freinage du frein (102) pas à pas pour le libérer lors de la réception d'un signal de démarrage de l'ascenseur à partir de l'unité de commande d'ascenseur (2) ;
 une unité de commande de couple (23) configurée pour commander un couple de l'unité d'entraînement (103) de sorte que la vitesse de la cabine (104) approche zéro, lors d'une réception du signal de démarrage de l'ascenseur à partir de l'unité de commande d'ascenseur (2) ; et **caractérisé en ce qu'il** comprend en outre un commutateur de contrôle de frein (8) configuré pour détecter un état de contact entre le frein (102) et le corps rotatif, dans lequel l'unité de commande de couple (23) est configurée pour commander le couple de l'unité d'entraîne-

ment (103) de sorte que la vitesse de la cabine (104) approche zéro après détection de la séparation du frein (102) à partir du corps rotatif par le commutateur de contrôle de frein (8), jusqu'à réception d'une commande de déplacement de l'ascenseur. 5

2. Ascenseur selon la revendication 1, dans lequel dans le cas où le commutateur de contrôle de frein (8) détecte une séparation du frein (102) à partir du corps rotatif, l'unité de commande de frein (20) libère complètement le frein (102) à partir du corps rotatif. 10

3. Ascenseur selon la revendication 1, dans lequel l'unité de commande de frein (20) détermine un processus de commande de frein consistant à libérer progressivement le frein (102) à partir du corps rotatif sur la base d'informations stockées dans une base de données d'informations de type de l'unité de commande de frein (20). 15 20

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FIG. 1

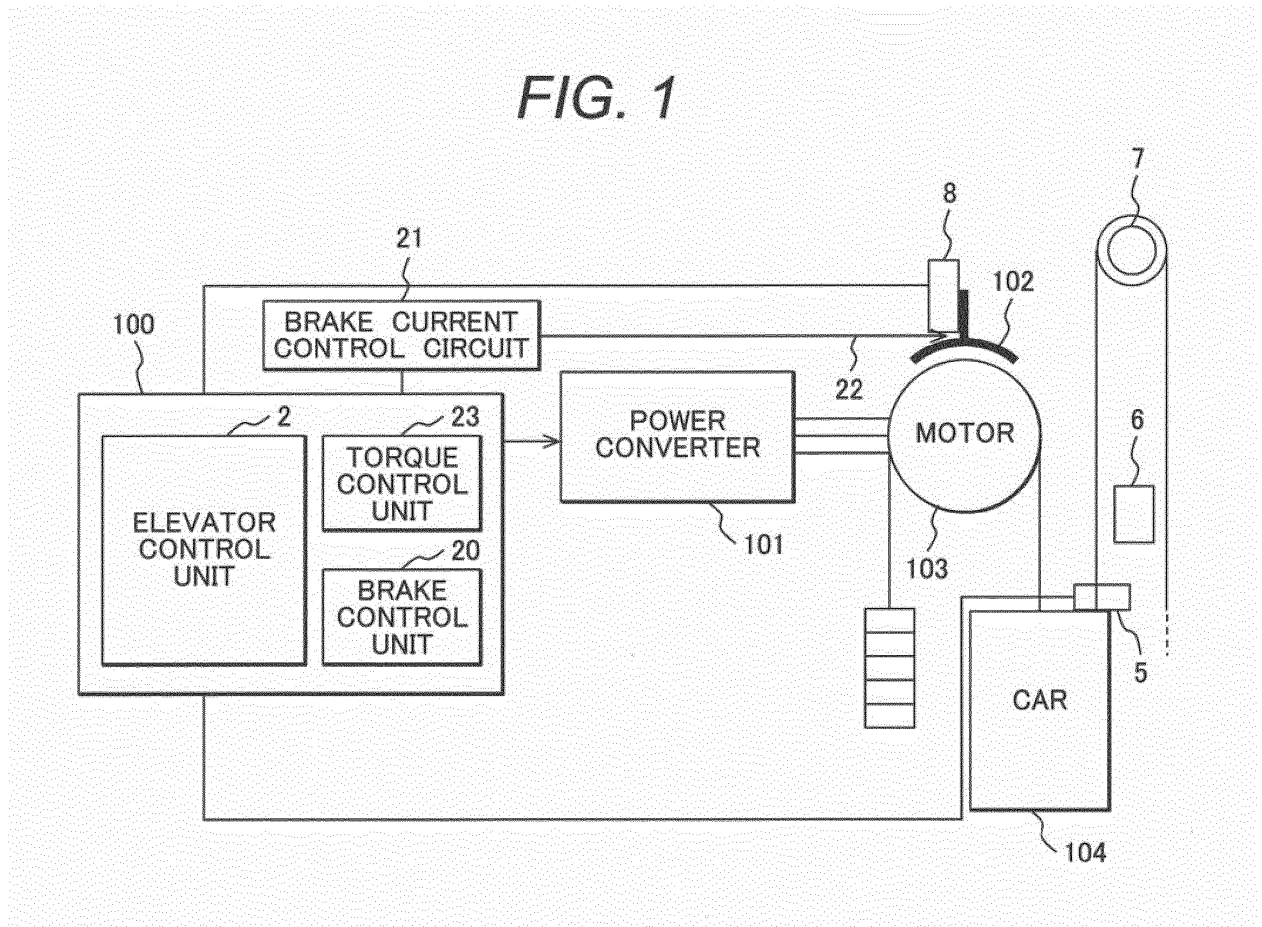


FIG. 2

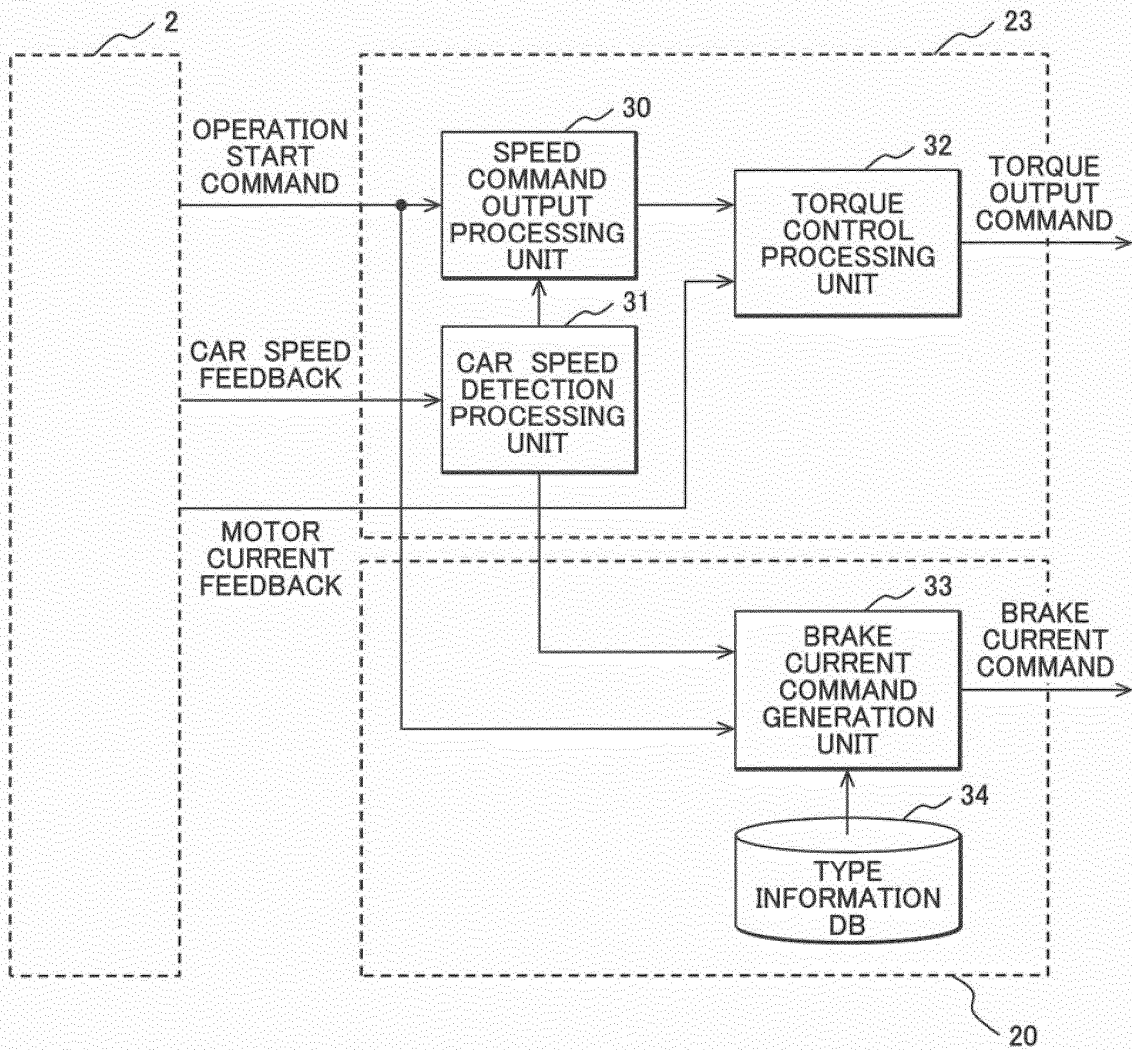


FIG. 3

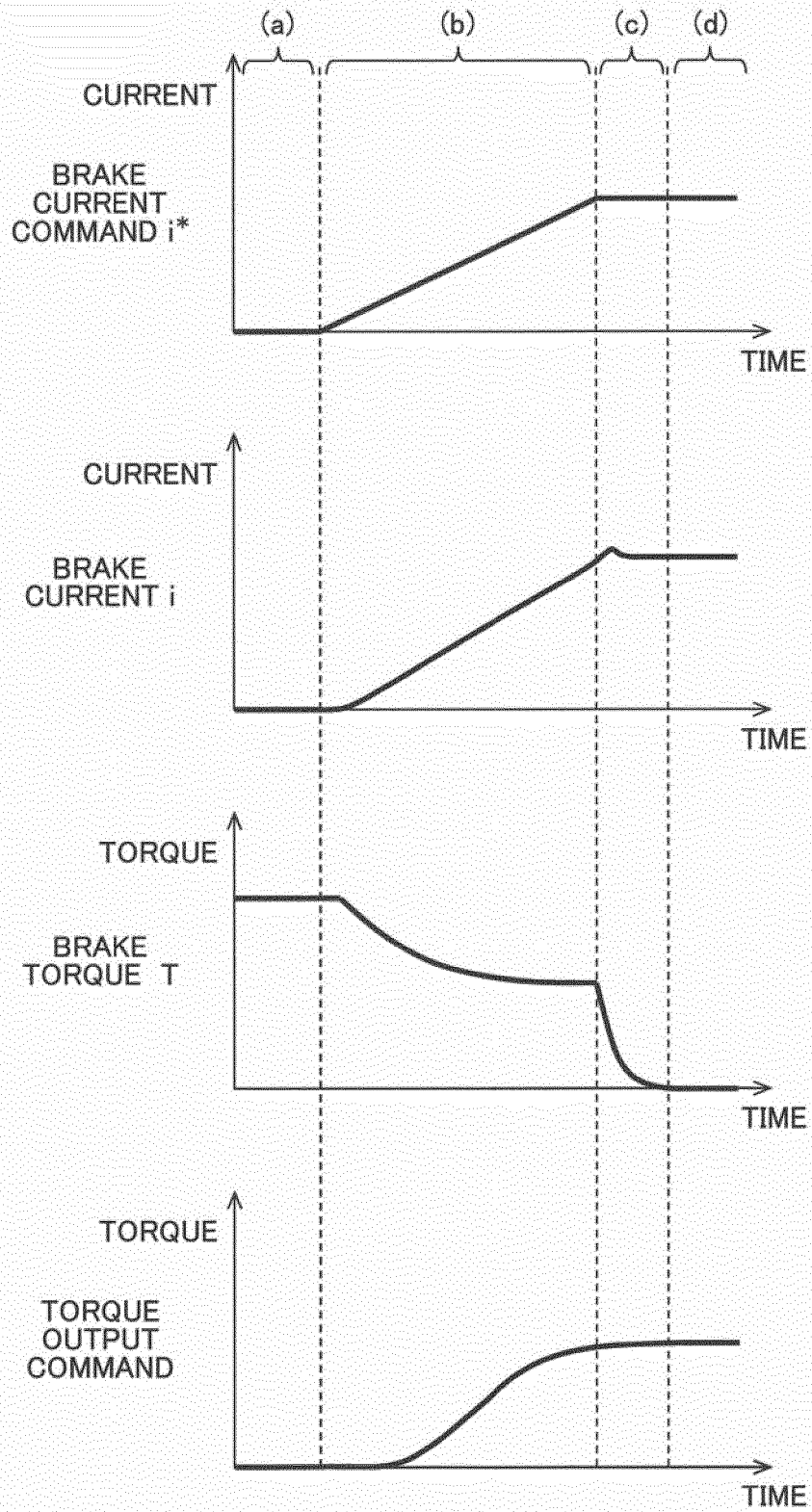
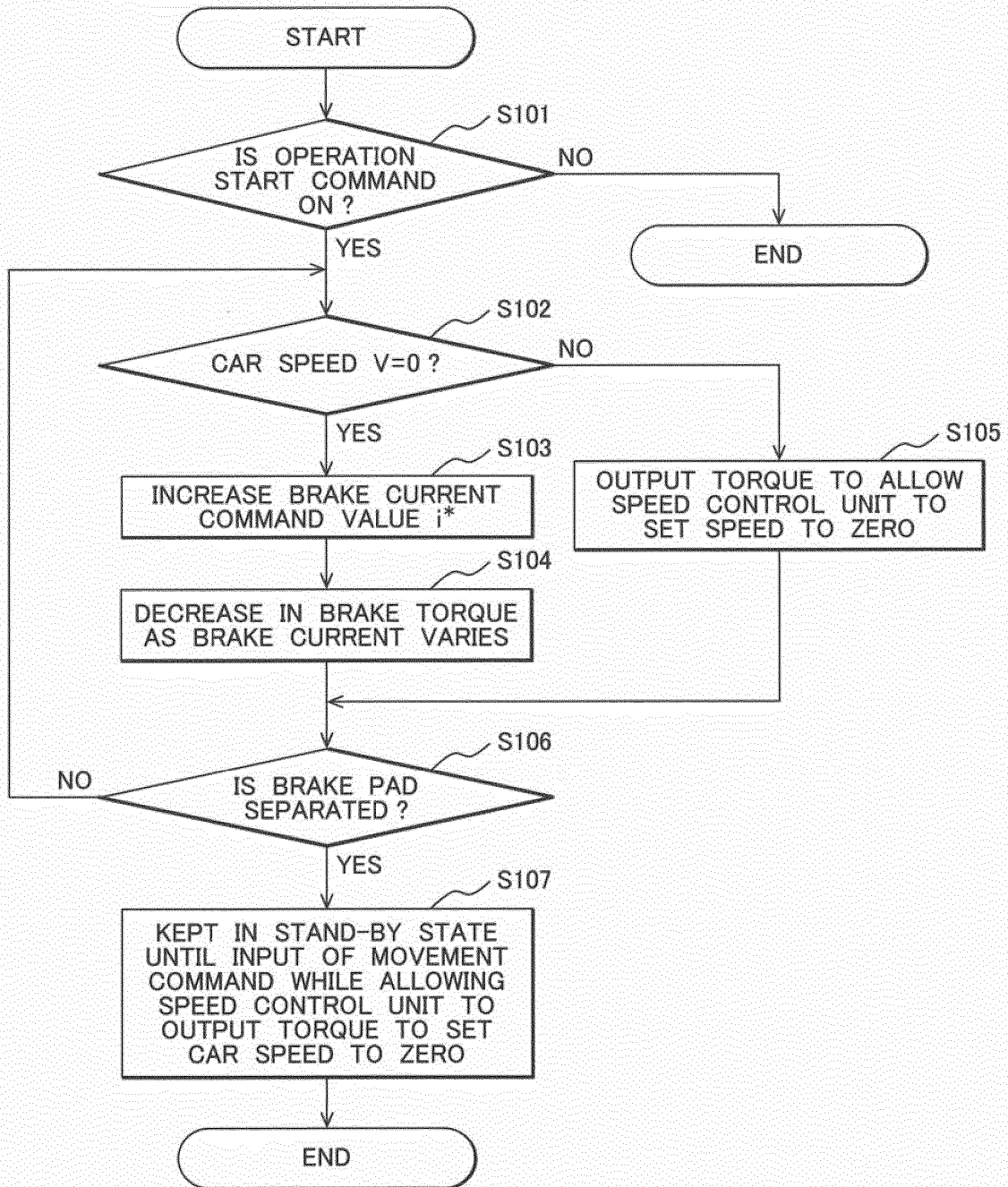


FIG. 4



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2015000796 A [0002]
- US 5247140 A [0003]
- CN 104671022 [0004]