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

(11) EP 1 953 107 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
06.08.2008 Bulletin 2008/32

(21) Application number: **05809480.6**

(22) Date of filing: **21.11.2005**

(51) Int Cl.:
B66B 5/02 *(2006.01)* ***B66B 1/32*** *(2006.01)*
B66B 5/04 *(2006.01)* ***B66B 5/14*** *(2006.01)*

(86) International application number:
PCT/JP2005/021362

(87) International publication number:
WO 2007/057973 (24.05.2007 Gazette 2007/21)

(84) Designated Contracting States:
DE

(71) Applicant: **MITSUBISHI ELECTRIC CORPORATION**
Chiyoda-ku
Tokyo 100-8310 (JP)

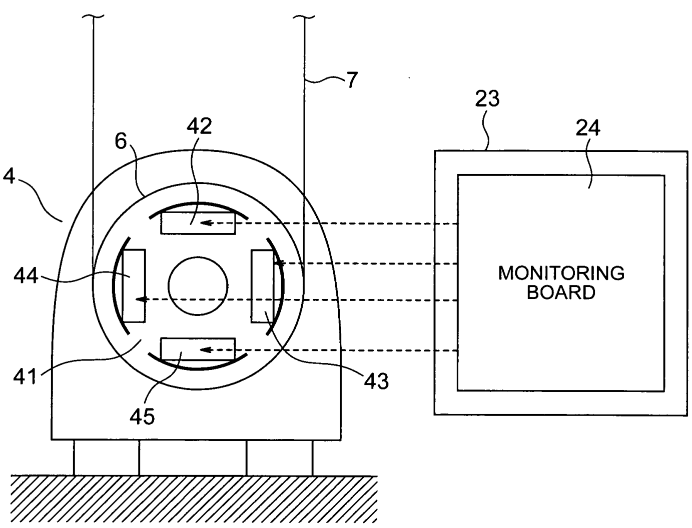
(72) Inventors:
- **KIGAWA, Hiroshi**
  Tokyo 100-8310 (JP)
- **OKAMOTO, Ken-Ichi**
  Tokyo 100-8310 (JP)
- **UEDA, Takaharu**
  Tokyo 100-8310 (JP)

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) BRAKE SYSTEM FOR ELEVATOR

(57) A brake device can perform a plurality of different braking operations. When the brake device performs each of the braking operations, a car is thereby braked. The car is mounted with an safety gear for preventing the car from falling. The safety gear is operated when a speed of the car reaches an emergency stop overspeed. A plurality of overspeed levels corresponding to the braking operations, respectively, and being values lower than the emergency stop overspeed are set in a safety device based on a position of the car. When the speed of the car reaches each of the overspeed levels, the safety device causes the brake device to perform one of the braking operations which corresponds to the overspeed level reached by the speed of the car.

FIG. 4



Printed by Jouve, 75001 PARIS (FR)

Description

Technical Field

[0001] The present invention relates to a brake system for an elevator, which performs a braking operation for stopping a car upon detection of an overspeed of the car.

Background Art

[0002] In a conventional elevator, there is proposed a brake device for forcibly stopping a car when an overspeed of the car is detected by overspeed detecting means. A single-stage overspeed detection level higher than a normal speed level of the car is set in the overspeed detecting means. The overspeed detection level continuously changes as the car is moved toward each terminal of a hoistway. When a speed of the car becomes equal to or higher than the overspeed detection level, the overspeed detecting means detects an overspeed of the car (see Patent Document 1).

[0003] Patent Document 1: JP 2004-123279 A

Disclosure of the Invention

Problem to be solved by the Invention

[0004] In the brake device for the conventional elevator configured as described above, however, only the single-stage overspeed detection level is set in the overspeed detecting means, so the same braking force is applied to the car through the same operation regardless of differences in conditions such as weight within the car and a moving direction of the car when the overspeed detecting means detects the overspeed of the car. Therefore, in the case where an unbalance occurs between the car side and a counterweight side and a force resulting from the unbalance is directed in such a direction as to stop the car, for example, where the car is being raised with a large number of passengers aboard within the car, a great shock may be caused to the car when the brake device is operated.

[0005] The present invention has been made to solve the above-mentioned problem, and it is therefore an obj ect of the present invention to obtain a brake system for an elevator which makes it possible to reduce a shock caused to a car upon operation of a brake device.

Means for solving the Problem

[0006] A brake system for an elevator according to the present invention includes: a brake device capable of performing a plurality of different braking operations, for braking a car through performance of the braking operations; an safety gear that is operated when a speed of the car reaches a preset emergency stop overspeed, for preventing the car from falling; and a safety device having set therein a plurality of overspeed levels corresponding to the braking operations, respectively, and being values lower than the emergency stop overspeed based on a position of the car, for causing the brake device to perform, when the speed of the car reaches each of the overspeed levels, one of the braking operations which corresponds to the overspeed level reached by the speed of the car.

Brief Description of the Drawings

[0007]

Fig. 1 is a schematic diagram showing an elevator according to Embodiment 1 of the present invention.
Fig. 2 is a graph showing the criterial data set in the monitoring board of Fig. 1.
Fig. 3 is a flowchart showing a processing operation of the safety device of Fig. 1.
Fig. 4 is a schematic diagram showing a brake system for an elevator according to Embodiment 2 of the present invention.
Fig. 5 is a graph showing the criterial data set in the monitoring board of Fig. 4.
Fig. 6 is a flowchart showing a processing operation of the safety device of Fig. 4.

Best Modes for carrying out the Invention

[0008] Preferred embodiments of the present invention will be described hereinafter with reference to the drawings.

Embodiment 1

[0009] Fig. 1 is a schematic diagram showing an elevator according to Embodiment 1 of the present invention. Referring to Fig. 1, a car 2 that is traveled while being guided by a car guide rail (not shown), and a counterweight 3 that is traveled while being guided by a counterweight guide rail (not shown) are provided within a hoistway 1. A hoisting machine (drive device) 4 for traveling the car 2 and the counterweight 3 is provided in a lower portion within the hoistway 1. The hoisting machine 4 has a hoisting machine body 5 including a motor, and a drive sheave 6 as a sheave that is rotated by the hoisting machine body 5.

[0010] A plurality of main ropes 7 are looped around the drive sheave 6. The car 2 and the counterweight 3 are suspended within the hoistway 1 by means of the respective main ropes 7. The car 2 and the counterweight 3 are traveled through rotation of the drive sheave 6. That is, the drive sheave 6 is rotated as the car 2 and the counterweight 3 are moved.

[0011] The hoisting machine 4 is mounted with a brake device 8 for braking the car 2 by braking rotation of the drive sheave 6. The brake device 8 has a brake shoe that is moved into contact with and away from the drive sheave 6, an urging spring for urging the brake shoe in such a direction that the brake shoe comes into contact with the drive sheave 6, and an electromagnet for moving the brake shoe away from the drive sheave 6 against an urging force of the urging spring through energization.

[0012] A pair of car suspending pulleys 9 are provided on a lower portion of the car 2. A counterweight suspending pulley 10 is provided on an upper portion of the counterweight 3. A pair of car-side return pulleys 11, a counterweight-side return pulley 12, a first suspension device 13, and a second suspension device 14 are provided in an upper portion within the hoistway 1. One end 7a of each of the main ropes 7 is connected to the first suspension device 13. The other end 7b of each of the main ropes 7 is connected to the second suspension device 14. Each of the main ropes 7 is looped, in a direction from the one end 7a thereof to the other end 7b thereof, around each of the car suspending pulleys 9, each of the car-side return pulleys 11, the drive sheave 6, the counterweight-side return pulley 12, and the counterweight suspending pulley 10 in the stated order.

[0013] The car 2 is mounted with an safety gear (not shown) for preventing the car 2 from falling. The safety gear brings a wedge (brakingmember) into contact with the car guide rail to directly apply a braking force to the car 2. The safety gear is operated through manipulation of an actuating lever 15 protruding from the car 2.

[0014] A speed governor 16 for manipulating the actuating lever 15 is provided in the upper portion within the hoistway 1. The speed governor 16 has a speed governor sheave 17. A tension pulley 18 is provided in the lower portion within the hoistway 1. A speed governor rope 19 connected to the actuating lever 15 is looped between the speed governor sheave 17 and the tension pulley 18. Thus, the speed governor rope 19 is moved together with the car 2, so the speed governor sheave 17 and the tension pulley 18 are rotated as the car 2 is moved. The speed governor rope 19 is gripped by the speed governor 16 when the speed of the car 2 becomes equal to a predetermined overspeed (emergency stop operation overspeed). The actuating lever 15 is manipulated through the gripping of the speed governor rope 19 by the speed governor 16.

[0015] The speed governor 16 is provided with a governor encoder (detector) 20 for generating a signal corresponding to rotation of the speed governor sheave 17. An upper reference position sensor 21 and a lower reference position sensor 22, each of which generates a detection signal when the car 2 is moved therepast, are provided within the hoistway 1. The upper reference position sensor 21 and the lower reference position sensor 22 are disposed apart from each other in the moving direction of the car 2. In this example, the upper reference position sensor 21 is disposed in the upper portion within the hoistway 1, and the lower reference position sensor 22 is disposed in the lower portion within the hoistway 1.

[0016] Information from the governor encoder 20, information from the upper reference position sensor 21, and information from the lower reference position sensor 22 are transmitted to a safety device 23. The safety device 23 controls the operation of the brake device 8 based on the information from the governor encoder 20, the information from the upper reference position sensor 21, and the information from the lower reference position sensor 22.

[0017] By being controlled by the safety device 23, the brake device 8 can perform a plurality of different braking operations. That is, the safety device 23 can control the brake device 8 such that rotation of the drive sheave 6 is braked by different methods.

[0018] In this example, the brake device 8 can perform, by being controlled by the safety device 23, a first braking operation for instantaneously applying a total braking force of the brake device 8 to the drive sheave 6 and a second braking operation for applying a braking force to the drive sheave 6 while making an adjustment of the braking force to absorb a shock caused to the car 2. That is, the brake device 8 is controlled by the safety device 23 such that the car 2 is moved at a lower deceleration when being braked through the second braking operation than when being braked through the first braking operation.

[0019] As the second braking operation, it is possible to mention, for example, a method of calculating a brake torque for stopping the car 2 from a load (laden weight) of the car 2 and a moving direction of the car 2 and supplying the electromagnet of the brake device 8 with a current corresponding to the calculated brake torque through selection of an electric circuit, a method of selecting those of a plurality of brake portions for braking rotation of the drive sheave 6 which correspond in number to a brake torque and causing only the selected brake portions to operate, a method of changing the time constant of the brake device 8 in accordance with a brake torque, a method of changing the operation dead time of the brake device 8, or the like.

[0020] The safety device 23 has a monitoring board (monitoring portion) 24 for monitoring the position of the car 2 and the speed of the car 2, and a brake control board (brake control portion) 25 for controlling the brake device 8 during the performance of the second braking operation.

[0021] The monitoring board 24 calculates a position of the car 2 and a speed of the car 2 based on information from the governor encoder 20, information from the upper reference position sensor 21, and information from the lower reference position sensor 22. Criterial data (criterial information) to be compared with the calculated position of the car 2 and the calculated speed of the car 2 are set beforehand in the monitoring board 24 to determine whether or not an overspeed of the car 2 has been detected. In addition, when an overspeed of the car 2 has been detected through a comparison of the position of the car 2 and the speed of the car 2 with the criterial data, the monitoring board 24 selectively outputs an actuation signal to the brake device 8 or the brake control board 25 in accordance with the level of the overspeed of the car 2.

[0022] The brake control board 25 performs control of the second braking operation for the brake device 8 upon receiving the actuation signal from the monitoring board 24.

[0023] The brake device 8 performs the first braking operation upon receiving the actuation signal from the monitoring board 24, and performs the second braking operation by being controlled by the brake control board 25.

[0024] On a bottom within the hoistway 1, a car buffer 26 is disposed at a position below the car 2, and a counterweight buffer 27 is disposed at a position below the counterweight 3. An upper limit switch 28 that is actuated when the car 2 reaches a preset upper-limit position is disposed at a position above the upper reference position sensor 21 within the hoistway 1, and a lower limit switch 29 that is actuated when the car 2 reaches a preset lower-limit position is disposed at a position below the lower reference position sensor 22 within the hoistway 1. Further, the operation of the elevator is controlled by a control device 30 provided within the hoistway 1.

[0025] Fig. 2 is a graph showing the criterial data set in the monitoring board 24 of Fig. 1. As shown in Fig. 2, the criterial data include a normal speed pattern 31 according to which the speed of the car 2 during normal operation is set based on the position of the car 2, a first overspeed pattern 32 set at a higher level than the normal speed pattern 31, and a second overspeed pattern 33 set at a higher level than the normal speed pattern 31. In the criterial data, out of the first overspeed pattern 32 and the second overspeed pattern 33, the first overspeed pattern 32 is set as the highest-level overspeed pattern.

[0026] The first overspeed pattern 32 is configured by setting the speed (first overspeed level) of the car 2 in causing the brake device 8 to perform the first braking operation based on the position of the car 2. The second overspeed pattern 33 is configured by setting the speed (second overspeed level) of the car 2 in causing the brake device 8 to perform the second braking operation based on the position of the car 2.

[0027] The monitoring board 24 outputs an actuation signal to the brake control board 25 when the speed of the car 2 reaches the second overspeed pattern 33, and outputs an actuation signal to the brake device 8 when the speed of the car 2 reaches the first overspeed pattern 32. That is, the second overspeed pattern 33 corresponds to the second braking operation, and the first overspeed pattern 32 corresponds to the first braking operation.

[0028] A constant-speed zone and a variable-speed zone, which are adjacent to each other in the moving direction of the car 2, are provided in the hoistway 1. The variable-speed zone is located on a terminal side of the hoistway 1 with respect to the constant-speed zone. The constant-speed zone and the variable-speed zone are adjacent to each other at a zone border position within the hoistway 1.

[0029] The normal speed pattern 31 has a normal constant speed pattern portion that assumes a constant value in the constant-speed zone, and a normal variable speed pattern portion that continuously decreases as the car 2 approaches the terminal of the hoistway 1 in the variable-speed zone. The first overspeed pattern 32 has a first constant overspeed pattern portion OS1 that is a constant value in the constant-speed zone, and a first variable overspeed pattern portion SETS1 that continuously decreases as the car 2 approaches the terminal of the hoistway 1 in the variable-speed zone. The second overspeed pattern 33 has a second constant overspeed pattern portion OS2 that assumes a constant value in the constant-speed zone, and a second variable overspeed pattern portion SETS2 that continuously decreases as the car 2 approaches the terminal of the hoistway 1 in the variable-speed zone.

[0030] The value of the first constant overspeed pattern portion OS1 is 1.3 times the value of the normal constant speed pattern portion. The first variable overspeed pattern portion SETS1 has the value of a permissible collision speed of the car buffer 26 as a lower limit.

[0031] Next, an operation will be described. Fig. 3 is a flowchart showing a processing operation of the safety device 23 of Fig. 1. As shown in Fig. 3, information from the governor encoder 20, information from the upper reference position sensor 21, and information from the lower reference position sensor 22 are constantly transmitted to the monitoring board 24 (S1). Thus, the monitoring board 24 calculates a position of the car 2 and a speed of the car 2 (S2). After that, it is determined in the monitoring board 24 whether or not the calculated position of the car 2 is within the variable-speed zone (S3).

[0032] When it is determined that the position of the car 2 is outside the variable-speed zone, the monitoring board 24 determines whether or not the calculated speed of the car 2 is lower than the first constant overspeed pattern portion OS1 (S4). When it is determined that the speed of the car 2 is equal to or higher than the first constant overspeed pattern portion OS1, an actuation signal is output from the monitoring board 24 to the brake device 8 (S5). Thus, the first braking operation of the brake device 8 is performed (S6).

[0033] When it is determined that the speed of the car 2 is lower than the first constant overspeed pattern portion OS1, the monitoring board 24 determines whether or not the speed of the car 2 is lower than the second constant overspeed pattern portion OS2 (S7). When it is determined that the speed of the car 2 is equal to or higher than the second constant overspeed pattern portion OS2, an actuation signal is output from the monitoring board 24 to the brake control board 25 (S8). Thus, the second braking operation of the brake device 8 is performed through the control performed by the brake control board 25 (S9). When it is determined that the speed of the car 2 is lower than the second constant overspeed pattern portion OS2, the stopping of the outputting of an actuation signal from the monitoring board 24 is continued (S10).

[0034] On the other hand, when it is determined that the position of the car 2 is within the variable-speed zone, the monitoring board 24 determines whether or not the calculated speed of the car 2 is lower than the first variable overspeed pattern portion SETS1 (S11). When it is determined that the speed of the car 2 is equal to or higher than the first variable overspeed pattern portion SETS1, an actuation signal is output from the monitoring board 24 to the brake device 8 (S12). As a result, the first braking operation of the brake device 8 is performed (S13).

[0035] When it is determined that the speed of the car 2 is lower than the first variable overspeed pattern portion SETS1, the monitoring board 24 determines whether or not the speed of the car 2 is lower than the second variable overspeed pattern portion SETS2 (S14). When it is determined that the speed of the car 2 is equal to or higher than the second variable overspeed pattern portion SETS2, an actuation signal is output from the monitoring board 24 to the brake control board 25 (S15). Thus, the second braking operation of the brake device 8 is performed through the control performed by the brake control board 25 (S16). When it is determined that the speed of the car 2 is lower than the second variable overspeed pattern portion SETS2, the stopping of the outputting of an actuation signal from the monitoring board 24 is continued (S17).

[0036] The emergency stop operation overspeed is set higher than the first overspeed pattern 32. Accordingly, when the speed of the car 2 further rises for some reason even after the performance of the first braking operation of the brake device 8 and then reaches the emergency stop operation overspeed, the speed governor rope 19 is gripped by the speed governor 16, and the safety gear is operated.

[0037] In the brake system for the elevator configured as described above, the first overspeed pattern and the second overspeed pattern, which are different from each other, are set in the safety device 23, and the safety device 23 causes the brake device 8 to perform the first braking operation when the speed of the car 2 reaches the first overspeed pattern, and causes the brake device 8 to perform the second braking operation when the speed of the car 2 reaches the second overspeed pattern. It is therefore possible to select a suitable one of the different braking operations in accordance with the level of the overspeed of the car 2. Thus, it is possible to gradually increase the braking force applied to the drive sheave 6 before a shift in the overspeed of the car 2 from a low level to a high level, and hold the deceleration of the car 2 low. Accordingly, it is possible to reduce a shock caused to the car 2 upon operation of the brake device 8.

[0038] In the first braking operation, which is performed when the speed of the car 2 reaches the first overspeed pattern 32 at the highest level, a total braking force of the brake device 8 is instantaneously applied to the drive sheave 6. In the second braking operation, which is performed when the speed of the car 2 reaches the second overspeed pattern 33 lower than the first overspeedpattern 32, an adjustment of a braking force is made to absorb a shock caused to the car 2. It is therefore possible to hold the deceleration of the car 2 lower when the overspeed of the car 2 is at a low level. As a result, it is possible to further reduce a shock caused to the car 2.

[0039] In the foregoing example, the position of the car 2 and the speed of the car 2 are calculated based on information from the governor encoder 20 for generating a signal corresponding to rotation of the speed governor sheave 17. However, it is also appropriate to provide the hoisting machine 4 with a hoisting machine encoder for generating a signal corresponding to rotation of the drive sheave 6, and calculate a position of the car 2 and a speed of the car 2 based on information from the hoisting machine encoder. The speed of the car 2 to be compared with the first overspeed pattern 32 and the speed of the car 2 to be compared with the second overspeed pattern 33 may be calculated based on information from different encoders, for example, the governor encoder 20 and the hoisting machine encoder. It is also possible to provide an acceleration sensor within the car 2 or use a signal from an existing weighing device.

Embodiment 2

[0040] Fig. 4 is a schematic diagram showing a brake system for an elevator according to Embodiment 2 of the present invention. Referring to Fig. 4, the hoisting machine 4 is mounted with a brake device 41 for braking rotation of the drive sheave 6. The brake device 41 has a first braking portion 42, a second braking portion 43, a third braking portion 44, and a fourth braking portion 45 (a plurality of braking portions), which are disposed at intervals between each other in a direction of rotation of the drive sheave 6. Each of the first braking portion 42, the second braking portion 43, the third braking portion 44, and the fourth braking portion 45 has a brake shoe that is moved into contact with and away from the drive sheave 6, an urging spring for urging the brake shoe in a direction in which the brake shoe comes into contact with the drive sheave 6, and an electromagnet for moving the brake shoe away from the drive sheave 6 against an urging force of the urging spring through energization. Brake torques generated by the first braking portion 42, the second braking portion 43, the third braking portion 44, and the fourth braking portion 45 are equal to one another.

[0041] By selectively causing the first braking portion 42, the second braking portion 43, the third braking portion 44, and the fourth braking portion 45 to operate, the brake device 41 performs different braking operations, namely, a first braking operation, a second braking operation, a third braking operation, and a fourth braking operation (a plurality of braking operations), respectively. That is, the first braking operation is performed by causing only the first braking portion 42 to operate, the second braking operation is performed by causing the second braking portion 43 to operate while holding the first braking portion 42 in operation, the third braking operation is performed by causing the third braking portion 44 to operate while holding the first braking portion 42 and the second braking portion 43 in operation, and the fourth braking operation is performed by causing the fourth braking portion 45 to operate while holding the first to third braking portions 42 to 44 in operation.

[0042] The safety device 23 has the monitoring board 24. The monitoring board 24 calculates a position of the car 2 and a speed of the car 2 based on information from the governor encoder 20, information from the upper reference position sensor 21, and information from the lower reference position sensor 22. Criterial data (criterial information) to be compared with the calculated position of the car 2 and the calculated speed of the car 2 are set beforehand in the monitoring board 24 to determine whether or not an overspeed of the car 2 has been detected. In addition, upon detecting an overspeed of the car 2 through a comparison of the position of the car 2 and the speed of the car 2 with the criterial data, the monitoring board 24 selectively outputs an actuation signal to one of the first braking portion 42, the second braking portion 43, the third braking portion 44, and the fourth braking portion 45 in accordance with the level of the overspeed of the car 2.

[0043] Each of the first braking portion 42, the second braking portion 43, the third braking portion 44, and the fourth braking portion 45 operates upon receiving the actuation signal from the monitoring board 24. That is, in each of the first braking portion 42, the second braking portion 43, the third braking portion 44, and the fourth braking portion 45 which has received the actuation signal from the monitoring board 24, the electromagnet is stopped from being energized, so the brake shoe comes into contact with the drive sheave 6 due to an urging force of the urging spring.

[0044] Fig. 5 is a graph showing the criterial data set in the monitoring board 24 of Fig. 4. As shown in Fig. 5, the criterial data include the normal speed pattern 31, a first overspeed pattern 46, a second overspeed pattern 47, a third overspeed pattern 48, and a fourth overspeed pattern 49. Each of the first overspeed pattern 46, the second overspeed pattern 47, the third overspeed pattern 48, and the fourth overspeed pattern 49 is set at a higher level than the normal speed pattern 31. In the criterial data, among the first to fourth overspeed patterns 46 to 49, the first overspeed pattern 46 is set as the highest-level overspeed pattern, and the second overspeed pattern 47, the third overspeed pattern 48, and the fourth overspeed pattern 49 are set so as to descend in level in the stated order.

[0045] The first overspeed pattern 46, the second overspeed pattern 47, the third overspeed pattern 48, and the fourth overspeed pattern 49 have the first constant overspeed pattern portion OS1, the second constant overspeed pattern portion OS2, a third constant overspeed pattern portion OS3, and a fourth constant overspeed pattern portion OS4, respectively, and the first variable overspeed pattern portion SETS1, the second variable overspeed pattern portion SETS2, a third variable overspeed pattern portion SETS3, and a fourth variable overspeed pattern portion SETS4, respectively. Each of the first to fourth constant overspeed pattern portions OS1 to OS4 assumes a constant value in a constant-speed zone. Each of the first to fourth variable overspeed pattern portions SETS1 to SETS4 continuously decreases as the car 2 approaches a terminal of the hoistway 1 in a variable-speed zone.

[0046] An actuation signal from the monitoring board 24 is output to the first braking portion 42 when the speed of the car 2 reaches the fourth overspeed pattern 49, to the second braking portion 43 when the speed of the car 2 reaches the third overspeed pattern 48, to the third braking portion 44 when the speed of the car 2 reaches the second overspeed pattern 47, and to the fourth braking portion 45 when the speed of the car 2 reaches the first overspeed pattern 46. In other words, it is set beforehand in the monitoring board 24 to which one of the first braking portion 42, the second braking portion 43, the third braking portion 44, and the fourth braking portion 45 the actuation signal is to be output, in accordance with the first overspeed pattern 46, the second overspeed pattern 47, the third overspeed pattern 48, and the fourth overspeed pattern 49. Embodiment 2 of the present invention is identical to Embodiment 1 of the present invention in other structural details.

[0047] Next, an operation will be described. Fig. 6 is a flowchart showing a processing operation of the safety device 23 of Fig. 4. As shown in Fig. 6, information from the governor encoder 20, information from the upper reference position sensor 21, and information from the lower reference position sensor 22 are constantly transmitted to the monitoring board 24 (S21). Thus, the monitoring board 24 calculates a position and a speed of the car 2 (S22). After that, it is determined in the monitoring board 24 whether or not the calculated position of the car 2 is within the constant-speed zone (S23).

[0048] When it is determined that the position of the car 2 is within the constant-speed zone, the monitoring board 24 determines whether or not the calculated speed of the car 2 is equal to or higher than the fourth constant overspeed pattern portion OS4 (S24). When it is determined that the speed of the car 2 is lower than the fourth constant overspeed pattern portion OS4, no actuation signal is output from the monitoring board 24 to the first braking portion 42, so the first braking portion 42 is not operated (S25).

[0049] When it is determined that the speed of the car 2 is equal to or higher than the fourth constant overspeed pattern portion OS4, an actuation signal is output from the monitoring board 24 to the first braking portion 42. Thus, the first braking portion 42 is operated (S26), so the first braking operation of the brake device 41 is performed.

[0050] After that, the monitoring board 24 determines whether or not the speed of the car 2 is equal to or higher than the third constant overspeed pattern portion OS3 (S27). When it is determined that the speed of the car 2 is lower than the third constant overspeed pattern portion OS3, no actuation signal is output from the monitoring board 24 to the second braking portion 43, so the second braking portion 43 is not operated (S28).

[0051] When it is determined that the speed of the car 2 is equal to or higher than the third constant overspeed pattern portion OS3, an actuation signal is output from the monitoring board 24 to the second braking portion 43. Thus, the second braking portion 43 is operated (S29), so the second braking operation of the brake device 41 is performed.

[0052] After that, the monitoring board 24 determines whether or not the speed of the car 2 is equal to or higher than the second constant overspeed pattern portion OS2 (S30). When it is determined that the speed of the car 2 is lower than the second constant overspeed pattern portion OS2, no actuation signal is output from the monitoring board 24 to the third braking portion 44, so the third braking portion 44 is not operated (S31).

[0053] When it is determined that the speed of the car 2 is equal to or higher than the second constant overspeed pattern portion OS2, an actuation signal is output from the monitoring board 24 to the third braking portion 44. Thus, the third braking portion 44 is operated (S32), so the third braking operation of the brake device 41 is performed.

[0054] After that, the monitoring board 24 determines whether or not the speed of the car 2 is equal to or higher than the first constant overspeed pattern portion OS1 (S33). When it is determined that the speed of the car 2 is lower than the first constant overspeed pattern portion OS1, no actuation signal is output from the monitoring board 24 to the fourth braking portion 45, so the fourth braking portion 45 is not operated (S34).

[0055] When it is determined that the speed of the car 2 is equal to or higher than the first constant overspeed pattern portion OS1, an actuation signal is output from the monitoring board 24 to the fourth braking portion 45. Thus, the fourth braking portion 45 is operated (S35), so the fourth braking operation of the brake device 41 is performed.

[0056] On the other hand, when it is determined that the position of the car 2 is outside the constant-speed zone, the monitoring board 24 determines whether or not the calculated speed of the car 2 is equal to or higher than the fourth variable overspeed pattern portion SETS4 (S36). When it is determined that the speed of the car 2 is lower than the fourth variable overspeed pattern portion SETS4, no actuation signal is output from the monitoring board 24 to the first braking portion 42, so the first braking portion 42 is not operated (S37).

[0057] When it is determined that the speed of the car 2 is equal to or higher than the fourth variable overspeed pattern portion SETS4, an actuation signal is output from the monitoring board 24 to the first braking portion 42. Thus, the first braking portion 42 is operated (S38), so the first braking operation of the brake device 41 is performed.

[0058] After that, the monitoring board 24 determines whether or not the speed of the car 2 is equal to or higher than the third variable overspeed pattern portion SETS3 (S39). When it is determined that the speed of the car 2 is lower than the third variable overspeed pattern portion SETS3, no actuation signal is output from the monitoring board 24 to the second braking portion 43, so the second braking portion 43 is not operated (S40).

[0059] When it is determined that the speed of the car 2 is equal to or higher than the third variable overspeed pattern portion SETS3, an actuation signal is output from the monitoring board 24 to the second braking portion 43. Thus, the second braking portion 43 is operated (S41), so the second braking operation of the brake device 41 is performed.

[0060] After that, the monitoring board 24 determines whether or not the speed of the car 2 is equal to or higher than the second variable overspeed pattern portion SETS2 (S42). When it is determined that the speed of the car 2 is lower than the second variable overspeed pattern portion SETS2, no actuation signal is output from the monitoring board 24 to the third braking portion 44, so the third braking portion 44 is not operated (S43).

[0061] When it is determined that the speed of the car 2 is equal to or higher than the second variable overspeed pattern portion SETS2, an actuation signal is output from the monitoring board 24 to the third braking portion 44. Thus, the third braking portion 44 is operated (S44), so the third braking operation of the brake device 41 is performed.

[0062] After that, the monitoring board 24 determines whether or not the speed of the car 2 is equal to or higher than the first variable overspeed pattern portion SETS1 (S45). When it is determined that the speed of the car 2 is lower than the first variable overspeed pattern portion SETS1, no actuation signal is output from the monitoring board 24 to the fourth braking portion 45, so the fourth braking portion 45 is not operated (S46).

[0063] When it is determined that the speed of the car 2 is equal to or higher than the first variable overspeed pattern portion SETS1, an actuation signal is output from the monitoring board 24 to the fourth braking portion 45. Thus, the fourth braking portion 45 is operated (S47), so the fourth braking operation of the brake device 41 is performed.

[0064] In the brake system for the elevator configured as described above, the brake device 41 has the first braking portion 42, the second braking portion 43, the third braking portion 44, and the fourth braking portion 45, which are selectively operated when the first braking operation, the second braking operation, the third braking operation, and the fourth braking operation are performed, respectively. It is set beforehand in the safety device 23 in accordance with the four braking operations which one of the four braking portions 42 to 45 is to be selected. It is therefore possible to cause the brake device 41 to perform the different braking operations in accordance with the level of the overspeed of the car 2 with a simple configuration. Accordingly, it is possible to hold the deceleration of the car 2 low, and reduce a shock caused to the car 2 upon operation of the brake device 41.

[0065] In each of the foregoing embodiments of the present invention, the brake device 8 or 41 mounted on the hoisting machine 4 can perform the plurality of the different braking operations. However, it is also appropriate to allow a rail grip brake for gripping the car guide rail to hold the car 2 or a rope brake for gripping the main ropes 7 to brake the car 2 to perform a plurality of braking operations.

Claims

1. A brake system for an elevator, comprising:

> a brake device capable of performing a plurality of different braking operations, for braking a car through performance of the braking operations;
> an safety gear that is operated when a speed of the car reaches a preset emergency stop overspeed, for preventing the car from falling; and
> a safety device having set therein a plurality of overspeed levels corresponding to the braking operations, respectively, and being values lower than the emergency stop overspeed based on a position of the car, for causing the brake device to perform, when the speed of the car reaches each of the overspeed levels, one of the braking operations which corresponds to the overspeed level reached by the speed of the car.

2. A brake system for an elevator according to Claim 1, wherein:

> the brake device instantaneously applies a total braking force to a sheave in the one of the braking operations which is performed when the speed of the car reaches a highest one of the overspeed levels; and
> the braking force is adjusted to absorb a shock caused to the car in the braking operations which are performed when the speed of the car is lower than the highest one of the overspeed levels.

3. A brake system for an elevator according to Claim 1, wherein:

> the brake device has a plurality of braking portions that are selectively operated when the respective braking operations are performed; and
> the safety device has set therein beforehand which one of the braking portions is to be selected, in accordance with the respective braking operations.

FIG. 1

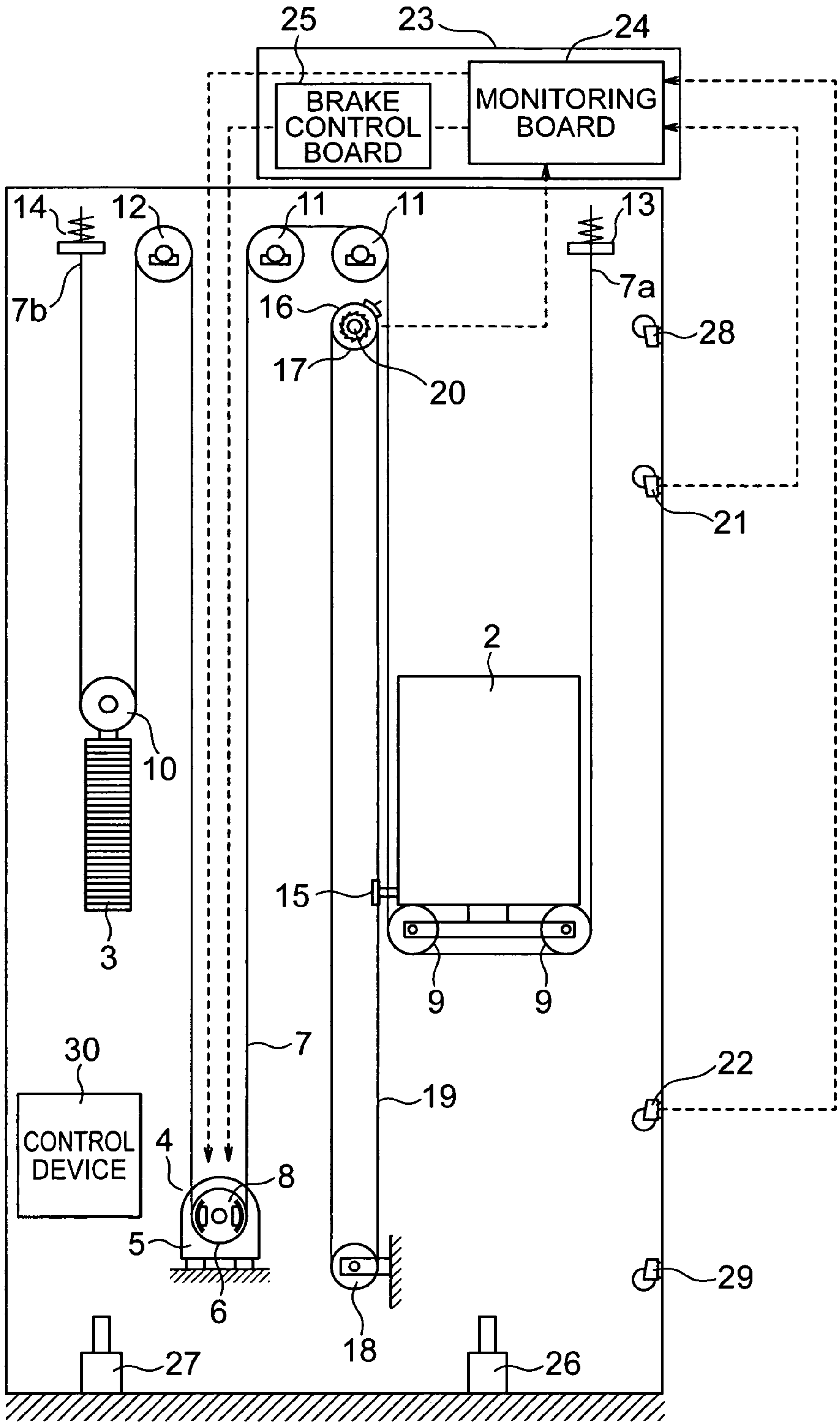

25
23
24
BRAKE CONTROL BOARD
MONITORING BOARD
14
12
11
11
13
7b
7a
16
28
17
20
21
2
10
3
15
9
9
30
7
19
22
CONTROL DEVICE
4
8
5
6
18
29
27
26

FIG. 2

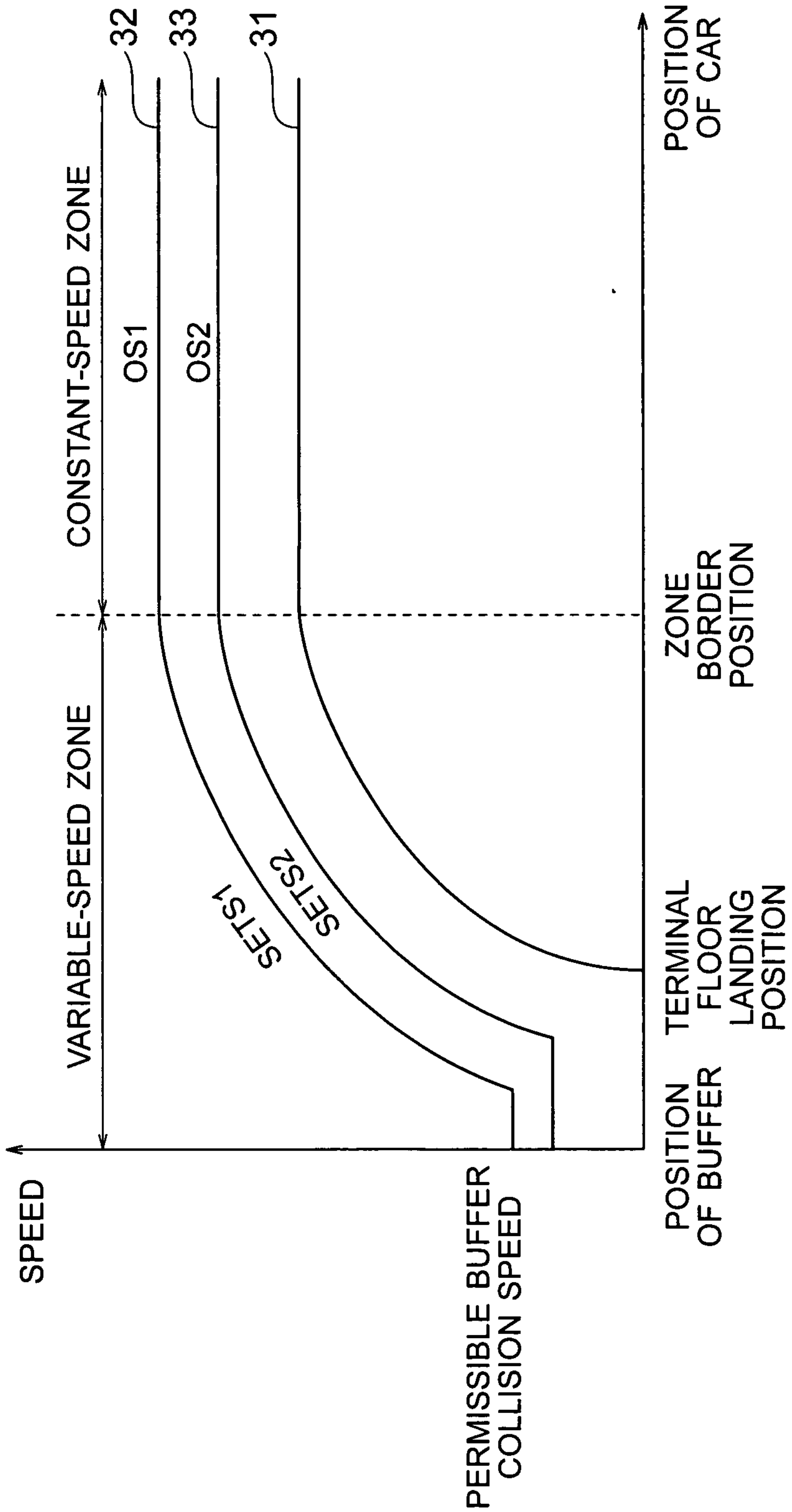

SPEED
PERMISSIBLE BUFFER COLLISION SPEED
VARIABLE-SPEED ZONE
CONSTANT-SPEED ZONE
32
33
31
OS1
OS2
SETS1
SETS2
POSITION OF BUFFER
TERMINAL FLOOR LANDING POSITION
ZONE BORDER POSITION
POSITION OF CAR

FIG. 3

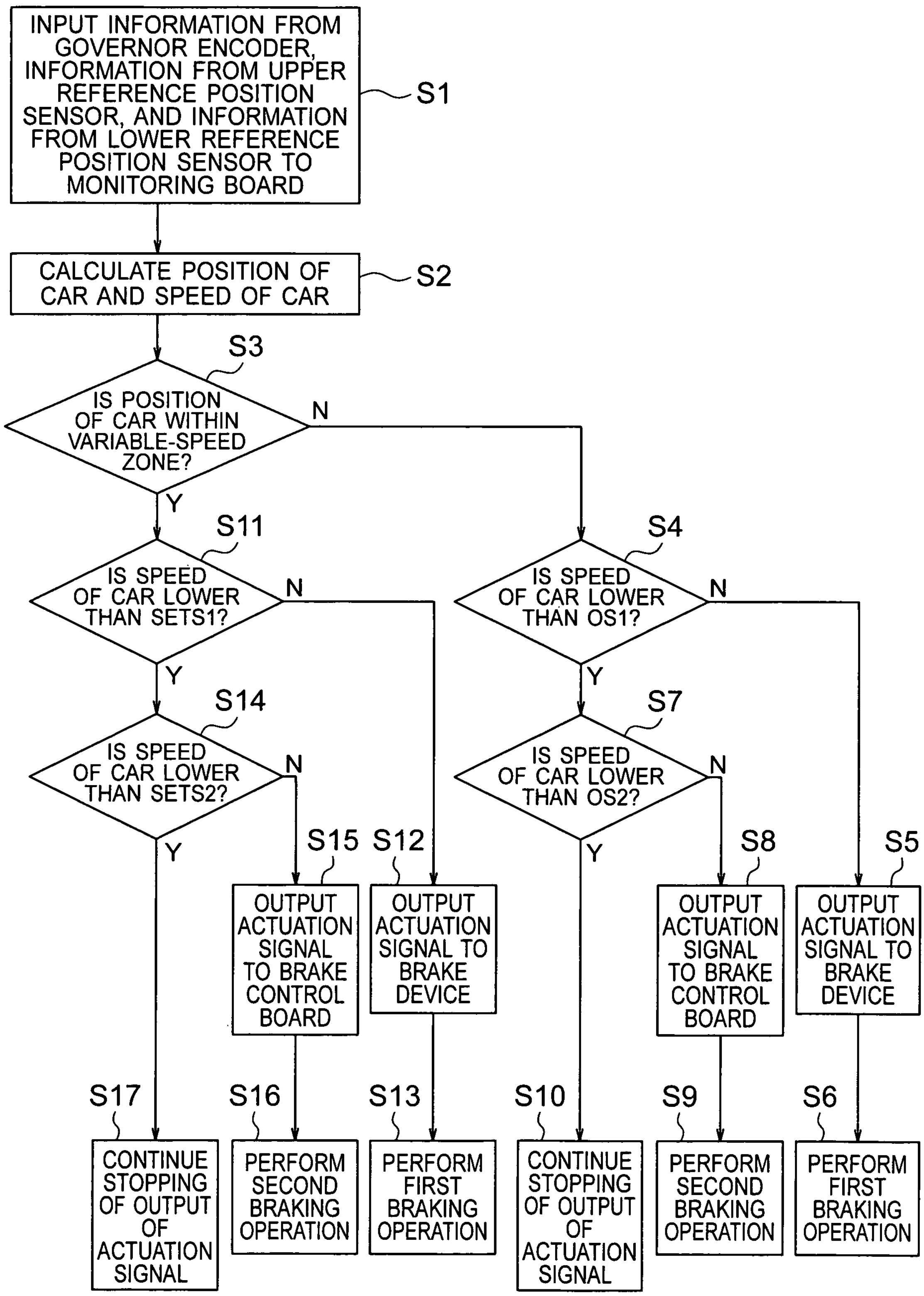

INPUT INFORMATION FROM GOVERNOR ENCODER, INFORMATION FROM UPPER REFERENCE POSITION SENSOR, AND INFORMATION FROM LOWER REFERENCE POSITION SENSOR TO MONITORING BOARD
S1
CALCULATE POSITION OF CAR AND SPEED OF CAR
S2
S3
IS POSITION OF CAR WITHIN VARIABLE-SPEED ZONE?
N
Y
S11
IS SPEED OF CAR LOWER THAN SETS1?
N
Y
S14
IS SPEED OF CAR LOWER THAN SETS2?
N
Y
S4
IS SPEED OF CAR LOWER THAN OS1?
N
Y
S7
IS SPEED OF CAR LOWER THAN OS2?
N
Y
S15
OUTPUT ACTUATION SIGNAL TO BRAKE CONTROL BOARD
S12
OUTPUT ACTUATION SIGNAL TO BRAKE DEVICE
S8
OUTPUT ACTUATION SIGNAL TO BRAKE CONTROL BOARD
S5
OUTPUT ACTUATION SIGNAL TO BRAKE DEVICE
S17
CONTINUE STOPPING OF OUTPUT OF ACTUATION SIGNAL
S16
PERFORM SECOND BRAKING OPERATION
S13
PERFORM FIRST BRAKING OPERATION
S10
CONTINUE STOPPING OF OUTPUT OF ACTUATION SIGNAL
S9
PERFORM SECOND BRAKING OPERATION
S6
PERFORM FIRST BRAKING OPERATION

FIG. 4

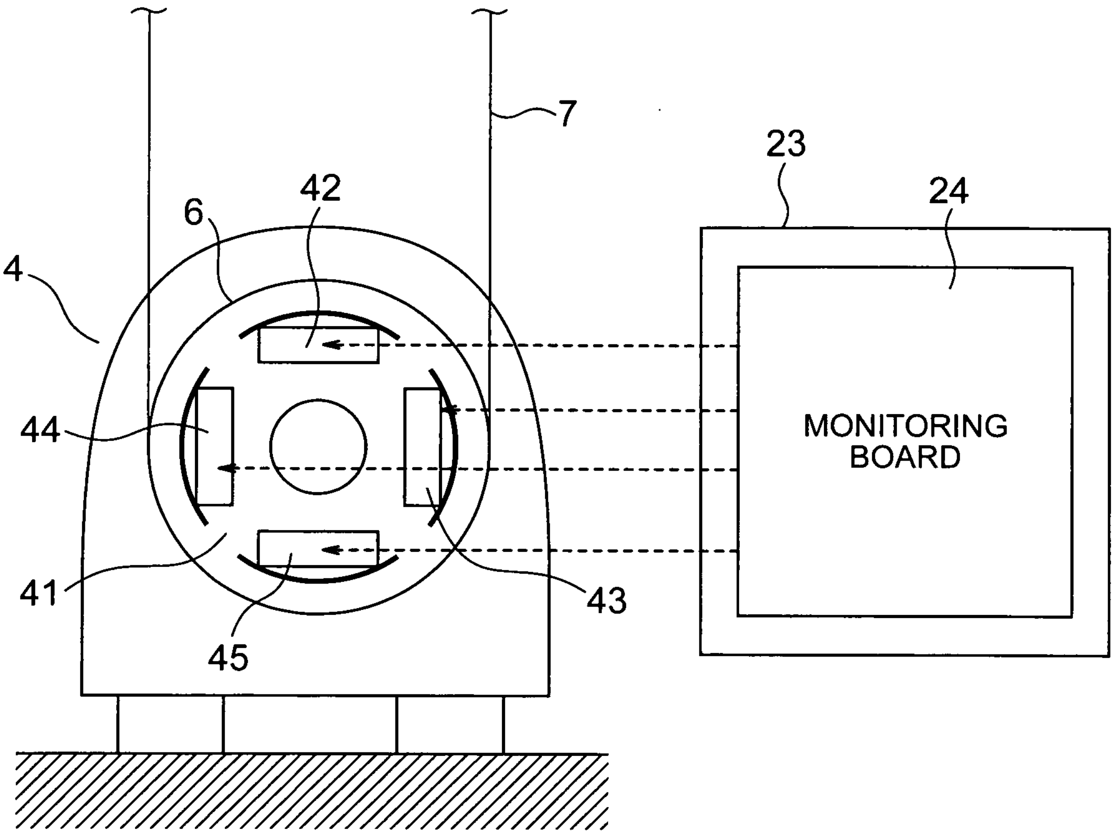


FIG. 5

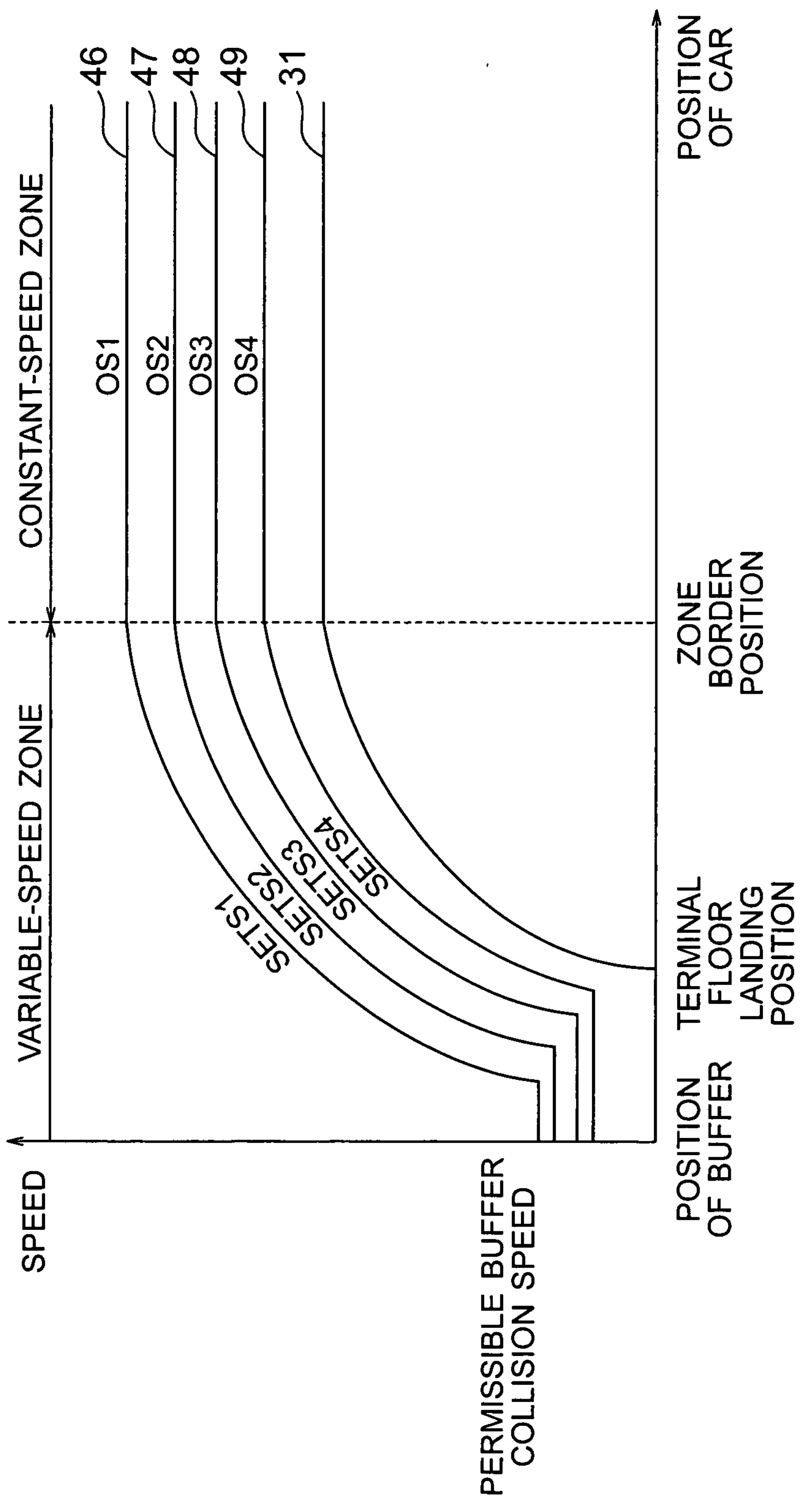
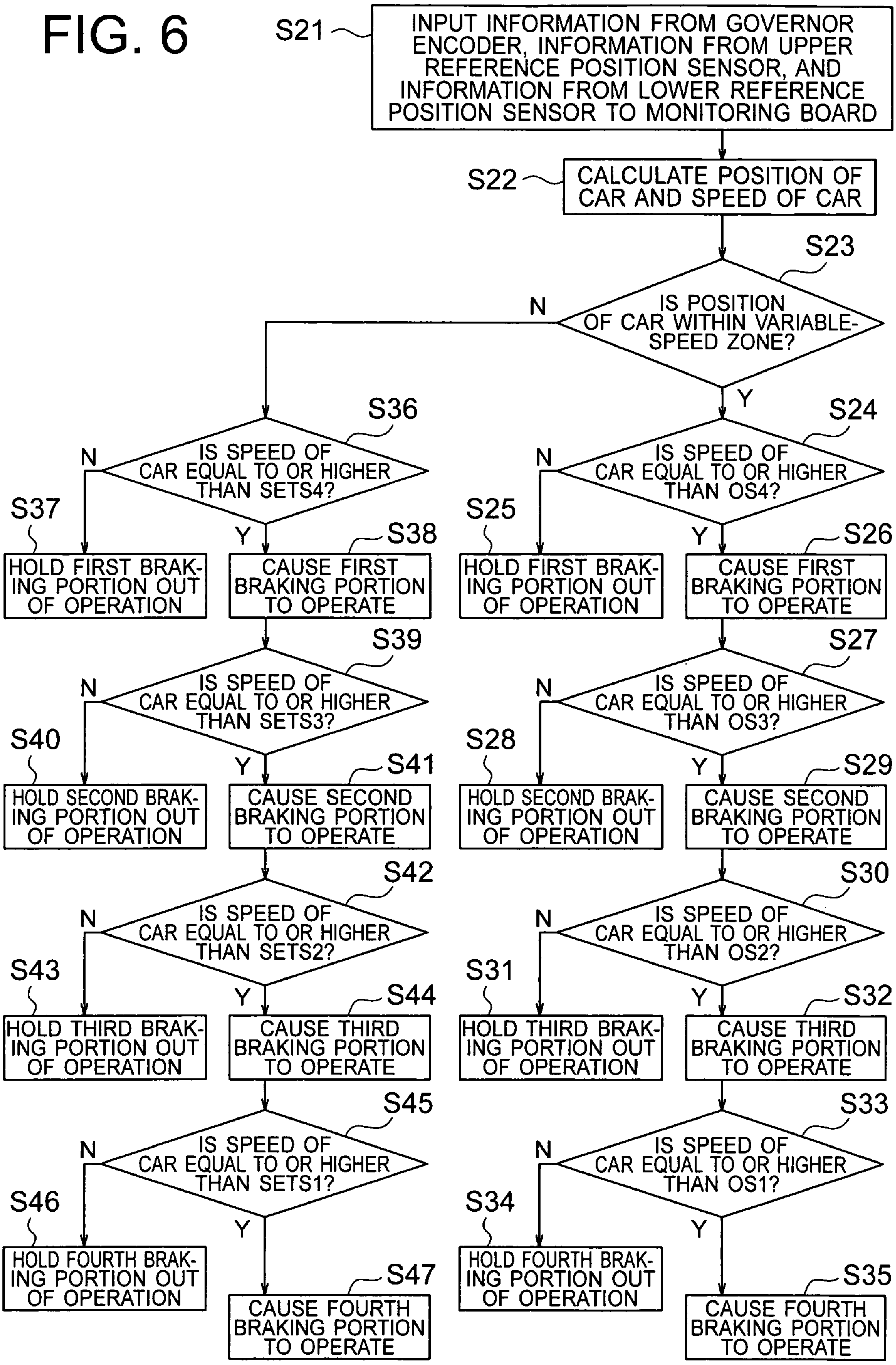

SPEED
PERMISSIBLE BUFFER COLLISION SPEED
VARIABLE-SPEED ZONE
CONSTANT-SPEED ZONE
SETS1
SETS2
SETS3
SETS4
OS1
OS2
OS3
OS4
46
47
48
49
31
POSITION OF BUFFER
TERMINAL FLOOR LANDING POSITION
ZONE BORDER POSITION
POSITION OF CAR

FIG. 6


S21
INPUT INFORMATION FROM GOVERNOR ENCODER, INFORMATION FROM UPPER REFERENCE POSITION SENSOR, AND INFORMATION FROM LOWER REFERENCE POSITION SENSOR TO MONITORING BOARD
S22
CALCULATE POSITION OF CAR AND SPEED OF CAR
S23
IS POSITION OF CAR WITHIN VARIABLE-SPEED ZONE?
N
Y
S24
IS SPEED OF CAR EQUAL TO OR HIGHER THAN OS4?
S25
HOLD FIRST BRAKING PORTION OUT OF OPERATION
S26
CAUSE FIRST BRAKING PORTION TO OPERATE
S27
IS SPEED OF CAR EQUAL TO OR HIGHER THAN OS3?
S28
HOLD SECOND BRAKING PORTION OUT OF OPERATION
S29
CAUSE SECOND BRAKING PORTION TO OPERATE
S30
IS SPEED OF CAR EQUAL TO OR HIGHER THAN OS2?
S31
HOLD THIRD BRAKING PORTION OUT OF OPERATION
S32
CAUSE THIRD BRAKING PORTION TO OPERATE
S33
IS SPEED OF CAR EQUAL TO OR HIGHER THAN OS1?
S34
HOLD FOURTH BRAKING PORTION OUT OF OPERATION
S35
CAUSE FOURTH BRAKING PORTION TO OPERATE
S36
IS SPEED OF CAR EQUAL TO OR HIGHER THAN SETS4?
S37
HOLD FIRST BRAKING PORTION OUT OF OPERATION
S38
CAUSE FIRST BRAKING PORTION TO OPERATE
S39
IS SPEED OF CAR EQUAL TO OR HIGHER THAN SETS3?
S40
HOLD SECOND BRAKING PORTION OUT OF OPERATION
S41
CAUSE SECOND BRAKING PORTION TO OPERATE
S42
IS SPEED OF CAR EQUAL TO OR HIGHER THAN SETS2?
S43
HOLD THIRD BRAKING PORTION OUT OF OPERATION
S44
CAUSE THIRD BRAKING PORTION TO OPERATE
S45
IS SPEED OF CAR EQUAL TO OR HIGHER THAN SETS1?
S46
HOLD FOURTH BRAKING PORTION OUT OF OPERATION
S47
CAUSE FOURTH BRAKING PORTION TO OPERATE

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/021362

A. CLASSIFICATION OF SUBJECT MATTER
B66B5/02(2006.01)i, *B66B1/32*(2006.01)i, *B66B5/04*(2006.01)i, *B66B5/14* (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, B66B1/32, B66B5/04, B66B5/14

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	JP 2001-278572 A (Mitsubishi Electric Corp.), 10 October, 2001 (10.10.01), Par. Nos. [0012] to [0029]; Figs. 1 to 4 (Family: none)	1-3
Y	WO 2004/031064 A1 (Hitachi, Ltd.), 15 April, 2004 (15.04.04), Description; page 3, line 2 to page 7, line 22; Figs. 1 to 4 (Family: none)	1-3

☐ 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	Date of mailing of the international search report
16 August, 2006 (16.08.06)	29 August, 2006 (29.08.06)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2004123279 A **[0003]**