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(72) Inventor: **SHIBATA, Masunori**

Tokyo 100-8310 (JP)

(74) Representative: **HOFFMANN EITLE**

Patent- und Rechtsanwälte

Arabellastraße 4

81925 München (DE)

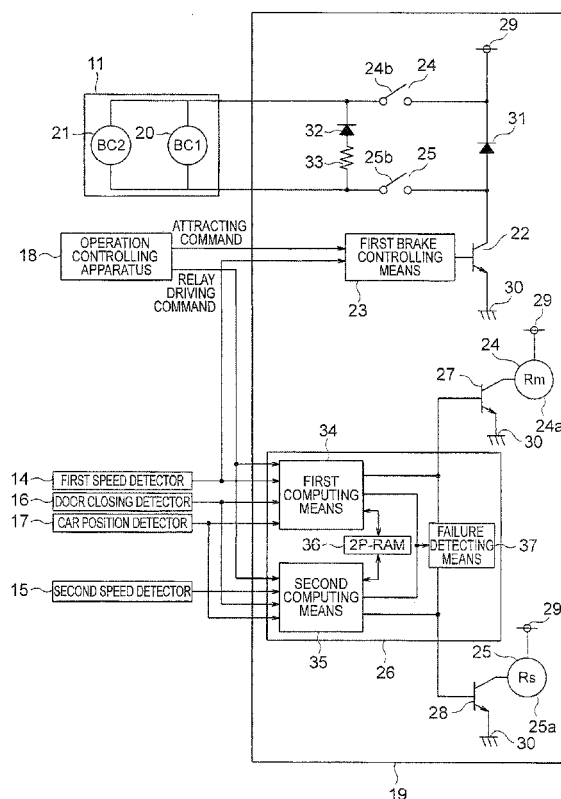
(71) Applicant: **Mitsubishi Electric Corporation**

Tokyo 100-8310 (JP)

(54) **ELEVATOR DEVICE**

(57) In an elevator apparatus, braking force on a car is generated by stopping passage of electric current to a brake coil of a braking apparatus, and generation of the braking force on the car is stopped by passing electric current to the brake coil. A brake controlling apparatus has: a first brake controlling means that controls the braking force on the car by adjusting a quantity of electric current that is passed to the brake coil, and a second brake controlling means that can forcibly stop the passage of electric current to the brake coil. The second brake controlling means has a plurality of computing means that separately determine the presence or absence of elevator abnormality based on information from predetermined detecting means, and that perform control that stops the passage of electric current to the brake coil if it is determined that there is an abnormality in the elevator.

FIG. 2



Description

TECHNICAL FIELD

[0001] The present invention relates to an elevator apparatus that performs control of a braking force that brakes a car using a brake controlling apparatus.

BACKGROUND ART

[0002] Generally, if an abnormality occurs in an elevator, a car is braked by a braking force from a brake so as to decelerate and stop the car. Conventionally, in order to reduce mechanical shock to the car during deceleration and stopping due to the braking operation, elevator braking apparatuses have been proposed that control the braking force of the brake such that the deceleration of the car is at a predetermined value. The control of the braking force of the brake is performed by comparing a deceleration command value and output from a speed detector that detects the speed of a car driving electric motor that moves the car (See Patent Literature 1).

[0003]

[Patent Literature 1]
Japanese Patent Laid-Open No. HEI 7-157211 (Gazette)

DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004] However, in conventional elevator braking apparatuses such as that described above, because control of deceleration and stopping of the car during an abnormality and control of deceleration and stopping of the car during normal conditions are performed by a common brake controlling apparatus, there is a risk that it will not be possible to stop the car forcibly using the brake during an elevator abnormality that requires stopping of the car if the brake controlling apparatus fails. Reliability in controlling the stopping of the car can also be improved by controlling deceleration and stopping of the car using a plurality of brake controlling apparatuses, but the configuration becomes complicated.

[0005] The present invention aims to solve the above problems and an object of the present invention is to provide an elevator apparatus that can stop a car more reliably during an elevator abnormality, and that can also suppress making configuration of a brake controlling apparatus complicated.

MEANS FOR SOLVING THE PROBLEM

[0006] In order to achieve the above object, according to one aspect of the present invention, there is provided an elevator apparatus characterized in including: a car that is movable inside a hoistway; a braking apparatus

that includes a brake coil, that generates a braking force that brakes the car by stopping passage of electric current to the brake coil, and that stops generation of the braking force by passing electric current to the brake coil; and a brake controlling apparatus that includes: a first brake controlling means that performs control of the braking force by adjusting a quantity of the electric current that is passed to the brake coil; and a second brake controlling means that includes a plurality of computing means that separately determine presence or absence of an abnormality in the elevator based on information from a predetermined detecting means, and that perform control that stops passage of electric current to the brake coil if it is determined that there is an abnormality in the elevator.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

Figure 1 is a structural diagram that shows an elevator apparatus according to Embodiment 1 of the present invention;

Figure 2 is a structural diagram that shows a brake controlling apparatus from Figure 1;

Figure 3 is a flowchart that explains computational processing by a first brake controlling means from Figure 2;

Figure 4 is a flowchart that explains computational processing by a first computing means from Figure 2;

Figure 5(a) through 5(d) are graphs that show respective temporal changes for speed of a car from Figure 1, car acceleration, a state of an adjusting switch from Figure 2, and a state of a first relay contact during normal operation; and

Figure 6(a) through 6(d) are graphs that show respective temporal changes for speed of the car from Figure 1 car acceleration, a state of the adjusting switch from Figure 2, and a state of the first relay contact when an abnormality occurs in car acceleration.

BEST MODE FOR CARRYING OUT THE INVENTION

[0008] A preferred embodiment of the present invention will now be explained with reference to the drawings.

Embodiment 1

[0009] Figure 1 is a structural diagram that shows an elevator apparatus according to Embodiment 1 of the present invention. In the figure, a car 2 and a counterweight 3 are suspended inside a hoistway 1 by a suspending means 4. Ropes or a belt can be used as the suspending means 4, for example. A hoisting machine (a driving apparatus) 5 that moves the car 2 and the counterweight 3 and a deflecting sheave are disposed in an upper portion of the hoistway 1.

[0010] The hoisting machine 5 has: a motor 7; and a driving sheave 8 that is rotated by the motor 7. The suspending means 4 is wound around the driving sheave 8 and the deflecting sheave 6. The car 2 and the counterweight 3 are moved inside the hoistway 1 by the driving sheave 8 being rotated.

[0011] A car doorway 9 and a pair of car doors 10 that open and close the car doorway 9 are disposed on the car 2. Each of the car doors 10 is displaced between a closed door position that closes the car doorway 9 and an open door position that opens the car doorway 9 by a driving force from a door driving apparatus that is mounted to the car 2.

[0012] Landing doorways and pairs of landing doors that open and close the landing doorways are disposed on landings on respective floors (none of which are depicted). Predetermined door opening and closing enabled zones that correspond to positions of the respective landings are set in a direction of movement of the car 2 inside the hoistway 1. When the car 2 is within a door opening and closing enabled zone, the car doors 10 can engage horizontally with the landing doors. Consequently, when the car 2 is within a door opening and closing enabled zone, the landing doors are engaged by the car doors while being displaced relative to a landing doorway by the car doors being displaced between the closed door position and the open door position. The landing doorways are opened and closed by the landing doors being displaced while being engaged by the car doors. Engagement between the car doors 10 and the landing doors is impossible when the car 2 is outside the door opening and closing enabled zones.

[0013] A braking apparatus 11 that brakes rotation of the driving sheave 8 is disposed on the hoisting machine 5. The braking apparatus 11 has: a brake disk (a rotating body) 12 that is rotated together with the driving sheave 8; braking members 13 that are displaceable toward or away from the brake disk 12; brake springs (forcing bodies) that force the braking members 13 toward the brake disk 12; and brake coils that displace the braking members 13 away from the brake disk 12 in opposition to the forces from the brake springs.

[0014] When passage of electric current to the brake coils is stopped, the braking members 13 contact the brake disk 12 due to the forces from the brake springs. Rotation of the brake disk 12 is braked by the braking members 13 contacting the brake disk 12. The braking force that brakes the car 2 is generated by the rotation of the brake disk 12 being braked. The braking members 13 are displaced away from the brake disk 12 in opposition to the forces from the brake springs by passing electric current to the brake coils. Generation of the braking force that brakes the car 2 is stopped by the braking members 13 separating from the brake disk 12.

[0015] A first speed detector (a detecting means) 14 and a second speed detector (a detecting means) 15 that separately detect rotational speed of the driving sheave 8 are disposed on the motor 7. Speed of the car 2 is

calculated based on information from the first and second speed detectors 14 and 15. Examples of first and second speed detectors 14 and 15 include encoders, etc.

[0016] A door closing detector (a detecting means) that detects whether or not the car doors 10 are in a closed door position 16 is disposed on the car 2. A car position detector (a detecting means) 17 that detects whether or not the car 2 is within a door opening and closing enabled zone is disposed inside the hoistway 1. A detector that has: plates that are fixed to an inner wall of the hoistway 1 parallel to the direction of movement of the car 2; and a plate detecting sensor that is mounted to the car 2, and that detects the plates only when the car 2 is within door opening and closing enabled zones can be used as the car position detector 17, for example.

[0017] Information from the first and second speed detectors 14 and 15 is sent to an operation controlling apparatus 18 that controls elevator operation. Information from each of the first and second speed detectors 14 and 15, the door closing detector 16, and the car position detector 17 is sent to a brake controlling apparatus 19 that controls operation of the braking apparatus 11.

[0018] When the car 2 is moved, the operation controlling apparatus 18 outputs to the brake controlling apparatus 19 an attracting command and a relay driving command that perform supply of electric power to the motor 7 and that stop the generation of the braking force on the car 2. The operation controlling apparatus 18 also determines the presence or absence of an abnormality in the acceleration of the car 2 based on the information from the first and second speed detectors 14 and 15, and stops output of the attracting command to the brake controlling apparatus 19 if it is determined that there is an abnormality in the acceleration of the car 2. In addition, the operation controlling apparatus 18 finds the speed of the car 2 based on the information from the first and second speed detectors 14 and 15, and stops output of the relay driving command to the brake controlling apparatus 19 if the car 2 stops (i.e., if the speed of the car 2 becomes zero).

[0019] The brake controlling apparatus 19 controls the operation of the braking apparatus 11 based on the respective information from the first and second speed detectors 14 and 15, the door closing detector 16, the car position detector 17, and the operation controlling apparatus 18.

[0020] Figure 2 is a structural diagram that shows the brake controlling apparatus 19 from Figure 1. In the figure, brake coils of the braking apparatus 11 have a plurality of electromagnetic coil portions 20 and 21 (in this example, two) that are connected in parallel with each other. The brake controlling apparatus 19 has: an adjusting switch 22 that can adjust the quantity of electric current that is passed to each of the electromagnetic coil portions 20 and 21; a first brake controlling means 23 that controls operation of the adjusting switch 22; a first relay 24 and a second relay 25 (a plurality of relays 24 and 25) that can forcibly stop passage of electric current

to each of the electromagnetic coil portions 20 and 21; and a second brake controlling means 26 that controls operation of the first and second relays 24 and 25.

[0021] The first relay 24 has: a first relay coil 24a; and a first relay contact 24b that is opened and closed by controlling passage of electric current to the first relay coil 24a. The second relay 25 has: a second relay coil 25a; and a second relay contact 25b that is opened and closed by controlling passage of electric current to the second relay coil 25a.

[0022] Adjustment of passage of electric current to the first relay coil 24a is performed by opening and closing operations (On/Off operation) of a first relay switch 27 that is a semiconductor switch. The first relay coil 24a and the first relay switch 27 are connected in series between an electric power source 29 and an earthed portion (ground) 30.

[0023] Adjustment of passage of electric current to the second relay coil 25a is performed by opening and closing operations (On/Off operation) of a second relay switch 28 that is a semiconductor switch. The second relay coil 25a and the second relay switch 28 are connected in series between the electric power source 29 and the earthed portion (ground) 30.

[0024] The brake coils, which include each of the electromagnetic coil portions 20 and 21, the adjusting switch 22, the first relay contact 24b and the second relay contact 25b are connected in series between the electric power source 29 and the earthed portion 30. In this example, the first relay contact 24b is connected between the brake coils and the electric power source 29, and the second relay contact 25b and the adjusting switch 22 are connected between the brake coils and the earthed portion 30.

[0025] The adjusting switch 22 is constituted by a semiconductor switch. Adjustment of the quantity of electric current that is passed to each of the electromagnetic coil portions 20 and 21 by the adjusting switch 22 is performed by repeating opening and closing operations (On/Off operation) of the adjusting switch 22 when the first relay contact 24b and the second relay contact 25b are both closed. The braking force on the car 2 is adjusted by adjusting the quantity of electric current that is passed to each of the electromagnetic coil portions 20 and 21. Passage of electric current to the electromagnetic coil portions 20 and 21 is forcibly stopped by at least one of the first relay contact 24b and the second relay contact 25b performing an opening operation.

[0026] Moreover, a discharge diode 31 is connected between the electric power source 29 and the adjusting switch 22. The discharge diode 31 protects the adjusting switch 22 from reverse electromotive pressure that is generated by each of the electromagnetic coil portions 20 and 21 if the adjusting switch 22 performs an opening operation when the first and second relay contacts 24b and 25b are in closed states. A discharge diode 32 and a discharge resistance 33 that are connected in series are connected between the first relay contact 24b and

second relay contact 25b and the brake coils. The discharge diode 32 and the discharge resistance 33 consume reverse electromotive force that is generated when at least one of the first and second relay contacts 24b and 25b performs an opening operation, and promptly lowers the quantity of electric current that is passed to each of the electromagnetic coil portions 20 and 21.

[0027] The attracting command from the operation controlling apparatus 18 and the signal from the first speed detector 14 are sent to the first brake controlling means 23. The first brake controlling means 23 controls operation of the adjusting switch 22 based on the respective information from the operation controlling apparatus 18 and the first speed detector 14. The quantity of electric current that is passed to each of the electromagnetic coil portions 20 and 21 is thereby adjusted to control the braking force on the car 2.

[0028] Specifically, the first brake controlling means 23 performs control over the adjusting switch 22 that stops generation of the braking force on the car 2 when receiving the attracting command from the operation controlling apparatus 18. In other words, the first brake controlling means 23 performs control that adjusts the quantity of electric current that is passed to each of the electromagnetic coil portions 20 and 21 such that the braking members 13 separate from the brake disk 12 when receiving the attracting command from the operation controlling apparatus 18. The first brake controlling means 23 also finds the acceleration of the car 2 based on the information from the first speed detector 14, and compares the found acceleration value and a predetermined threshold value αL (a negative value) while controlling operation of the adjusting switch 22. If deceleration (negative acceleration) of the car 2 exceeds the threshold value αL (i.e., if the acceleration of the car 2 is less than the threshold value αL), the first brake controlling means 23 performs control that maintains the acceleration of the car 2 at the threshold value αL by adjusting the braking force on the car 2 by controlling the operation of the adjusting switch 22.

[0029] The second brake controlling means 26 has a first computing means (a computing means) 34, a second computing means (a computing means) 35, a shared memory (a memory portion) 36, and a failure detecting means 37.

[0030] Respective signals from the first speed detector 14, the door closing detector 16, and the car position detector 17, and the relay driving command from the operation controlling apparatus 18 are sent to the first computing means 34. The first computing means 34 performs control of the operation of the first relay contact 24b by controlling the operation of the first relay switch 27 based on the respective information from the first speed detector 14, the door closing detector 16, the car position detector 17, and the operation controlling apparatus 18.

[0031] Specifically, the first computing means 34 performs control over the first relay switch 27 that maintains a closing operation of the first relay contact 24b when

receiving the relay driving command from the operation controlling apparatus 18, and performs control over the first relay switch 27 that performs an opening operation of the first relay contact 24b when receipt of the relay driving command is stopped. The first computing means 34 also determines the presence or absence of an elevator abnormality based on the respective information from the first speed detector 14, the door closing detector 16, and the car position detector 17. The first computing means 34 performs control over the first relay switch 27 that maintains the closing operation of the first relay contact 24b if it is determined that there is no abnormality in the elevator, and performs control over the first relay switch 27 that performs an opening operation of the first relay contact 24b if it is determined that there is an abnormality in the elevator.

[0032] The first computing means 34 determines that there is an abnormality in the elevator if the speed of the car 2 that has been found based on the information from the first speed detector 14 exceeds a speed limiting value V_{lim} . The first computing means 34 also determines that there is an abnormality in the elevator if it is determined that the car 2 is outside the door opening and closing enabled zone in a state in which the positions of the car doors 10 are displaced from the closed door position based on the respective information from the door closing detector 16 and the car position detector 17.

[0033] The speed limiting value V_{lim} is set by comparing the threshold value αL and the acceleration of the car 2 that has been found based on the information from the first speed detector 14. Specifically, the speed limiting value V_{lim} is set to a predetermined set value V_{max} if the acceleration of the car 2 is greater than or equal to the threshold value αL , and is set to a reducing value that decreases over time if the acceleration of the car 2 is less than the threshold value αL (i.e., if the deceleration of the car 2 exceeds the threshold value αL).

[0034] Respective signals from the second speed detector 15, the door closing detector 16, and the car position detector 17, and the relay driving command from the operation controlling apparatus 18 are sent to the second computing means 35. The second computing means 35 performs control of the operation of the second relay contact 25b by controlling the operation of the second relay switch 28 based on the respective information from the second speed detector 15, the door closing detector 16, the car position detector 17, and the operation controlling apparatus 18. The processing of the second computing means 35 is similar to the processing of the first computing means 34.

[0035] Specifically, the second computing means 35 performs control over the second relay switch 28 that maintains a closing operation of the second relay contact 25b when receiving the relay driving command from the operation controlling apparatus 18, and performs control over the second relay switch 28 that performs an opening operation of the second relay contact 25b when receipt of the relay driving command is stopped. The second

computing means 35 also determines the presence or absence of an elevator abnormality based on the respective information from the second speed detector 15, the door closing detector 16, and the car position detector 17. The second computing means 35 performs control over the second relay switch 28 that maintains the closing operation of the second relay contact 25b if it is determined that there is no abnormality in the elevator, and performs control over the second relay switch 28 that performs an opening operation of the second relay contact 25b if it is determined that there is an abnormality in the elevator.

[0036] The second computing means 35 determines that there is an abnormality in the elevator if the speed of the car 2 that has been found based on the information from the second speed detector 15 exceeds a speed limiting value V_{lim} . The second computing means 35 also determines that there is an abnormality in the elevator if it is determined that the car 2 is outside the door opening and closing enabled zone in a state in which the positions of the car doors 10 are displaced from the closed door position based on the respective information from the door closing detector 16 and the car position detector 17.

[0037] The speed limiting value V_{lim} is set by comparing the threshold value αL and the acceleration of the car 2 that has been found based on the information from the second speed detector 15. Specifically, the speed limiting value V_{lim} is set to a predetermined set value V_{max} if the acceleration of the car 2 is greater than or equal to the threshold value αL , and is set to a reducing value that decreases over time if the acceleration of the car 2 is less than the threshold value αL (i.e., if the deceleration of the car 2 exceeds the threshold value αL).

[0038] In other words, the first computing means 34 and the second computing means 35 determine the presence or absence of elevator abnormality separately, and perform control that stops passage of electric current to each of the electromagnetic coil portions 20 and 21 if it is determined that there is an abnormality in the elevator.

[0039] The respective processing results in the first and second computing means 34 and 35 are stored in the shared memory 36. The first and second computing means 34 and 35 obtain the respective processing results of the first and second computing means 34 and 35 separately from the shared memory 36, and determine the presence or absence of failure of the brake controlling apparatus 19 by comparing the obtained processing results. The first and second computing means 34 and 35 output a failure signal to the failure detecting means 37 if a failure determination is made. An occurrence of failure is thereby detected if failure occurs in either of the first and second computing means 34 and 35.

[0040] The failure detecting means 37 performs control over the first relay switch 27 and the second relay switch 28 that performs respective opening operations of the first relay contact 24b and the second relay contact 25b on receiving a failure signal.

[0041] Next, computational processing by the first

brake controlling means 23 will be explained. Figure 3 is a flowchart that explains computational processing by the first brake controlling means 23 from Figure 2. Computation by the first brake controlling means 23 is performed at intervals of a predetermined period. The first brake controlling means 23 determine once every computational period whether or not an attracting command is being received from the operation controlling apparatus 18 (S1).

[0042] If it is determined that the first brake controlling means 23 is receiving an attracting command, the first brake controlling means 23 performs control over the adjusting switch 22 that releases the braking force on the car 2 by adjusting the quantity of electric current that is passed to each of the electromagnetic coil portions 20 and 21 (S2), and terminates computation for the period in question. Generation of braking force on the car 2 is thereby stopped. Here, the quantity of electric current that is passed to each of the electromagnetic coil portions 20 and 21 is adjusted by repeating On/Off operation of the adjusting switch 22.

[0043] If the first brake controlling means 23 is not receiving an attracting command, the first brake controlling means 23 determines whether or not the acceleration of the car 2 that has been found based on the information from the first speed detector 14 is less than the threshold value αL (S3).

[0044] If the acceleration of the car 2 is less than the threshold value αL , the first brake controlling means 23 performs control over the adjusting switch 22 that maintains the acceleration of the car 2 at the threshold value αL (deceleration control) in order to avoid sudden deceleration of the car 2 (S4), and terminates computation for the period in question. Here, the quantity of electric current that is passed to each of the electromagnetic coil portions 20 and 21 is adjusted by repeating On/Off operation of the adjusting switch 22.

[0045] If the acceleration of the car 2 is greater than the threshold value αL , the first brake controlling means 23 performs control that performs an Off operation of the adjusting switch 22 in order to generate a braking force on the car 2 (S5), and terminates computation for the period in question.

[0046] Next, computational processing by the first computing means 34 in the second brake controlling means 26 will be explained. Figure 4 is a flowchart that explains computational processing by the first computing means 34 from Figure 2. Computation by the first computing means 34 is performed at intervals of a predetermined period. Moreover, computation by the second computing means 35 is similar to computation by the first computing means 34.

[0047] The first computing means 34 determines once every computational period whether or not the speed of the car 2 is zero (S11). If the speed of the car 2 is zero, the first computing means 34 resets time t of a timer to zero, and performs initialization processing of variables by setting the speed limiting value V_{lim} to the predeter-

mined set value V_{max} (S12). The first computing means 34 then determines whether or not a relay driving command is being received from the operation controlling apparatus 18 (S13).

[0048] If the relay driving command is being received, the first computing means 34 performs control over the first relay switch 27 that performs a closing operation (an On operation) of the first relay contact 24b (S14), and terminates computation for the period in question.

[0049] If the relay driving command is not being received, the first computing means 34 performs control over the first relay switch 27 that performs an opening operation (an Off operation) of the first relay contact 24b (S15), and terminates computation for the period in question.

[0050] If the speed of the car 2 is not zero, on the other hand, the first computing means 34 determines whether or not the car 2 is outside the door opening and closing enabled zone in a state in which the car doors 10 have been displaced from the closed door position (an open door state) (S16).

[0051] If the car 2 is outside the door opening and closing enabled zone in an open door state, the first computing means 34 performs control over the first relay switch 27 that performs an opening operation of the first relay contact 24b in order to generate a braking force on the car 2 (S15), and terminates computation for the period in question.

[0052] If the car doors 10 are in the closed door position, or if the car 2 is within the door opening and closing enabled zone, the first computing means 34 determines whether or not the absolute value of the speed of the car 2 is less than the speed limiting value V_{lim} (S17).

[0053] If the absolute value of the speed of the car 2 is greater than or equal to the speed limiting value V_{lim} , the first computing means 34 performs control over the first relay switch 27 that performs an opening operation of the first relay contact 24b (S15), and terminates computation for the period in question.

[0054] If the absolute value of the speed of the car 2 is less than the speed limiting value V_{lim} , the first computing means 34 determines whether or not time t of the timer is zero (S18).

[0055] If time t of the timer is zero, the first computing means 34 determines whether or not the acceleration of the car 2 is greater than the threshold value αL (S19). As a result, if the acceleration of the car 2 is greater than the threshold value αL , the first computing means 34 performs control over the first relay switch 27 that performs a closing operation of the first relay contact 24b (S14), and terminates computation for the period in question. If the acceleration of the car 2 is less than or equal to the threshold value αL , the first computing means 34 sets time t of the timer to $(t+1)$ (S20), then performs control over the first relay switch 27 that performs a closing operation of the first relay contact 24b (S14), and terminates computation for the period in question.

[0056] If time t of the timer is not zero, on the other

hand, the first computing means 34 determines whether or not time t of the timer is greater than a preset set time $t_{\max}$ (S21).

[0057] If time t of the timer is less than or equal to the set time $t_{\max}$, the first computing means 34 sets time t of the timer to $(t+1)$ (S20), then performs control over the first relay switch 27 that performs a closing operation of the first relay contact 24b (S14), and terminates computation for the period in question.

[0058] If time t of the timer is greater than the set time $t_{\max}$, the speed limiting value $V_{\lim}$ is set to $(V_{\lim} - V1)$ (S22), then control is performed over the first relay switch 27 that performs a closing operation of the first relay contact 24b (S14), and terminates computation for the period in question. Moreover, $V1$ is a preset fixed value. The speed limiting value $V_{\lim}$ can thereby be set to a value that decreases over time.

[0059] Next, temporal changes in the speed of the car 2, in the acceleration of the car 2, in the state of the adjusting switch 22, and in the state of the first relay contact 24b during normal operation will be explained. Figures 5 (a) through 5(d) are graphs that show respective temporal changes for the speed of the car 2 from Figure 1, the acceleration of the car 2, the state of the adjusting switch 22 from Figure 2, and the state of the first relay contact 24b during normal operation. During normal operation, because acceleration of the car 2 is maintained at greater than or equal to the threshold value αL (i.e., sudden deceleration of the car 2 does not occur) (Figure 5(b)), control that releases the braking force on the car 2 is performed over the adjusting switch 22. Here, the quantity of electric current that is passed to each of the electromagnetic coil portions 20 and 21 is adjusted by the adjusting switch 22 repeating On/Off operation.

[0060] Moreover, in reality the On/Off operation of the adjusting switch 22 is repeated in order to adjust the quantity of electric current that is passed to each of the electromagnetic coil portions 20 and 21, but the On/Off operation of the adjusting switch 22 has been omitted in Figure 5(c). Because the speed of the car 2 is maintained at a value that is lower than the speed limiting value $V_{\max}$ during normal operation (Figure 5(a)), control that performs a closing operation of the first relay contact 24b is performed over the first relay switch 27.

[0061] Next, temporal changes in the speed of the car 2, in the acceleration of the car 2, in the state of the adjusting switch 22, and in the state of the first relay contact 24b when the car 2 is suddenly decelerated will be explained. Figures 6(a) through 6(d) are graphs that show respective temporal changes for the speed of the car 2 from Figure 1, the acceleration of the car 2, the state of the adjusting switch 22 from Figure 2, and the state of the first relay contact 24b when an abnormality occurs in the acceleration of the car 2.

[0062] If an elevator abnormality occurs at time $t1$, output of the attracting command from the operation controlling apparatus 18 to the brake controlling apparatus 19 and supply of electric power to the motor 7 are

stopped. Thus, the speed and acceleration of the car 2 first increase due to imbalances between the car 2 and the counterweight 3 (Figure 6(a) and Figure 6(b)). Next, the adjusting switch 22 is opened to stop passage of electric current to the electromagnetic coil portions 20 and 21. The car 2 is thereby rapidly decelerated, and the acceleration of the car 2 becomes less than the threshold value αL at time $t2$.

[0063] When the acceleration of the car 2 becomes less than the threshold value αL , the opening and closing operations of the adjusting switch 22 are repeated under control from the brake controlling apparatus 19 (Figure 6(c)) to maintain the acceleration of the car 2 at the threshold value αL (Figure 6(b)). Here, when a set time $t_{\max}$ has elapsed from time $t2$, the value of the speed limiting value $V_{\lim}$ is set to a value that decreases over time from the set value $V_{\max}$.

[0064] The speed of the car 2 is maintained at less than or equal to the speed limiting value $V_{\lim}$, and when the car 2 is at a sufficiently low speed at time $t3$, the repeated operation of opening and closing the adjusting switch 22 is stopped, and the state of the adjusting switch 22 is maintained in the open state (the Off state) (Figure 6(c)).

[0065] Next, when the car 2 is stopped completely at time $t4$, output of the relay driving command from the operation controlling apparatus 18 to the brake controlling apparatus 19 is stopped (Figure 6(d)). Thus, the first and second relay contacts 24b and 25b are both opened.

[0066] If the speed of the car 2 exceeds the speed limiting value $V_{\lim}$ when the car 2 is moving, at least one of the first and second relay contacts 24b and 25b is opened under control from the brake controlling apparatus 19, irrespective of the presence or absence of output of the relay driving command from the operation controlling apparatus 18. Thus, passage of electric current to each of the electromagnetic coil portions 20 and 21 is forcibly stopped, generating braking force on the car 2.

[0067] In an elevator apparatus of this kind, because a first brake controlling means 23 that controls the quantity of electric current that is passed to each of the electromagnetic coil portions 20 and 21, and a second brake controlling means 26 that includes a plurality of computing means 34 and 35 that separately determine the presence or absence of elevator abnormality, and perform control that stops passage of electric current to each of the electromagnetic coil portions 20 and 21 if it is determined that there is an abnormality in the elevator are disposed on the brake controlling apparatus 19, the presence or absence of the elevator abnormality can be monitored by each of the computing means 34 and 35 separately, and even if either of the computing means 34 and 35 or the first brake controlling means 23 fails, the car 2 can be stopped more reliably during an elevator abnormality under control from the remaining normal computing means. Because it is no longer necessary to dispose a plurality of brake controlling apparatuses in order to improve reliability in controlling the stopping of

the car 2, complication of the configuration of the brake controlling apparatus 19 can be suppressed.

[0068] Because each of the computing means 34 and 35 prepares a speed limiting value V_{lim} that decreases over time if deceleration of the car 2 exceeds a threshold value αL , and performs control that stops passage of electric current to each of the electromagnetic coil portions 20 and 21 if the speed of the car 2 exceeds the speed limiting value V_{lim} , abnormalities in the speed of the car 2 can be determined at a stage when the speed of the car 2 is low, enabling the stopping of the car 2 during an elevator abnormality to be made even more reliable.

[0069] Because each of the computing means 34 and 35 performs control that stops passage of electric current to each of the electromagnetic coil portions 20 and 21 if it is determined that the car 2 is outside the door opening and closing enabled zone in a state in which the positions of the car doors 10 have been displaced from the closed door position, elevator abnormality can be determined even if the speed or acceleration of the car 2 is not abnormal, enabling the safety level of the elevator to be improved.

[0070] Moreover, in the above example, the number of computing means 34 and 35 is assumed to be two, but the number of computing means may also be set to three or more.

Claims

1. An elevator apparatus **characterized in** comprising:

a car that is movable inside a hoistway;
a braking apparatus that comprises a brake coil, that generates a braking force that brakes the car by stopping passage of electric current to the brake coil, and that stops generation of the braking force by passing electric current to the brake coil; and
a brake controlling apparatus that comprises:

a first brake controlling means that performs control of the braking force by adjusting a quantity of the electric current that is passed to the brake coil; and
a second brake controlling means that includes a plurality of computing means that separately determine presence or absence of an abnormality in the elevator based on information from a predetermined detecting means, and that perform control that stops passage of electric current to the brake coil if it is determined that there is an abnormality in the elevator.

2. An elevator apparatus according to Claim 1, **characterized in that**:

a speed detector that detects a speed of the car is included in the detecting means; and
each of the computing means prepares a speed limiting value that decreases over time if deceleration of the car that has been found based on information from the speed detector exceeds a predetermined threshold value, and performs control that stops passage of electric current to the brake coil if the speed of the car exceeds the speed limiting value.

3. An elevator apparatus according to Claim 1, **characterized in that**:

a car door position detector that detects whether or not a car door is in a closed door position that closes a car doorway, and a car position detector that detects whether or not the car is within a door opening and closing enabled zone in which the car door and a landing door that opens and closes a landing doorway can engage are included in the detecting means; and
each of the computing means performs control that stops passage of electric current to the brake coil if it is determined that the car is outside the door opening and closing enabled zone in a state in which a position of the car door is displaced from the closed door position based on respective information from the car door position detector and the car position detector.

FIG. 1

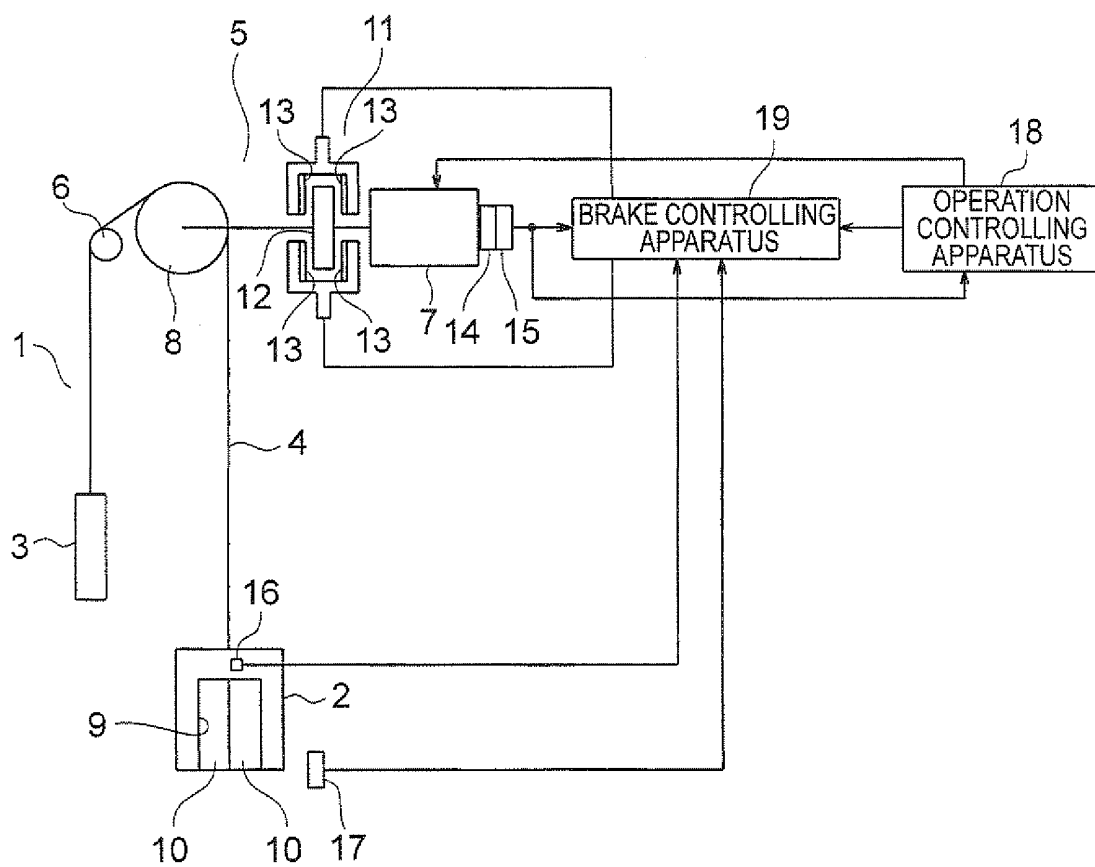


FIG. 2

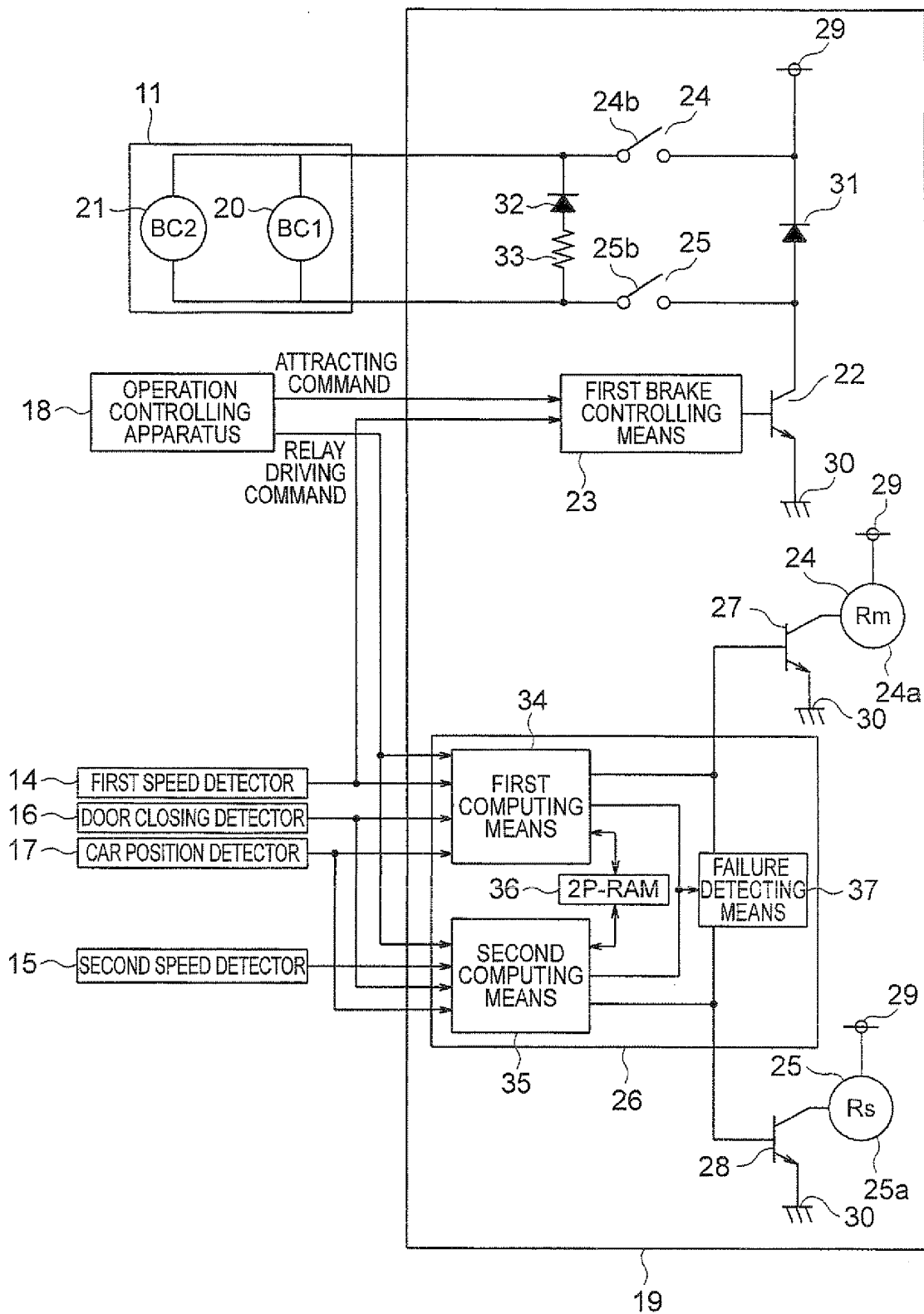


FIG. 3

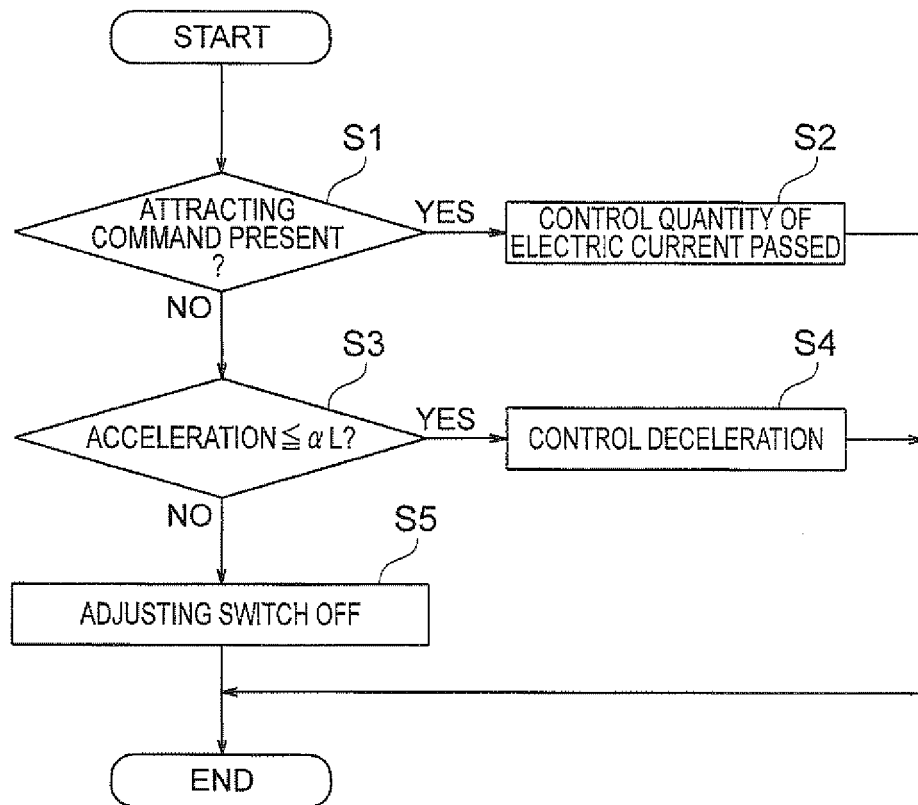


FIG. 4

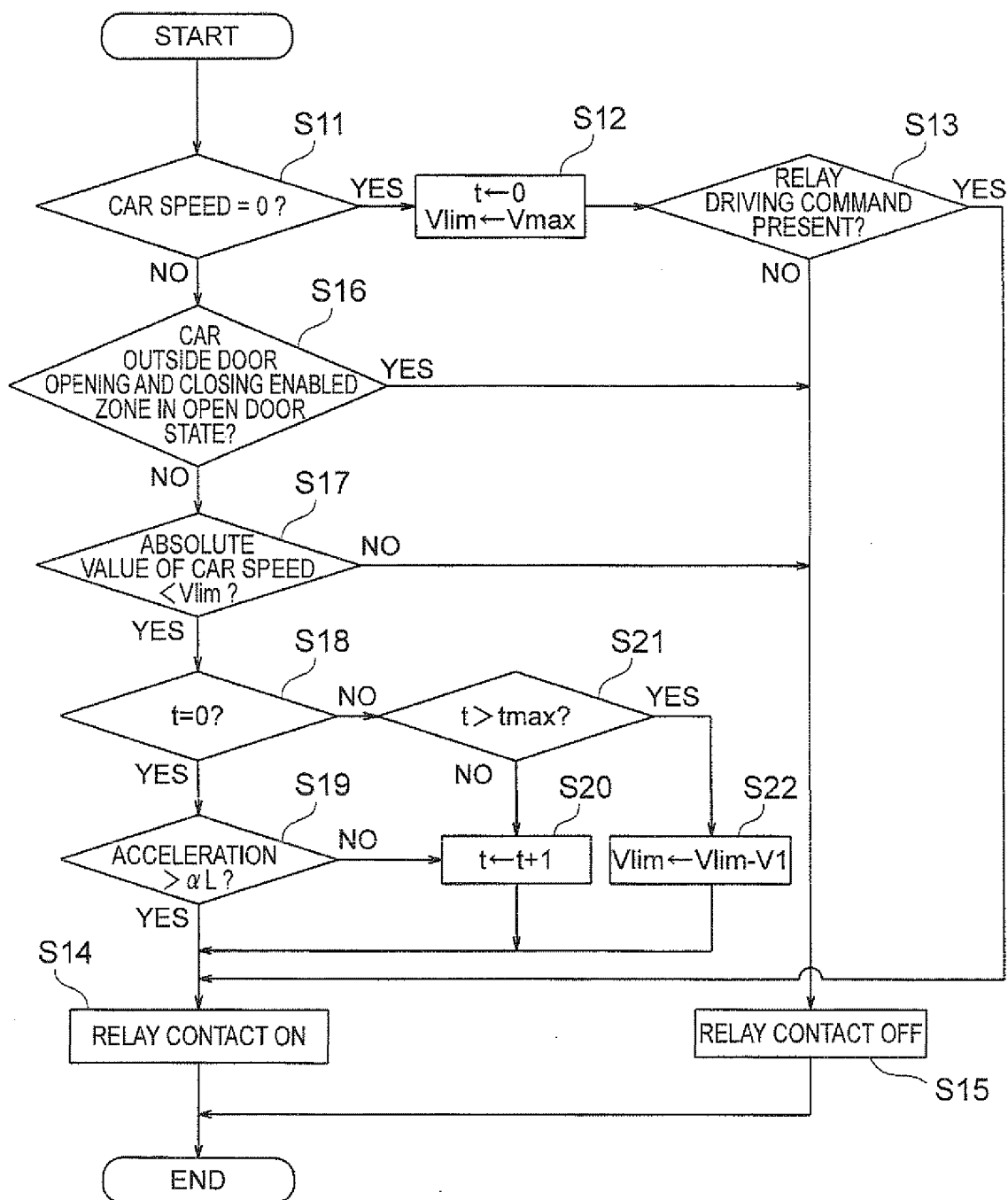


FIG. 5

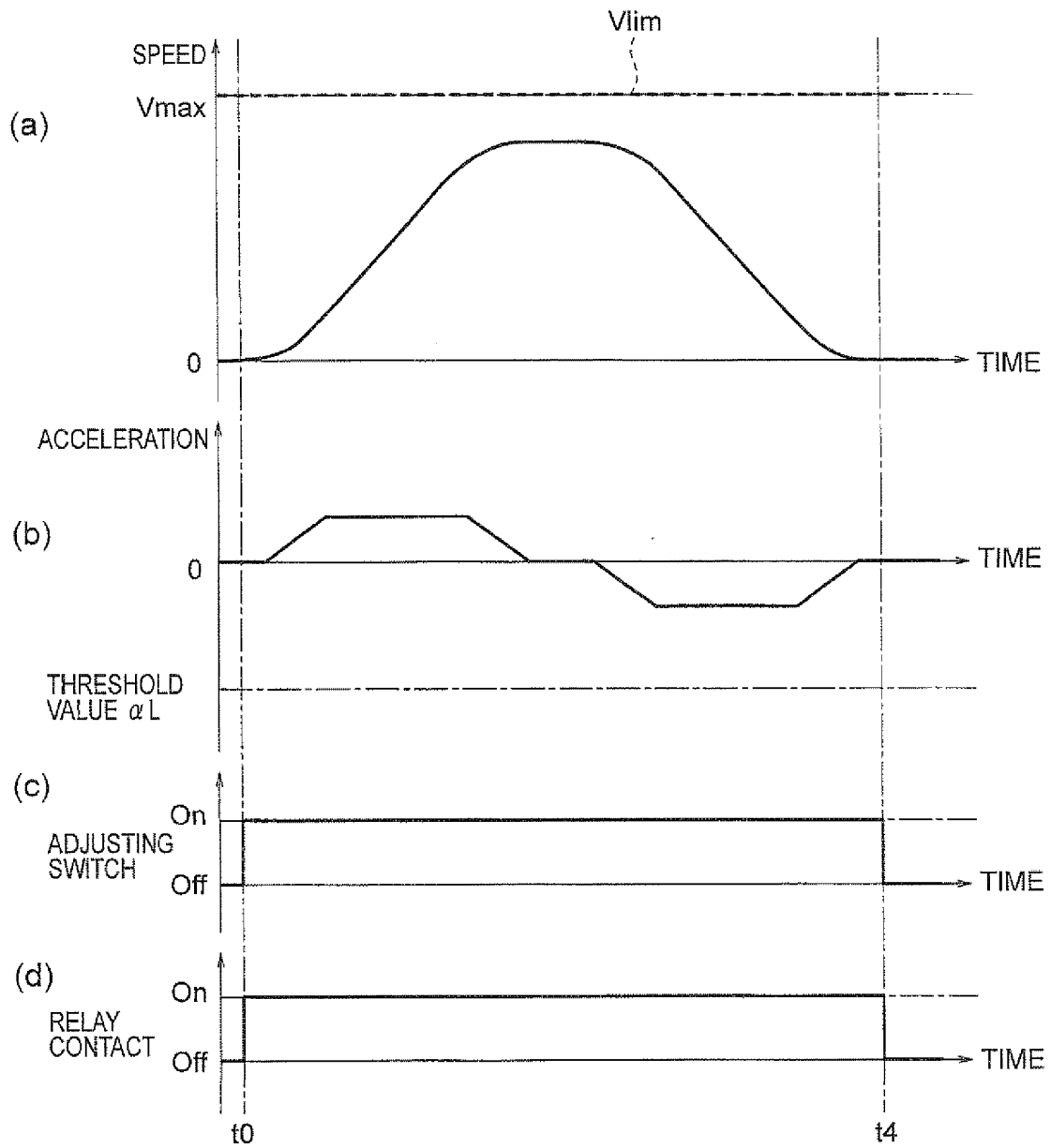
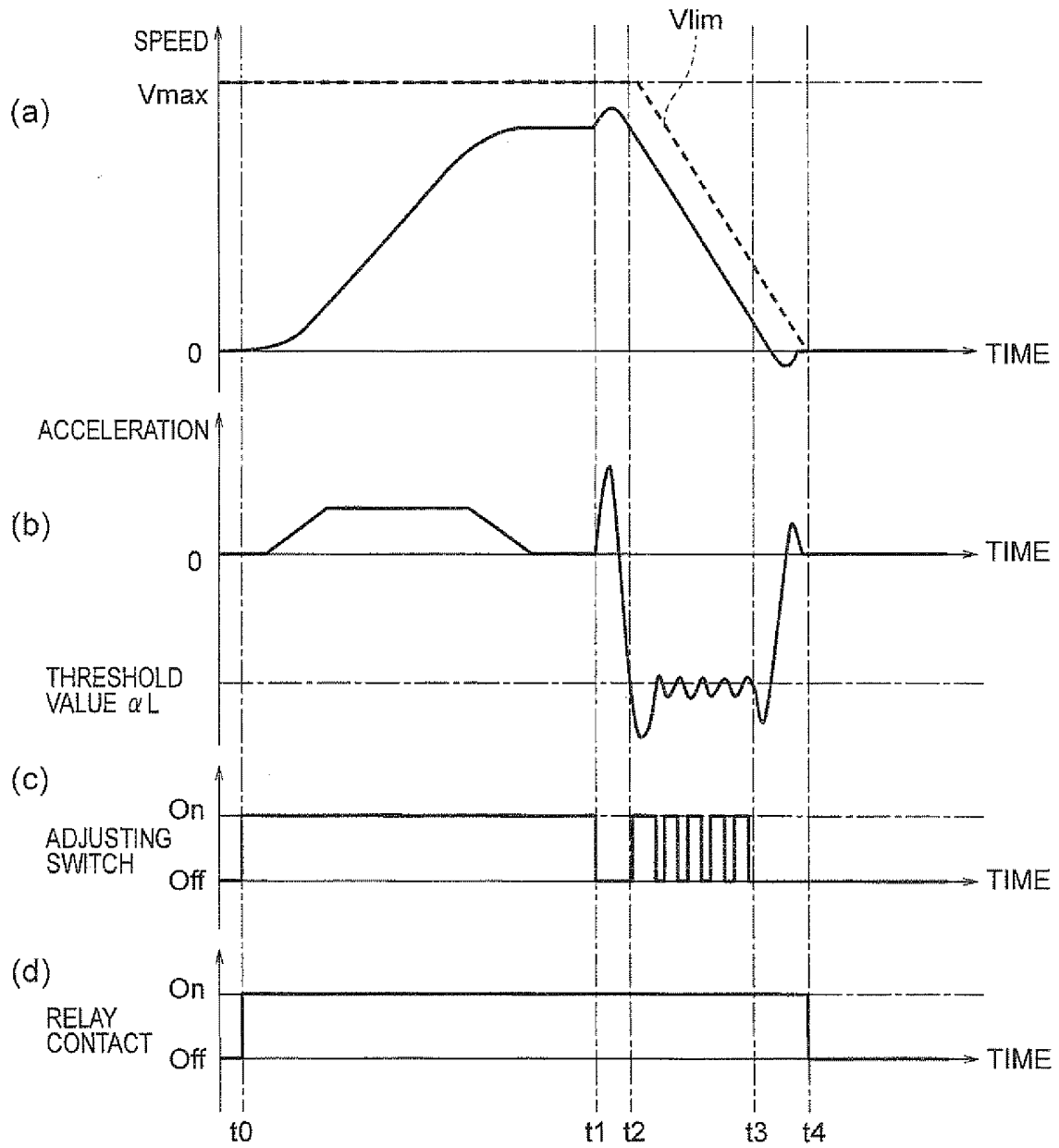


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/072162

A. CLASSIFICATION OF SUBJECT MATTER

B66B5/02 (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

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 1996-2009

Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009

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.
X Y	WO 2008/136114 A1 (Mitsubishi Electric Corp.), 13 November, 2008 (13.11.08), Full text; all drawings (Family: none)	1, 3 2
Y A	WO 2007/099633 A1 (Mitsubishi Electric Corp.), 07 September, 2007 (07.09.07), Full text; all drawings & EP 1990305 A1 & CN 101128380 A	2 1
A	JP 11-139733 A (Hitachi, Ltd.), 25 May, 1999 (25.05.99), Full text; all drawings (Family: none)	3

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

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"&" document member of the same patent family

Date of the actual completion of the international search

29 May, 2009 (29.05.09)

Date of mailing of the international search report

09 June, 2009 (09.06.09)

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP HEI7157211 B [0003]