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(54) **CONTROL DEVICE FOR ELEVATOR**

(57) The missing traction of sheaves is prevented in an elevator including a plurality of sheaves and motors for driving the respective sheaves.

An elevator control device 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 out-

puts 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.

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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.

[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.

ation 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 τ_a and τ_b 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 τ_a , τ_b 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 τ_b to be lowered. In sync therewith, since the motor 5a needs to output the necessary torque, the torque command value τ_a 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 t_1 (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 D_a and D_b , respectively, different from each other, it is sufficient that the comparator 82 compares $|D_a \times \tau_a - D_b \times \tau_b|$ with the predetermined reference value T' , and outputs error judgment flag if the following is satisfied.

$$|D_a \times \tau_a - D_b \times \tau_b| > T'$$

[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 still 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

T': a predetermined reference value.

[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 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; and
 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 in response to the error detection device outputting the error signal.

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

$$|D_a \times \tau_a - D_b \times \tau_b| > T'$$

where, τ_a : a torque command value from the velocity control device for the motor driving the first sheave,
 τ_b : a torque command value from the velocity control device for the motor driving the second sheave,

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 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 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 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 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 linking a cage with a balance weight;
 providing a plurality of sheaves around which the main cable is wound;
 providing a plurality of motors driving the respective sheaves;
 providing a plurality of velocity control devices controlling torque of the respective motors;
 performing a necessary operation mode in accordance with the velocity command value to the velocity control devices;
 comparing the torque command values of the velocity control devices; and
 changing the velocity command value to the velocity control devices 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.

FIG. 1

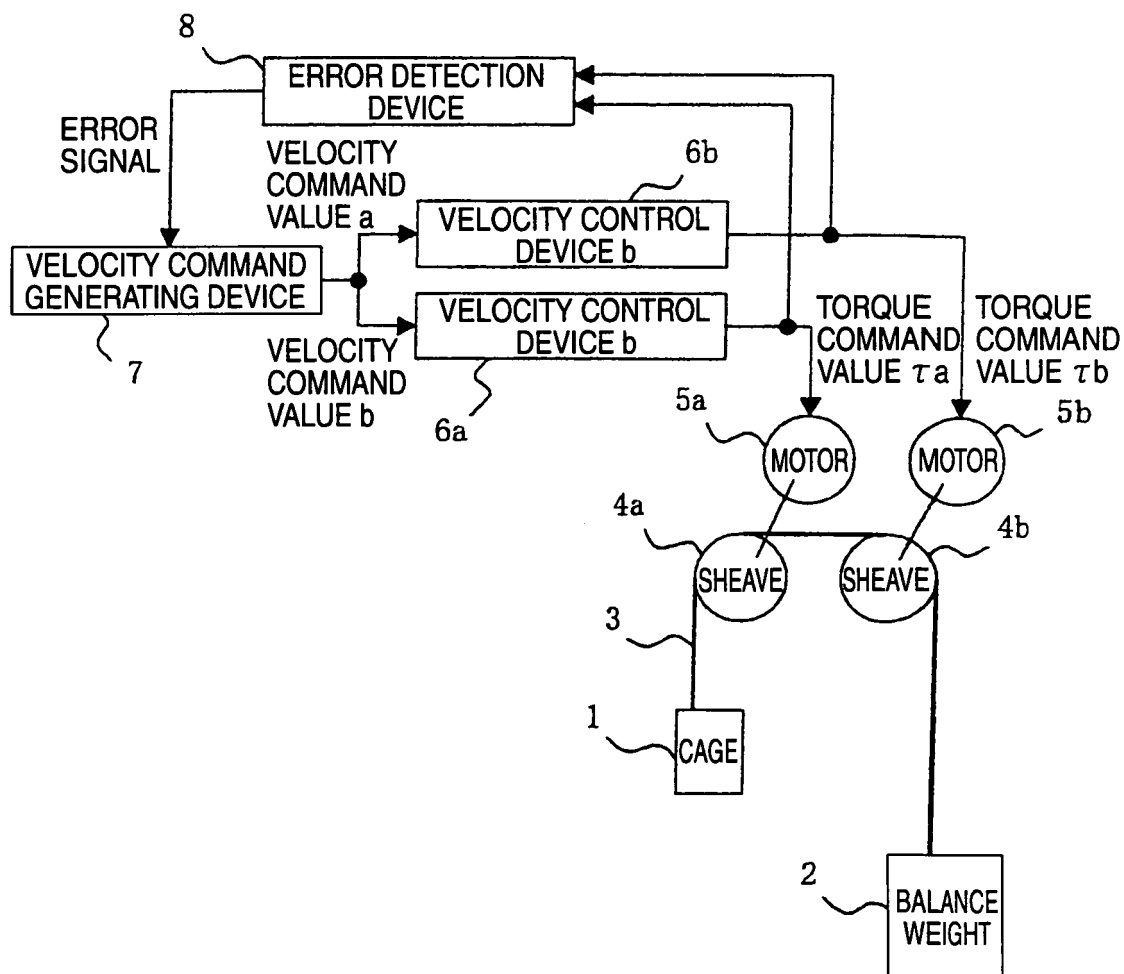


FIG. 2

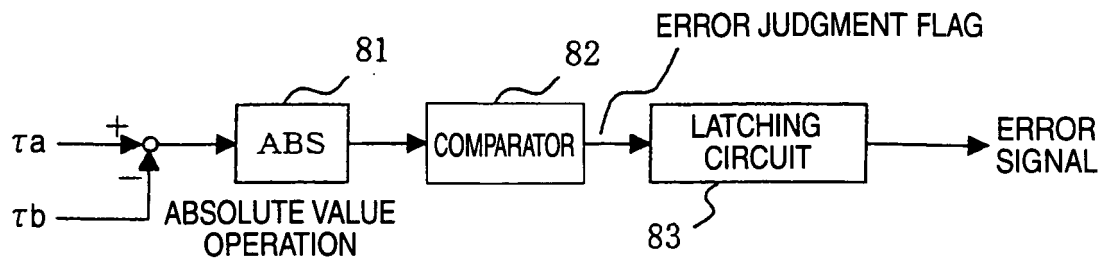


FIG. 3

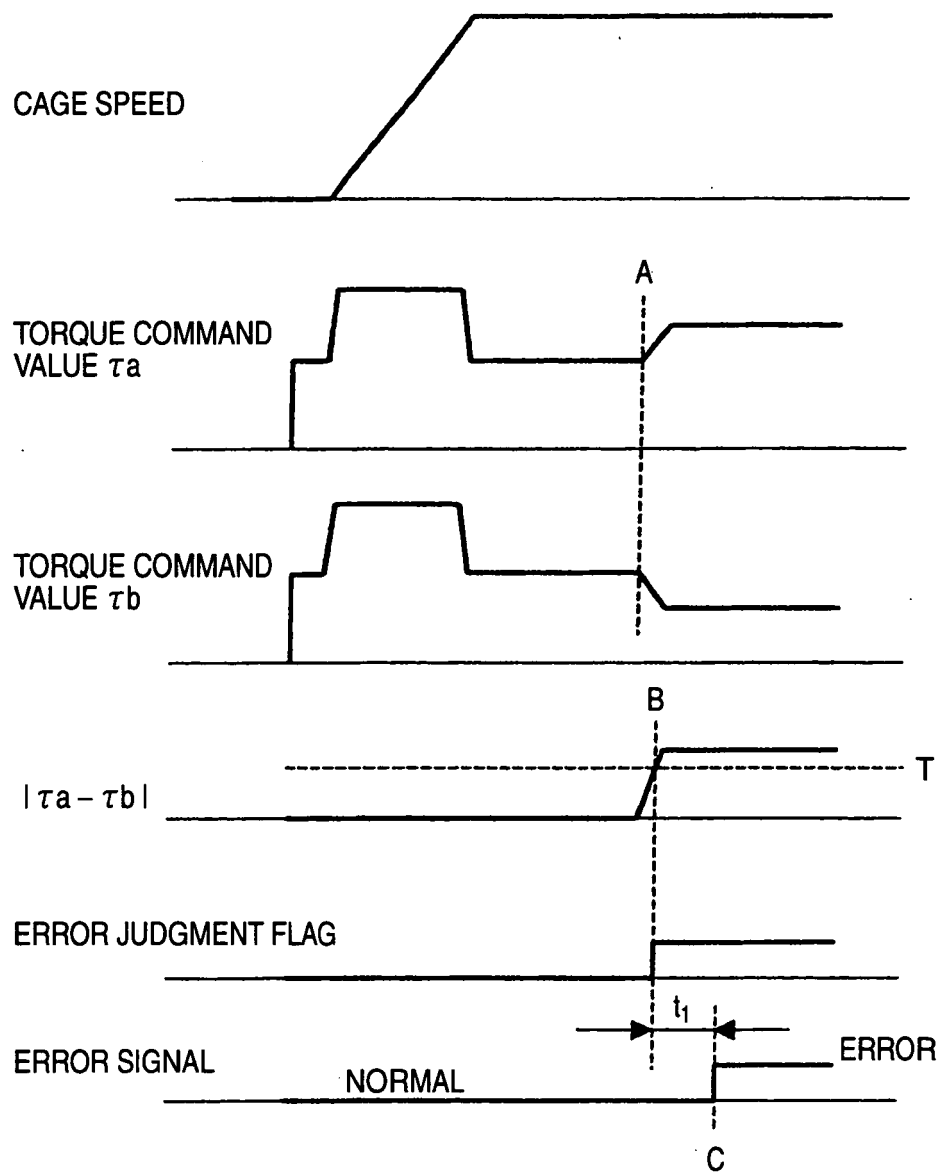
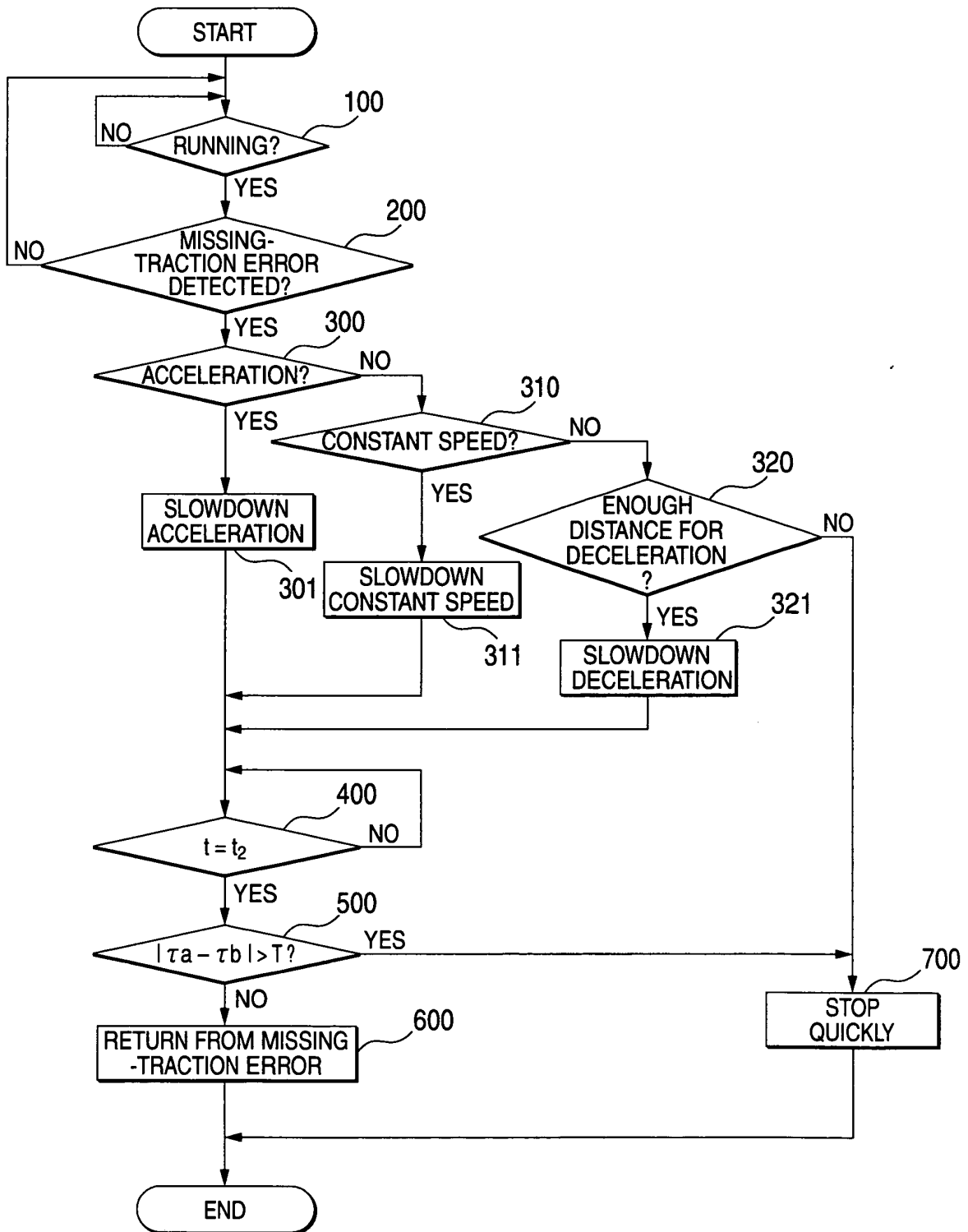


FIG. 4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/008624

A. CLASSIFICATION OF SUBJECT MATTER B66B1/30 (2006.01), B66B5/02 (2006.01)		
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) B66B1/00 (2006.01) - B66B11/08 (2006.01)		
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 1996-2006 Kokai Jitsuyo Shinan Koho 1971-2006 Toroku Jitsuyo Shinan Koho 1994-2006		
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.
Y A	JP 59-22867 A (Mitsubishi Electric Corp.), 06 February, 1984 (06.02.84), Claims 1, 3; page 2, upper left column, line 9 to lower right column, line 15 (Family: none)	1-3 4-7
Y A	JP 3-67882 A (Mitsubishi Electric Corp.), 22 March, 1991 (22.03.91), Claims 1 to 2; page 4, upper right column, lines 5 to 15 (Family: none)	1-3 4-7
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 10 February, 2006 (10.02.06)		Date of mailing of the international search report 21 February, 2006 (21.02.06)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/008624

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 2119/1989 (Laid-open No. 94875/1990) (Hitachi, Ltd.), 27 July, 1990 (27.07.90), Description, page 1, line 11 to page 2, line 17 (Family: none)	3
A	WO 03/093156 A1 (Mitsubishi Electric Corp.), 13 November, 2003 (13.11.03), Page 5, lines 20 to 30 & CN 1522220 A & EP 1500621 A1	4-5
A	JP 2001-316055 A (Toshiba Corp.), 13 November, 2001 (13.11.01), Abstract (Family: none)	6
A	JP 9-2752 A (Kabushiki Kaisha Hitachi Biru Shisutemu Sabisu), 07 January, 1997 (07.01.97), Abstract (Family: none)	7

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 55106971 A [0003]