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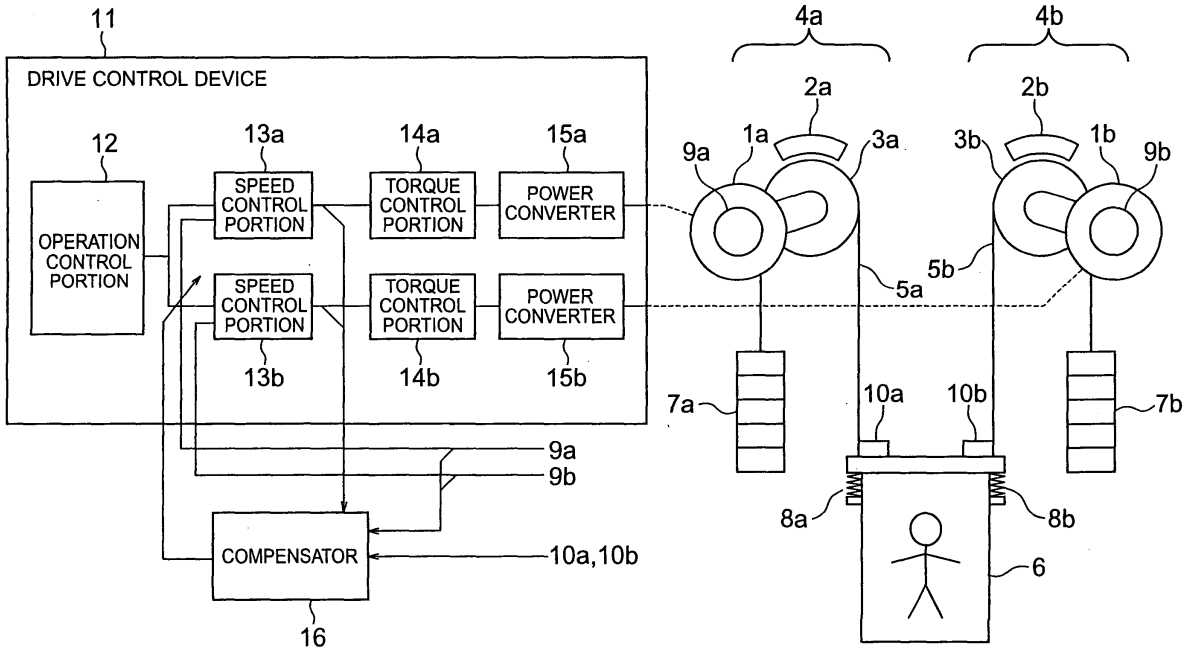
(54) CONTROL SYSTEM FOR ELEVATOR

(57) Provided is a control system for an elevator, capable of performing speed control while balancing rope tension applied to two hoists. The control system for an elevator two hoisting machines; two ropes looped around the two hoisting machines respectively; a car engaged with each of the two ropes at one end thereof; counterweights engaged with each of the two ropes at the other end thereof; a drive control device for driving the two hoisting machines; tension detectors for detecting respective rope tensions of the two ropes; and a compensator for outputting a feedback control signal to the drive control device in accordance with a difference between the tensions of the two ropes detected by the tension detectors to control rotational speeds of the hoisting machines with a view to balancing the rope tensions with each other.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to a control system for an elevator which employs two (or more) hoisting machines for driving a single car.

Background Art

[0002] In a machine room-less elevator or the like, a hoisting machine is installed between a moving space of a car and a wall of a hoistway, so there has been demanded a reduction in size of the hoisting machine. For example, some elevators have a hoisting machine disposed in a pit in a lower portion of a hoistway, or a hoisting machine disposed in a gap between a lateral wall of the hoistway and the car.

[0003] In a large-capacity elevator, however, a motor having a large output is required. Therefore, there is a limit of the reduction in the size of the hoisting machine, so there is a problem in that the dimension of the hoistway is increased to install the hoisting machine. There has been thus proposed an elevator employing two hoisting machines for driving the car and allowing the hoisting machines to be installed in a space between the moving space of the car and the wall of a hoistway with a reduction in the torque required of each of the hoisting machines.

[0004] In hoisting ropes to drive a car in such the elevator, the rope tensions applied to two hoisting machines need to be equalized with each other. This object is not achieved by simply performing speed control of the two hoisting machines.

[0005] That is, according to a control system for such the elevator, two drive control systems each composed of a hoisting machine and a drive device are arranged, and each hoisting machine is controlled such that a rotational speed thereof follows a speed command from an operation control portion, based on the speed command (e.g., see Patent Document 1).

[0006] In the foregoing conventional control system for the elevator, however, while the car is usually drivingly controlled with the tensions of the two ropes balanced with each other, the tension of the faster one of the ropes increases in raising the car if there is created a difference between the speeds of the ropes due to abrasion of grooves in sheaves or a difference between the effective diameters of the sheaves. On the contrary, the tension of the slower one of the ropes increases in lowering the car. When there is created a difference between the tensions of the ropes as described above, an adverse effect on equipment results from a strain on the car, an excessive load applied to rails, or the like, in addition to a deterioration in riding comfort. There is also a problem in that a deterioration in driving ability occurs because of the fact that one of motors is more heavily loaded than the other.

Patent Document 1: JP 07-42063 B

Disclosure of the Invention

Problem to be solved by the Invention

[0007] The present invention has been made to solve the problems regarding the foregoing conventional examples, and it is therefore an object of the invention to obtain a control system for an elevator which employs two (or more) hoisting machines to drive a single car and enables speed control while balancing rope tensions applied to the two hoisting machines with each other.

Means for solving the Problems

[0008] According to the present invention, a control system for an elevator is characterized in that the control system includes: two hoisting machines; two ropes looped around the two hoisting machines respectively; a car engaged with each of the two ropes at one end thereof; counterweights engaged with each of the two ropes at the other end thereof; a drive control device for driving the two hoisting machines; tension detectors for detecting respective rope tensions of the two ropes; and a compensator for outputting a feedback control signal to the drive control device in accordance with a difference between the tensions of the two ropes detected by the tension detectors to control rotational speeds of the hoisting machines with a view to balancing the rope tensions with each other.

Effect of the Invention

[0009] In a control system for an elevator which employs two hoisting machines to drive a single car, the present invention makes it possible to perform speed control while balancing rope tensions applied to the two hoisting machines with each other.

Brief Description of the Drawings

[0010]

Fig. 1 is a block diagram showing an entire configuration of a control system for an elevator according to the present invention.
Fig. 2 is a block diagram showing an internal configuration of a compensator shown in Fig. 1.

Best Mode for carrying out the Invention

[0011] The present invention will be described hereinafter based on an illustrated embodiment thereof.

Embodiment 1

[0012] Fig. 1 is a block diagram showing a configura-

tion of a control system for an elevator according to a first embodiment of the present invention. As shown in Fig. 1, the control system for the elevator according to the present invention is equipped with two hoisting machines 4a and 4b, which are composed of hoisting motors 1a and 1b, brakes 2a and 2b, and sheaves 3a and 3b, respectively. Ropes 5a and 5b are looped around the sheaves 3a and 3b, respectively. Each of the ropes 5a and 5b is engaged at one end thereof with a car 6 via each of springs 8a and 8b, and connected at the other end thereof to each of counterweights 7a and 7b. Rotational speeds of the hoisting machines 4a and 4b are detected by speed detectors 9a and 9b respectively. Tensions of the ropes 5a and 5b are detected by load detectors 10a and 10b respectively.

[0013] The load detectors 10a and 10b each function as a weighing device for detecting a load within the car through measurement of an amount of displacement of a spring, which expands/contracts in response to an increase/decrease in load when a passenger gets on/off the car 6. In principle, the amount of displacement of the spring is proportional to a rope tension, so the load detectors 10a and 10b each measure a rope tension and therefore function as tension detectors as well.

[0014] The hoisting motors 1a and 1b are drivingly controlled by a drive control device 11. This drive control device 11 is composed of an operation control portion 12, speed control portions 13a and 13b, torque control portions 14a and 14b, and power converters 15a and 15b. The operation control portion 12 determines a traveling pattern of the car 6, and issues a speed command. The speed control portions 13a and 13b compare the speed command from the operation control portion 12 with speed values detected by the speed detectors 9a and 9b respectively, calculate torques to be output by the two hoisting motors 1a and 1b respectively, and issue torque commands. The torque control portions 14a and 14b issue commands to control the torques generated by the hoisting motors 1a and 1b in accordance with the torque commands from the speed control portions 13a and 13b respectively. The power converters 15a and 15b control the powers supplied to the hoisting motors 1a and 1b in accordance with the commands from the torque control portions 14a and 14b respectively.

[0015] In addition, the control system for the elevator according to the present invention is equipped with a compensator 16, which outputs a feedback control signal to the drive control device 11 in accordance with a difference between the tensions of the two ropes detected by the load detectors 10a and 10b serving as tension detectors, and controls the rotational speeds of the hoisting motors 1a and 1b to balance the tensions of the ropes with each other. The compensator 16 outputs a feedback control signal to the drive control device 11 to control the rotational speed of at least one of the hoisting machines only when the difference between the tensions of the two ropes detected by the load detectors 10a and 10b serving as the tension detectors has exceeded a predetermined value. The compensator 16 operates to reduce the speed of that one of the hoisting motors which rotates faster due to the difference between the tensions of the ropes, and equalize this speed with the speed of the slower one of the hoisting motors.

[0016] Fig. 2 is a block diagram showing an internal configuration of the compensator 16. As shown in Fig. 2, this compensator 16 compensates for a gain K 17 for the speed commands issued to a speed control portion 13 (a generic designation of the speed control portions 13a and 13b) from the operation control portion 12. The compensator 16 is equipped with a compensation element 18, a dynamic compensation calculation portion 19, and an abnormality detecting portion 20. The compensation element 18 issues a compensation amount of the gain K in accordance with a difference between tensions of the two ropes detected by the load detectors 10a and 10b serving as the tension detectors. The dynamic compensation calculation portion 19 selects the slower one of the hoisting machines as a reference based on speed values detected by the speed detectors 9a and 9b and torque commands from the speed control portions 13a and 13b, and reduces the compensation amount of the gain K of the compensation element 18 to perform gain correction in the faster one of the hoisting machines, thereby equalizing the speeds of both the hoisting machines, namely, the tensions of the ropes with each other. When the difference between torque command values output from the speed control portions 13a and 13b respectively based on a difference between the speeds of both the hoisting machines or speed feedback is smaller than a predetermined value, the dynamic compensation calculation portion 19 reduces the gain of the compensation element 18 and refrains from correcting the gain K, thereby making the gain K insensitive to a difference in torque, namely, an offset load. When the compensation amount from the compensation element 18 is larger than a predetermined value, the abnormality detecting portion 20 determines that there is an abnormality, and issues an emergency stop command.

[0017] Next, an operation regarding the control system for the elevator having the configuration shown in Figs. 1 and 2 will be described. When a call button (not shown) in a hall or the car 6 is pressed, the operation control portion 12 determines a traveling pattern of the car 6, and outputs a speed command to the speed control portion 13.

[0018] The speed control portion 13 compares a speed command from the operation control portion 12 with rotational speeds of the two hoisting machines 4a and 4b (the hoisting motors 1a and 1b) detected by the speed detectors 9a and 9b respectively, calculates torques to be output by the two hoisting motors 1a and 1b respectively, and issues torque commands to the torque control portions 14a and 14b respectively. The torque control portions 14a and 14b operate the power converters 15a and 15b in accordance with the respective torque commands, thereby controlling the torques generated by the

motors 1a and 1b respectively.

[0019] Owing to the foregoing operation of the drive control device 11, the rotational speeds of the hoisting machines 1a and 1b and the sheaves 3a and 3b are controlled according to a predetermined speed pattern, and the ropes 5a and 5b are driven in a tractive manner to carry the car 6 to a target floor.

[0020] Furthermore, when the car 6 reaches the target floor, the brakes 2a and 2b are actuated to stop rotation of the sheaves 3a and 3b, and the supply of power to the hoisting motors 1a and 1b is suspended to terminate a series of operations.

[0021] The springs 8a and 8b serve to prevent vibrations from being transmitted from the ropes 3a and 3b to the car 6 and ensure passengers of riding comfort. The springs 8a and 8b are expanded/contracted in response to an increase/decrease in load when someone gets on/off the car 6. Therefore, a load within the car can be detected by measuring amounts of displacement of the springs. In principle, the amounts of displacement of the springs are proportional to the tensions of the ropes. Therefore, the tensions of the ropes are measured when the amounts of displacement of the springs are measured respectively. The load detectors 10a and 10b, which make use of this principle for example, detect the tensions of the ropes 3a and 3b respectively. There are other methods of detecting the tensions of the ropes. The present invention described herein does not depend on the method of detecting the tension of the ropes.

[0022] In the control system for the elevator according to the present invention, the compensator 16 outputs a feedback control signal to the drive control device 11 to control the rotational speed of at least one of the hoisting machines only when the difference between the tensions of the two ropes has exceeded the predetermined value. As a result, the control system operates to reduce the speed of that one of the hoisting motors which rotates faster due to the difference between the tensions of the ropes and equalize this speed with the speed of the slower-rotating one of the hoisting motors.

[0023] That is, the control system operates such that the compensation element 18 issues a compensation amount of the gain K for a speed command that is issued from the operation control portion 12 to the speed control portion 13 (generic designation of the speed control portions 13a and 13b) in accordance with the difference between the tensions of the two ropes, and that the dynamic compensation calculation portion 19 selects the slower one of the hoisting machines as a reference based on speed values detected by the speed detectors 9a and 9b and torque commands from the speed control portions 13a and 13b, reduces the compensation amount for the gain K of the compensation element, and performs gain correction of the faster one of the hoisting machines to thereby make the speeds of both the hoisting machines, namely, the tensions of the ropes coincide with each other.

[0024] Thus, according to the foregoing embodiment of the present invention, the tensions of the ropes are controlled to be balanced with each other, so the following problem is not caused. That is, the car is prevented from being driven while being biased toward one of the hoisting machines. In other words, speed control can be performed while balancing the rope tensions applied to the two hoisting machines with each other.

[0025] The load detectors 10a and 10b serving as the weighing devices for detecting a load within the car also serve as the tension detectors, so the control system for the elevator can be configured at low cost. It is also possible to check whether or not there is an operational failure.

[0026] Feedback control is performed toward the lower one of the tensions of the ropes, so a design on the safe side can be realized through a compensation in a speed-reducing direction.

[0027] Furthermore, feedback is carried out only when the difference between the tensions of the ropes has exceeded the predetermined value, so the gain K is made insensitive to an offset load to omit any unnecessary compensation. As a result, the occurrence of a malfunction can be prevented.

Claims

1. A control system for an elevator, comprising:

two hoisting machines;
two ropes looped around the two hoisting machines respectively;
a car engaged with each of the two ropes at one end thereof;
counterweights engaged with each of the two ropes at the other end thereof;
a drive control device for driving the two hoisting machines;
tension detectors for detecting respective rope tensions of the two ropes; and
a compensator for outputting a feedback control signal to the drive control device in accordance with a difference between the tensions of the two ropes detected by the tension detectors to control rotational speeds of the hoisting machines with a view to balancing the rope tensions with each other.

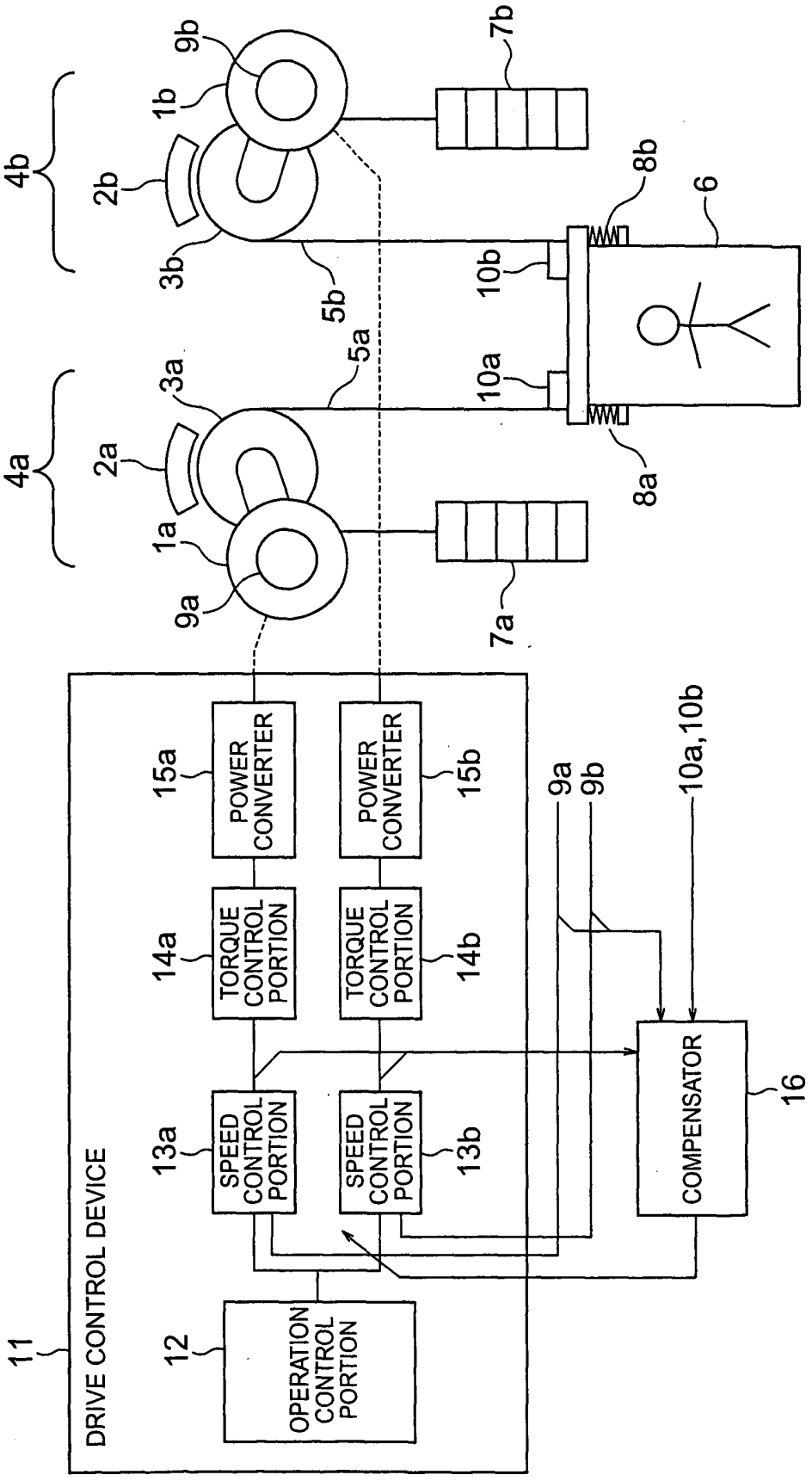
2. The control system for an elevator according to Claim 1, **characterized in that** the tension detector also serves as a weighing device for detecting a load within the car.

3. The control system for an elevator according to Claim 1, **characterized in that** the compensator outputs a feedback control signal to the drive control device to make a compensation in order to lower a rotation speed of the higher tension of the hoisting

machine based on the lower tension of the hoisting machine among two tensions of the two ropes detected by the tension detectors.

4. The control system for an elevator according to any one of Claims 1 to 3,
characterized in that the compensator outputs a feedback control signal to the drive control device to control a rotational speed of at least one of the hoisting machines only when the difference between the tensions of the two ropes detected by the tension detectors has exceeded a predetermined value.

FIG. 1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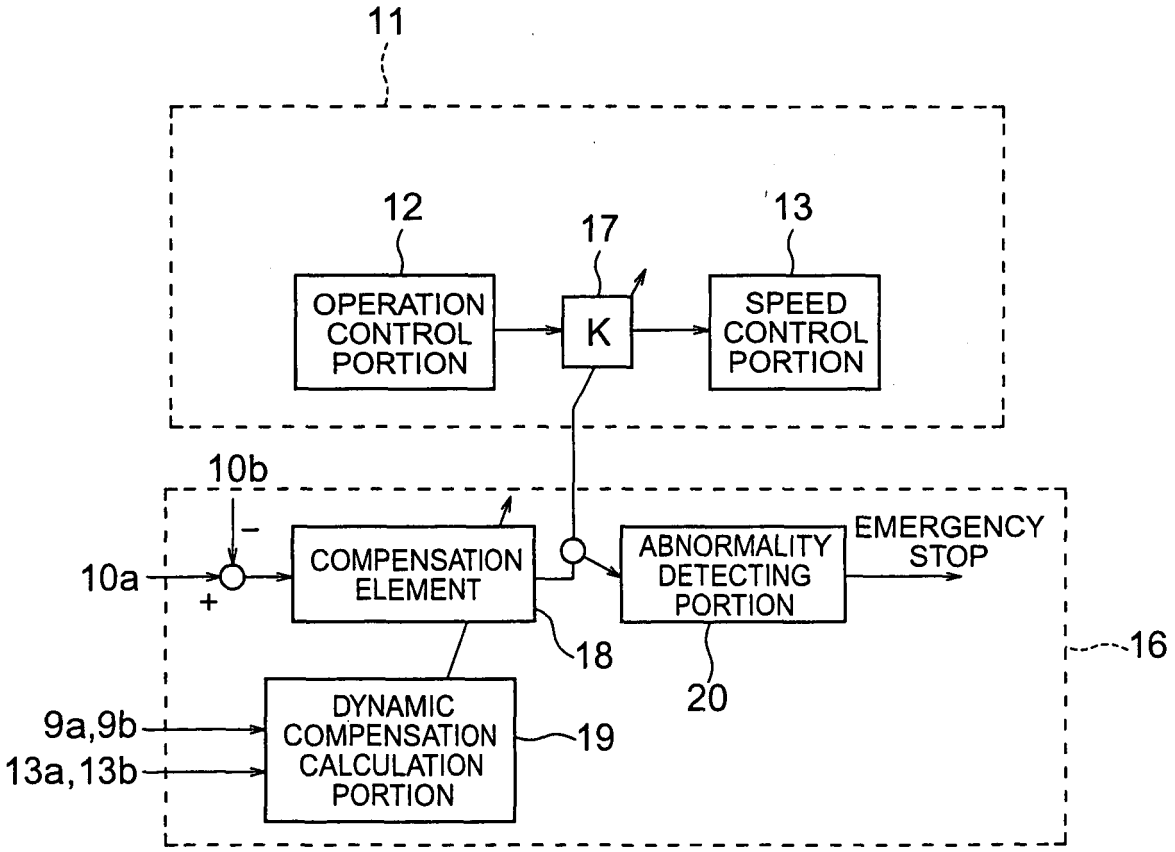
1a
9a
7a
8a
11
DRIVE CONTROL DEVICE
12
OPERATION CONTROL PORTION
13a
SPEED CONTROL PORTION
13b
SPEED CONTROL PORTION
14a
TORQUE CONTROL PORTION
14b
TORQUE CONTROL PORTION
15a
POWER CONVERTER
15b
POWER CONVERTER
9a
9b
10a,10b
COMPENSATOR
16

FIG. 2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17
13
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K
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10b
−
10a
+
COMPENSATION ELEMENT
ABNORMALITY DETECTING PORTION
EMERGENCY STOP
16
18
20
9a,9b
13a,13b
DYNAMIC COMPENSATION CALCULATION PORTION
19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/009918

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B66B1/06

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)
Int.Cl[7] B66B1/00-11/08

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 1996-2005
Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005

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	JP 2002-504471 A (Otis Elevator Co.), 12 February, 2002 (12.02.02), Pay attention to Par. No. [0015]; Figs. 1 to 3 & WO 99/43593 A1	1-4
Y	JP 62-205973 A (Hitachi, Ltd.), 10 September, 1987 (10.09.87), Pay attention to page 3, lower left column, line 10 to page 4, upper left column, line 11; Figs. 1 to 4 (Family: none)	1-4
Y	JP 59-228467 A (Mitsubishi Electric Corp.), 06 February, 1984 (06.02.84), Pay attention to page 1, lower left column, line 5 to lower right column, line 10; Fig. 2 (Family: none)	4

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

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Date of the actual completion of the international search	Date of mailing of the international search report
11 April, 2005 (11.04.05)	10 May, 2005 (10.05.05)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/009918

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 7-25553 A (Mitsubishi Electric Corp.), 27 January, 1995 (27.01.95), Pay attention to Par. Nos. [0006] to [0010]; Figs. 1 to 2 (Family: none)	1-4
A	JP 6-64863 A (Mitsubishi Electric Corp.), 08 March, 1994 (08.03.94), Pay attention to Par. Nos. [0012] to [0014]; Figs. 1, 5 to 6 (Family: none)	1-4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 7042063 B **[0006]**