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(54) CONTROL DEVICE FOR ELEVATOR

STEUERVORRICHTUNG FÜR AUFZUG

DISPOSITIF DE COMMANDE POUR ASCENSEUR

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Description

Technical Field

[0001] The present invention relates to an elevator control device having a plurality of sheaves and motors for driving the respective sheaves.

Background Art

[0002] A conventional elevator of this kind includes, for example, as shown in Patent Document 1, a main cable for linking a cage with a balance weight, a plurality of sheaves, which the main cable is wound around, a plurality of motors for respectively driving the sheaves, and a plurality of velocity control devices for controlling torques of the motors, respectively, and performs required operation modes in accordance with velocity command values to the velocity control devices. Additionally document JP-S-5922867 presents an elevator control system for two sheaves/two motors operating a single elevator cable. This system relies on speed feedback from the motors.

[0003] Patent Document 1: JP-A-55-106971

Disclosure of the Invention

Problems that the Invention is to Solve

[0004] In such an elevator control device, the velocity of the main cable is usually controlled to be even through the portions wound around respective sheaves. However, if a velocity difference is caused temporarily for some reasons, the tension between the both sheaves may be lowered to cause slack in the main cable, which causes "missing traction" in one of the sheaves to cause the sheave to make idle rotation, resulting in failure of elevator driving. Note here that "missing traction" denotes a condition in which the traction between the sheave and the main cable is reduced, for some reasons, to cause the main cable to slip and the sheave to make idle rotation.

[0005] The invention has been made for solving the problem as described above, and has an object of preventing the missing traction of sheaves in an elevator including a plurality of sheaves and motors for driving the respective sheaves, thereby enhancing safety of the elevator.

Means for Solving the Problem

[0006] An elevator control device according to the invention includes a main cable linking a cage with a balance weight, a plurality of sheaves around which the main cable is wound, a plurality of motors driving the respective sheaves, a plurality of velocity control devices controlling torque of the respective motors, an error detection device which compares torque command values of the velocity control devices and outputs an error signal based on assumption that missing traction arises in either of the sheaves in response to the difference exceeding a predetermined reference value, wherein, a necessary operation mode is performed in accordance with the velocity command value to the velocity control devices, and the velocity command value to the velocity control devices is changed in accordance with the operation mode at the time when the error detection device outputs the error signal. Advantage of the Invention

[0007] According to the invention, in an elevator including a plurality of sheaves and motors for driving the respective sheaves, idle rotation of a certain sheave caused by the missing traction can be detected. And, by making the elevator run with the lowered acceleration, constant speed, or deceleration in accordance with the running condition of the elevator, it becomes possible to make the elevator recover from the missing traction error and run, or to stop the elevator quickly before a secondary malfunction is caused if the elevator cannot recover from the missing traction error, thus a safer elevator control device can be provided.

Best Mode for Carrying Out the Invention

Embodiment 1

[0008] Hereinafter, an embodiment 1 of the invention will be explained with reference to Fig. 1. In Fig. 1, a cage 1 and a balance weight 2 are connected to each other with a main cable 3, which is wound around two sheaves 4a, 4b driven by respective hoisting motors 5a, 5b. When driving the elevator, a velocity command value for the elevator cage is provided from a velocity command generating device 7 to velocity control devices 6a, 6b of the respective hoisting motors 5a, 5b, and then each of the velocity control devices 6a, 6b gives the torque command value to respective one of the hoisting motors 5a, 5b so as to follow the velocity command value to control its output torque, and runs the elevator cage 1 by hoisting the main cable 3 by driving respective one of the sheaves 4a, 4b. An error detection device 8 compares the torque command values τa and τb with each other, which are the output signals of the respective velocity control devices 6a, 6b. And, if the difference between the two becomes equal to or greater than the reference value, the error detection device 8 determines the missing traction error, and outputs an error signal to the velocity command generating device 7 to cause the velocity command generating device 7 to change the velocity command value a and the velocity command value b in accordance with the operating mode of the elevator at that moment.

[0009] Fig. 2 shows a specific configuration of the error detection device 8, and Fig. 3 shows state of the signals in respective sections at the moment of the error detection. In Fig. 2, $|\tau a-\tau b|$ is calculated by an operation unit 81 from the torque command values τa, τb as the output signals of respective velocity control devices 6a, 6b and

is input to a comparator 82. In the present embodiment 1, since the diameters of the both sheaves 4a, 4b are arranged to be the same, $\tau a \approx \tau b$ is generally satisfied while the elevator runs normally.

[0010] Here, if the traction of the sheave 4b is missing (A in Fig. 3), for example, the sheave 4b makes idle rotation to cause the torque command value τb to be lowered. In sync therewith, since the motor 5a needs to output the necessary torque, the torque command value τa rises. Therefore, $|\tau a - \tau b|$ becomes to take a certain large value. Therefore, the comparator 82 compares $|\tau a - \tau b|$ with the predetermined reference value T, and outputs error judgment flag (B in Fig. 3) if the following is satisfied.

$$|\tau a - \tau b| > T$$

And, a latching circuit 83 is arranged to latch it as the error signal if the error judgment flag lasts for a certain period of time t1 (C in Fig. 3). Thus, the missing traction in the sheave 4b can be detected.

[0011] Note here that, although the certain period of time t_1 is provided to avoid false detection, real-time detection can also be performed with $t_1=0$. Further, although in the present embodiment, the diameters of the sheaves 4a, 4b are arranged to be the same, if the diameters of the sheaves 4a, 4b are Da and Db, respectively, different from each other, it is sufficient that the comparator 82 compares $|Da \times \tau a - Db \times \tau b|$ with the predetermined reference value T', and outputs error judgment flag if the following is satisfied.

$$|\ Da \times \tau a - Db \times \tau b\ | > T'$$

[0012] Fig. 4 is a flowchart for explaining the operation of the embodiment 1 of the invention. Firstly, whether or not the elevator is running is judged in the step 100, and if it is running, whether or not the missing traction error is detected is judged in the step 200. If the missing traction is detected, the operation mode is then judged. Whether or not it is accelerated is first judged in the step 300, if it is accelerated, it is made run with lowered acceleration in the step 301. If it is not accelerated, whether or not it is running with a constant speed is judged next in step 310. If it is running with a constant speed, it is made run with a lowered speed. If it is not running with a constant speed, it must be decelerated. Therefore, whether or not the enough distance for deceleration remains is judged in the step 320, and if the enough distance for deceleration remains, it is made run with lowered deceleration in the step 321. If the enough distance for deceleration does not remain, the elevator is stopped quickly in the step 700.

[0013] The acceleration, the constant speed, or the deceleration is lowered (slowdown) in the steps 301, 311, or 321, respectively, and then whether or not a constant time period t_2 has elapsed is judged in the step 400, and after the constant time period of t_2 has elapsed, whether or not the following is satisfied is judged in the step 500.

$$|\tau a - \tau b| > T$$

If the following is satisfied, it is assumed that it is recovered from the missing traction error in the step 600, and running is continued.

$$|\tau a - \tau b| \leq T$$

If the following condition is sill maintained, it is judged that it cannot be recovered from the missing traction error, and elevator is stopped quickly in the step 700.

$$|\tau a - \tau b| > T$$

[0014] Thus, if the missing traction error occurs, it is possible to make the elevator be recovered from the missing traction error by making it run with the lowered acceleration, constant speed, or deceleration, thereby running the elevator safely. Further, by stopping the elevator quickly in the case in which it cannot be recovered from the missing traction error, a secondary malfunction of the elevator can be prevented from being caused.

[0015] Note that the invention is not limited to the case with two sheave and motor sets, but can similarly be applied to the case with three or more sheave and motor sets.

Brief Description of the Drawings

[0016]

[Fig. 1]
Fig. 1 is an explanatory block diagram showing an elevator control device according to an embodiment 1 of the invention.
[Fig. 2]
Fig. 2 is a block diagram showing an error detection device in the embodiment 1.
[Fig. 3]
Fig. 3 is a chart showing state of the signals for explaining the operation of the error detection device in the embodiment 1.
[Fig. 4]
Fig. 4 is a flowchart for explaining the operation of the embodiment 1.

Description of Reference Numerals and Signs

[0017]

1: cage
2: balance weight
3: main cable
4a: sheave
4b: sheave
5a: motor
5b: motor
6a: velocity control device
6b: velocity control device
7: velocity command generating device
8: error detection device

Claims

1. An elevator control device comprising:

a main cable (3) linking a cage(1) with a balance weight(2);
a plurality of sheaves(4a,4b) around which the main cable(3) is wound;
a plurality of motors(5a,5b) driving the respective sheaves(4a,4b);
a plurality of velocity control devices(6a,6b) controlling torque of the respective motors(5a,5b); and **characterised by** an error detection device(8) which compares torque command values of the velocity control devices (6a, 6b) and outputs an error signal based on assumption that missing traction arises in either of the sheaves(4a,4b) in response to the difference exceeding a predetermined reference value,
wherein, a necessary operation mode is performed in accordance with the velocity command value to the velocity control devices(6a, 6b), and
the velocity command value to the velocity control devices (6a, 6b) is changed in accordance with the operation mode in response to the error detection device(8) outputting the error signal.

2. The elevator control device according to Claim 1, wherein the plurality of sheaves (4a, 4b) is composed of first and second sheaves (4a, 4b) respectively having diameters Da, Db different from each other, and the error detection device(8) output the error signal based on the following formula.

$$| Da \times \tau a - Db \times \tau b | > T'$$

where, τa: a torque command value from the velocity control device(6a) for the motor(5a) driving the first sheave(4a),
τb: a torque command value from the velocity control device(6b) for the motor(5b) driving the second sheave(4b),
T': a predetermined reference value.

3. The elevator control device according to one of Claims 1 and 2, wherein, the elevator is stopped quickly in response to the error detection device(8) outputting the error signal.

4. The elevator control device according to one of Claims 1 and 2, wherein, the elevator is running with a constant speed, and the speed of the elevator is lowered in response to the error detection device(8) outputting the error signal.

5. The elevator control device according to one of Claims 1 and 2, wherein, the elevator is one of accelerated and decelerated, and one of the acceleration and the deceleration of the elevator is lowered in response to the error detection device(8) outputting the error signal.

6. The elevator control device according to one of Claims 4 and 5, wherein, the torque command values of the velocity control devices (6a, 6b) are compared after lowering one of the speed, the acceleration, and the deceleration of the elevator, and the elevator is stopped quickly in response to the difference remaining higher than the reference value.

7. A method of controlling an elevator comprising:

providing a main cable (3) linking a cage(1) with a balance weight(2);
providing a plurality of sheaves (4a, 4b) around which the main cable(3) is wound;
providing a plurality of motors(5a,5b) driving the respective sheaves(4a,4b);
providing a plurality of velocity control devices (6a,6b) controlling torque of the respective motors(5a,5b);
performing a necessary operation mode in accordance with the velocity command value to the velocity control devices(6a,6b) **characterised by** comparing the torque command values of the velocity control devices(6a,6b); and
changing the velocity command value to the velocity control devices (6a, 6b) to perform one of stopping the elevator quickly, lowering the speed of the elevator, lowering the acceleration of the elevator, and lowering the deceleration of the elevator in accordance with the operation mode in response to the difference exceeding a predetermined value.

Patentansprüche

1. Aufzugsteuervorrichtung, umfassend:

ein Hauptseil (3), das eine Aufzugkabine (1) mit einem Gegengewicht (2) verbindet;
eine Vielzahl von Seilrollen (4a, 4b), um welche das Hauptkabel (3) gewunden ist;
eine Vielzahl von Motoren (5a, 5b), welche die jeweiligen Seilrollen (4a, 4b) antreiben;
eine Vielzahl von Geschwindigkeits-Steuervorrichtungen (6a, 6b), die ein Drehmoment der jeweiligen Motoren (5a, 5b) steuern; und
gekennzeichnet durch
eine Fehlerdetektionsvorrichtung (8), die Drehmoment-Befehlswerte der Geschwindigkeits-Steuervorrichtungen (6a, 6b) und Ausgaben eines Fehlersignals vergleicht, basierend auf der Annahme, dass eine fehlende Traktion in einer der Seilrollen (4a, 4b) auftritt, in Reaktion darauf, dass die Differenz einen vorbestimmten Referenzwert übersteigt,
wobei ein notwendiger Betriebsmodus in Übereinstimmung mit dem Geschwindigkeits-Befehlswert an die Geschwindigkeits-Steuervorrichtungen (6a, 6b) durchgeführt wird, und
der Geschwindigkeits-Befehlswert an die Geschwindigkeits-Steuervorrichtungen (6a, 6b) in Übereinstimmung mit dem Betriebsmodus in Reaktion auf die das Fehlersignal ausgebende Fehlerdetektionsvorrichtung (8) verändert wird.

2. Aufzugsteuervorrichtung gemäß Anspruch 1, wobei die Vielzahl von Seilrollen (4a, 4b) aus ersten und zweiten Seilrollen (4a, 4b) aufgebaut ist, die Durchmesser Da bzw. Db aufweisen, die sich voneinander unterscheiden, und die Fehlerdetektionsvorrichtung (8) das Fehlersignal basierend auf der folgenden Formel ausgibt

$$| Da \times \tau a - Db \times \tau b | > T'$$

wobei τa: ein Drehmomentbefehlswert aus der Geschwindigkeits-Steuervorrichtung (6a) für den die erste Seilrolle (4a) antreibenden Motor (5a),
τb: ein Drehmomentbefehlswert aus der Geschwindigkeits-Steuervorrichtung (6b) für den die zweite Seilrolle (4b) antreibenden Motor (5b),
T': ein vorbestimmter Referenzwert.

3. Aufzugsteuervorrichtung gemäß einem der Ansprüche 1 und 2, wobei der Aufzug rasch in Reaktion darauf gestoppt wird, dass die Fehlerdetektionsvorrichtung (8) das Fehlersignal ausgibt.

4. Aufzugsteuervorrichtung gemäß einem der Ansprüche 1 und 2, wobei der Aufzug bei einer konstanten Geschwindigkeit fährt und die Geschwindigkeit des Aufzugs in Reaktion darauf gesenkt wird, dass die Fehlerdetektionsvorrichtung (8) das Fehlersignal ausgibt.

5. Aufzugsteuervorrichtung gemäß einem der Ansprüche 1 und 2, wobei der Aufzug entweder beschleunigt oder verlangsamt wird, und entweder die Beschleunigung oder die Verlangsamung des Aufzugs in Reaktion darauf gesenkt wird, dass die Fehlerdetektionsvorrichtung (8) das Fehlersignal ausgibt.

6. Aufzugsteuervorrichtung gemäß einem der Ansprüche 4 und 5, wobei die Drehmomentbefehlswerte der Geschwindigkeits-Steuervorrichtungen (6a, 6b) verglichen werden nach Senken der Geschwindigkeit, der Beschleunigung oder der Verlangsamung des Aufzugs, und der Aufzug rasch in Reaktion darauf gestoppt wird, dass die Differenz höher als der Referenzwert bleibt.

7. Verfahren des Steuerns eines Aufzugs, umfassend:

Bereitstellen eines Hauptseils (3), das einen Käfig (1) mit einem Gegengewicht (2) verbindet;
Bereitstellen einer Vielzahl von Seilrollen (4a, 4b), um welche das Hauptkabel (3) gewunden ist;
Bereitstellen einer Vielzahl von Motoren (5a, 5b), welche die jeweiligen Seilrollen (4a, 4b) antreiben;
Bereitstellen einer Vielzahl von Geschwindigkeits-Steuervorrichtungen (6a, 6b), die ein Drehmoment der jeweiligen Motoren (5a, 5b) steuern;
Durchführen eines notwendigen Betriebsmodus in Übereinstimmung mit dem Geschwindigkeits-Befehlswert an die Geschwindigkeits-Steuervorrichtungen (6a, 6b), **gekennzeichnet durch**
Vergleichen der Drehmoment-Befehlswerte der Geschwindigkeits-Steuervorrichtungen (6a, 6b); und
Ändern des Geschwindigkeits-Befehlswerts an die Geschwindigkeits-Steuervorrichtungen (6a, 6b), um ein rasches Stoppen des Aufzugs, Senken der Geschwindigkeit des Aufzugs, Senken der Beschleunigung des Aufzugs oder Senken der Verlangsamung des Aufzugs in Übereinstimmung mit dem Betriebsmodus in Reaktion darauf durchzuführen, dass die Differenz einen vorbestimmten Wert übersteigt.

Revendications

1. Dispositif de commande d'ascenseur comprenant :

un câble principal (3) reliant une cabine (1) à un contrepoids (2) ;

une pluralité de poulies (4a, 4b) autour desquelles le câble principal (3) est enroulé ;
une pluralité de moteurs (5a, 5b) entraînant les poulies respectives (4a, 4b);
une pluralité de dispositifs de commande de vitesse (6a, 6b) commandant le couple des moteurs respectifs (5a, 5b) ; et
caractérisé par
un dispositif de détection d'erreur (8) qui compare des valeurs de commande de couple des dispositifs de commande de vitesse (6a, 6b) et émet un signal d'erreur basé sur l'hypothèse qu'un manque de traction survient dans l'une quelconque des poulies (4a, 4b) en réponse à la différence dépassant une valeur de référence prédéterminée,
dans lequel, un mode de fonctionnement nécessaire est effectué en fonction de la valeur de commande de vitesse pour les dispositifs de commande de vitesse (6a, 6b) ; et
la valeur de commande de vitesse pour les dispositifs de commande de vitesse (6a, 6b) est modifiée selon le mode de fonctionnement en réponse au dispositif de détection d'erreur (8) délivrant le signal d'erreur.

2. Dispositif de commande d'ascenseur selon la revendication 1, dans lequel la pluralité de poulies (4a, 4b) est composée de première et seconde poulies (4a, 4b) ayant respectivement des diamètres Da, Db différents l'un de l'autre, et le dispositif de détection d'erreur (8) émet le signal d'erreur sur la base de la formule suivante :

$$| Da \times \tau a - Db \times \tau b | > T'$$

où, τa : une valeur de commande de couple provenant du dispositif de commande de vitesse (6a) pour le moteur (5a) entraînant la première poulie (4a),
τb : une valeur de commande de couple provenant du dispositif de commande de vitesse (6b) pour le moteur (5b) entraînant la seconde poulie (4b),
T' : une valeur de référence prédéterminée.

3. Dispositif de commande d'ascenseur selon l'une des revendications 1 et 2, dans lequel l'ascenseur est arrêté rapidement en réponse au dispositif de détection d'erreur (8) émettant le signal d'erreur.

4. Dispositif de commande d'ascenseur selon l'une des revendications 1 et 2, dans lequel l'ascenseur fonctionne avec une vitesse constante, et la vitesse de l'ascenseur est abaissée en réponse au dispositif de détection d'erreur (8) émettant le signal d'erreur.

5. Dispositif de commande d'ascenseur selon l'une quelconque des revendications 1 et 2, dans lequel l'ascenseur est accéléré ou décéléré, et l'une de l'accélération et la décélération de l'ascenseur est abaissée en réponse au dispositif de détection d'erreur (8) émettant le signal d'erreur.

6. Dispositif de commande d'ascenseur selon l'une des revendications 4 et 5, dans lequel les valeurs de commande de couple des dispositifs de commande de vitesse (6a, 6b) sont comparées après avoir abaissé l'une de la vitesse, l'accélération et la décélération de l'ascenseur, et l'ascenseur est arrêté rapidement en réponse à la différence restant supérieure à la valeur de référence.

7. Procédé de commande d'un ascenseur comprenant les étapes consistant à :

fournir un câble principal (3) reliant une cabine (1) à un contrepoids (2) ;
fournir une pluralité de poulies (4a, 4b) autour desquelles le câble principal (3) est enroulé ;
fournir une pluralité de moteurs (5a, 5b) entraînant les poulies respectives (4a, 4b) ;
fournir une pluralité de dispositifs de commande de vitesse (6a, 6b) commandant le couple des moteurs respectifs (5a, 5b) ;
effectuer un mode de fonctionnement nécessaire en fonction de la valeur de commande de vitesse pour les dispositifs de commande de vitesse (6a, 6b), **caractérisé par** les étapes consistant à :

comparer les valeurs de commande de couple des dispositifs de commande de vitesse (6a, 6b) ; et
changer la valeur de commande de vitesse pour les dispositifs de commande de vitesse (6a, 6b) pour effectuer l'un d'un arrêt de l'ascenseur rapidement, d'un abaissement de la vitesse de l'ascenseur, d'un abaissement de l'accélération de l'ascenseur et d'un abaissement de la décélération de l'ascenseur selon le mode de fonctionnement en réponse à la différence dépassant une valeur prédéterminée.

FIG. 1

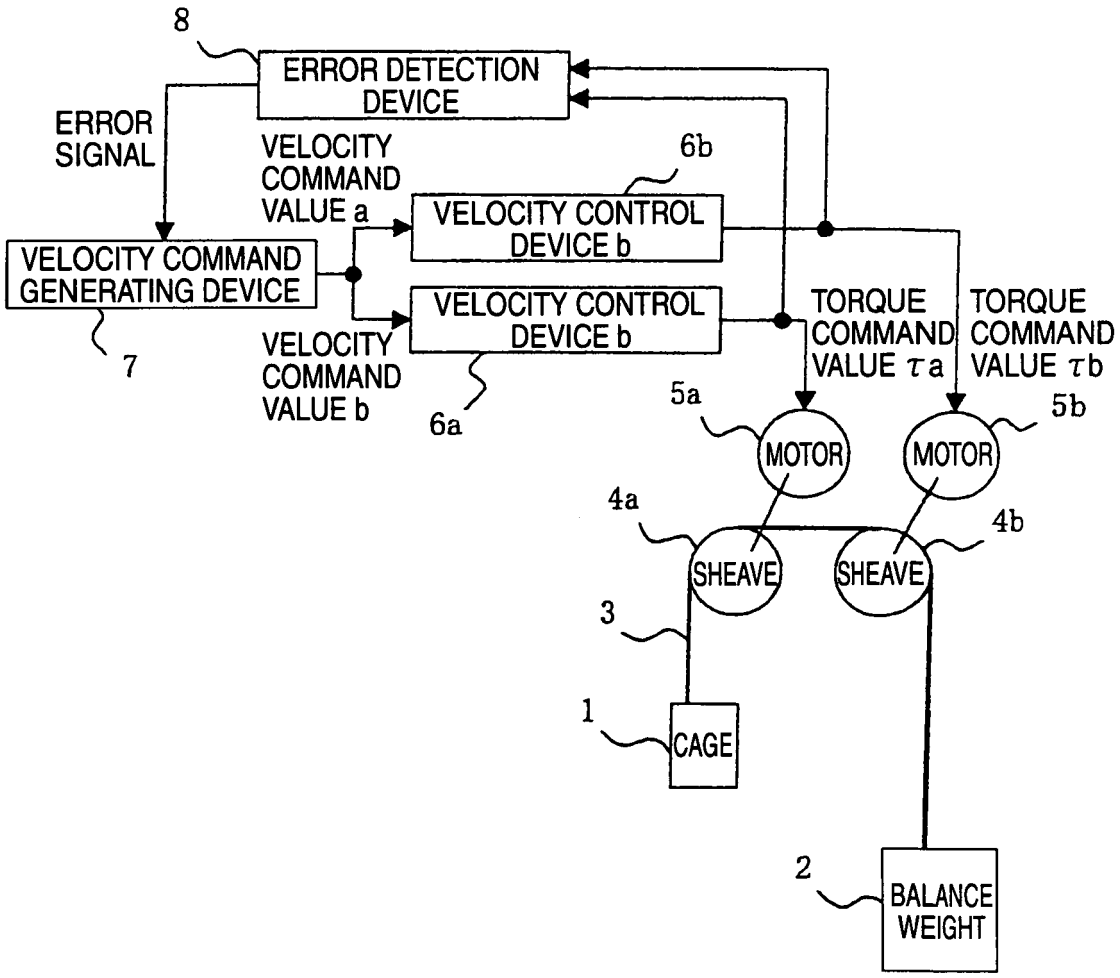

8
ERROR DETECTION DEVICE
ERROR SIGNAL
VELOCITY COMMAND VALUE a
6b
VELOCITY CONTROL DEVICE b
VELOCITY COMMAND GENERATING DEVICE
7
VELOCITY CONTROL DEVICE b
VELOCITY COMMAND VALUE b
6a
TORQUE COMMAND VALUE τa
TORQUE COMMAND VALUE τb
5a
5b
MOTOR
MOTOR
4a
4b
SHEAVE
SHEAVE
3
1
CAGE
2
BALANCE WEIGHT

FIG. 2

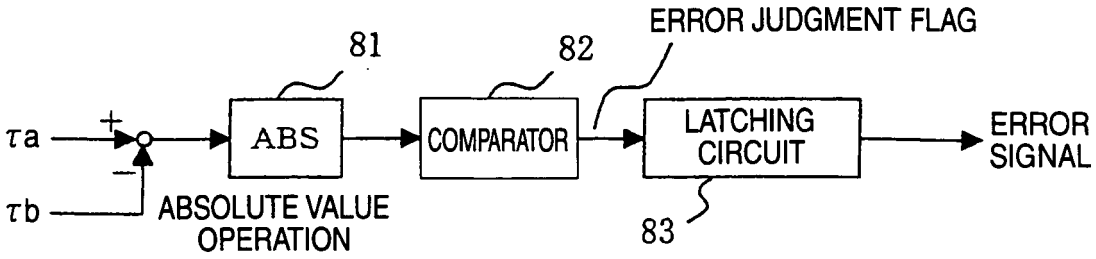

ERROR JUDGMENT FLAG
81
82
τa
+
ABS
COMPARATOR
LATCHING CIRCUIT
ERROR SIGNAL
τb
−
ABSOLUTE VALUE OPERATION
83

FIG. 3

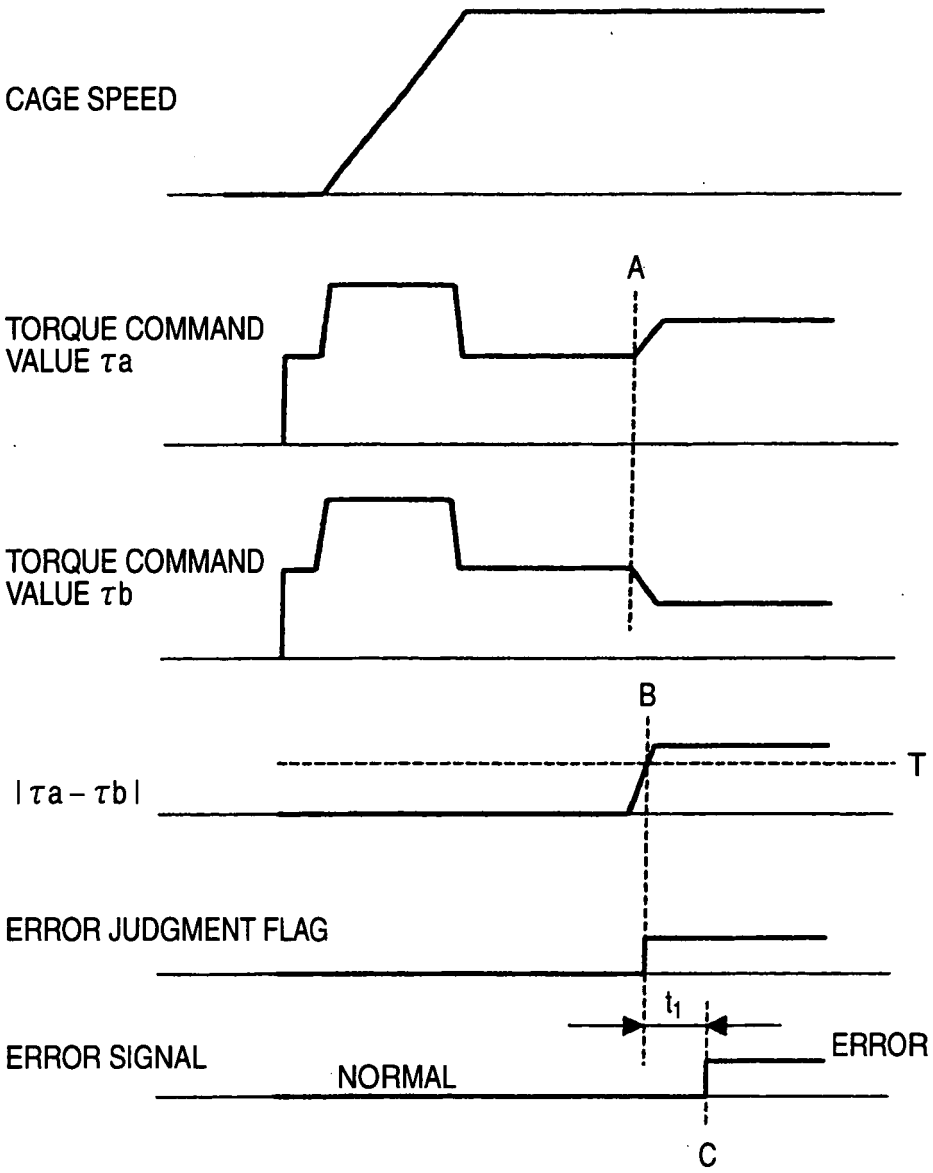
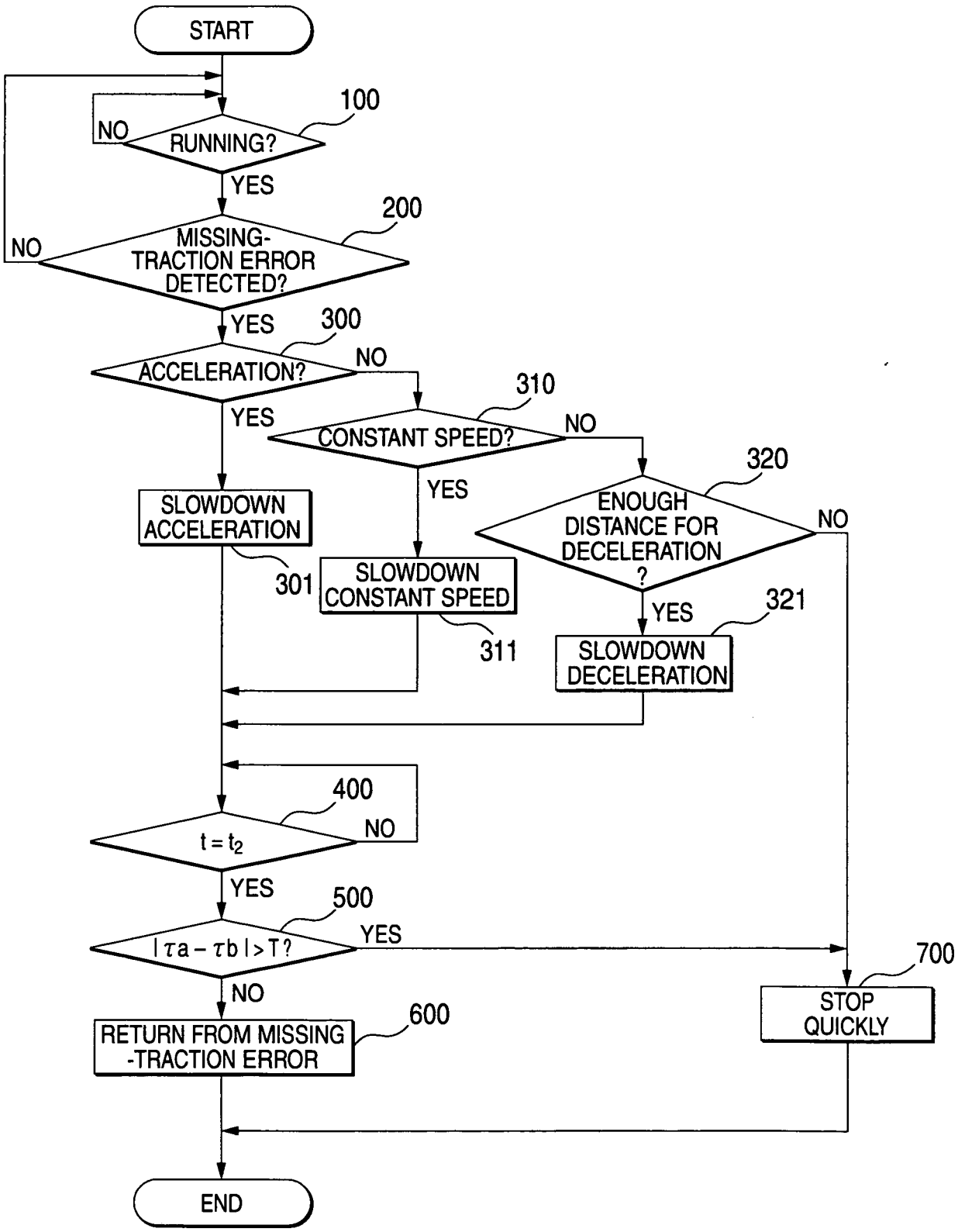

CAGE SPEED
A
TORQUE COMMAND VALUE τa
TORQUE COMMAND VALUE τb
B
T
|τa – τb|
ERROR JUDGMENT FLAG
t1
ERROR SIGNAL
NORMAL
ERROR
C

FIG. 4


START
100
RUNNING?
NO
YES
200
MISSING-TRACTION ERROR DETECTED?
NO
YES
300
ACCELERATION?
NO
YES
310
CONSTANT SPEED?
NO
YES
320
ENOUGH DISTANCE FOR DECELERATION ?
NO
YES
SLOWDOWN ACCELERATION
301
SLOWDOWN CONSTANT SPEED
311
321
SLOWDOWN DECELERATION
400
t = t2
NO
YES
500
|τa − τb| > T?
YES
NO
700
STOP QUICKLY
RETURN FROM MISSING -TRACTION ERROR
600
END

REFERENCES CITED IN THE DESCRIPTION

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- JP 5922867 B **[0002]**
- JP 55106971 A **[0003]**