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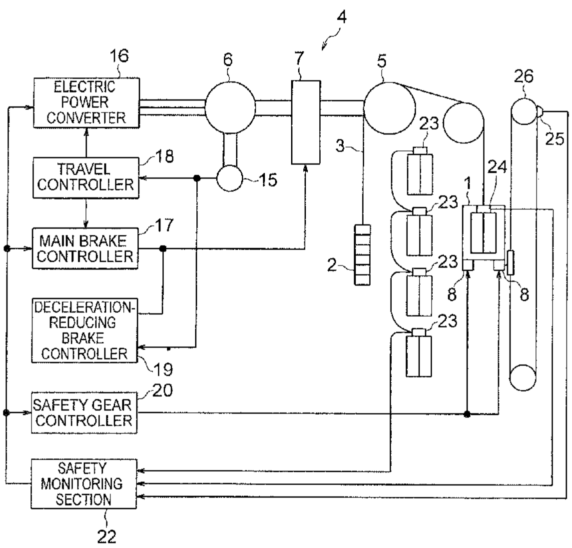
(54) ELEVATOR APPARATUS

(57) In an elevator apparatus, a safety monitoring section detects an abnormal state relating to an operation based on signals from a plurality of sensors for detecting states of a plurality of elevator equipments. Upon detection of the abnormal state, the safety monitoring section causes a plurality of types of braking devices to selectively perform a braking operation according to the type of abnormal state to reduce the speed of the car to stop the car.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to an elevator apparatus including a safety monitoring section for detecting an abnormal state relating to an operation based on signals from a plurality of sensors.

Background Art

[0002] In a conventional elevator apparatus, a wedge type safety gear is made to electrically perform a braking operation by signals from a car door opening/closing sensor and a car speed sensor when the car is raised or lowered with a car door open. In this manner, the time to generation of a braking force is intended to be reduced (for example, see Patent Document 1).

[0003]

Patent Document 1: WO2004/083091

Disclosure of the Invention

Problem to be Solved by the Invention

[0004] However, the braking force of the safety gear is set to deal with the sum of the weight of a car and the loaded weight in the case where a main rope breaks, and hence the braking force of the safety gear is extremely large. If the safety gear is made to perform the braking operation where the main rope did not break, the shock at the time of speed reduction becomes large. On the other hand, the selection of a braking method cannot be set in detail according to the type of abnormal state in the conventional elevator apparatus, and there is fear that the car may be stopped at an unnecessarily large deceleration.

[0005] The present invention is devised to solve the problem as described above, and has an object of obtaining an elevator apparatus capable of stopping a car with an appropriate braking force according to the type of abnormal state.

Means for Solving the Problem

[0006] An elevator apparatus according to the present invention includes: a car raised and lowered in a hoistway; a plurality of braking device types for decelerating and stopping the car; a plurality of sensors for detecting the state of a plurality of elevator equipments; and a safety monitoring section for detecting an abnormal state relating to an operation based on signals from the sensors and causing the braking devices to selectively perform a braking operation according to the type of abnormal state.

Brief Description of the Drawings

[0007]

[FIG. 1] A configuration diagram illustrating an elevator apparatus according to a first embodiment of the present invention.

[FIG. 2] A configuration diagram illustrating in detail a relation of a hoisting machine brake, a main brake controller, and a deceleration-reducing brake controller illustrated in FIG. 1.

[FIG. 3] A circuit diagram illustrating a control circuit of the hoisting machine brake illustrated in FIG. 1.

[FIG. 4] A configuration diagram illustrating a safety gear illustrated in FIG. 1.

[FIG. 5] A sectional view taken along a line V-V illustrated in FIG. 4.

[FIG. 6] A flowchart illustrating an operation of a safety monitoring section illustrated in FIG. 1, for selecting a braking device.

[FIG. 7] An explanatory view illustrating a relation between statuses of various sensors and the braking device selected by the safety monitoring section illustrated in FIG. 1.

[FIG. 8] A configuration diagram illustrating an elevator apparatus according to a second embodiment of the present invention.

[FIG. 9] A flowchart illustrating an operation of a safety monitoring section illustrated in FIG. 8, for selecting a braking device.

[FIG. 10] An explanatory view illustrating a relation between statuses of various sensors and the braking device selected by the safety monitoring section illustrated in FIG. 8.

[FIG. 11] A flowchart illustrating an operation of a safety monitoring section according to a third embodiment of the present invention, for selecting a braking device.

[FIG. 12] An explanatory view illustrating a relation between statuses of various sensors and the braking device selected by the safety monitoring section in the third embodiment.

[FIG. 13] A flowchart illustrating an operation of a safety monitoring section according to a fourth embodiment of the present invention, for selecting a braking device.

[FIG. 14] An explanatory view illustrating a relation between statuses of various sensors and the braking device selected by the safety monitoring section in the fourth embodiment.

[FIG. 15] A configuration diagram illustrating an elevator apparatus according to a fifth embodiment of the present invention.

[FIG. 16] A flowchart illustrating an operation of a safety monitoring section illustrated in FIG. 15, for selecting a braking device.

Best Mode for Carrying out the Invention

[0008] Hereinafter, preferred embodiments of the present invention are described referring to the drawings.

First Embodiment

[0009] FIG. 1 is a configuration diagram illustrating an elevator apparatus according to a first embodiment of the present invention. In FIG. 1, a car 1 and a counterweight 2 are suspended by a main rope 3 in a hoistway, and are raised and lowered in the hoistway by a driving force of a hoisting machine 4. In the hoistway, a pair of guide rails 9 (FIG. 4) for guiding the raising and lowering of the car 1 and a pair of counterweight guide rails (not shown) for guiding the raising and lowering of the counterweight 2 are provided.

[0010] The hoisting machine 4 includes a driving sheave 5 around which the main rope 3 is looped, a motor 6 for rotating the driving sheave 5, and a hoisting machine brake 7 serving as a braking device for braking the rotation of the driving sheave 5. A safety gear 8 serving as a braking device for gripping the car guide rails 9 to brake the car 1 is mounted to the car 1. Both the hoisting machine brake 7 and the safety gear 8 electrically operate in response to a brake command signal.

[0011] A hoisting machine speed detector 15 for generating a signal according to a rotation speed of a rotation shaft of the motor 6, specifically, a rotation speed of the driving sheave 5 is provided to the motor 6. For example, an encoder or a resolve is used as the hoisting machine speed detector 15.

[0012] The motor 6 is supplied with electric power from an electric power converter 16 such as an inverter. The hoisting machine brake 7 is controlled by a main brake controller 17. The electric power converter 16 and the main brake controller 17 are controlled by a travel controller 18. The travel controller 18 controls the electric power converter 16 and the main brake controller 17 in response to a signal from the hoisting machine speed detector 15.

[0013] The braking force of the hoisting machine brake 7 can be controlled by a deceleration-reducing brake controller 19. Upon generation of a command for quickly stopping the car 1, the deceleration-reducing brake controller 19 monitors a deceleration of the car 1 based on the signal from the hoisting machine speed detector 15 to control the braking force of the hoisting machine brake 7 so as to keep the deceleration of the car 1 at a predetermined value or less.

[0014] The safety gear 8 is controlled by an safety gear controller 20. The electric power converter 16, the main brake controller 17, and the safety gear controller 20 are contralled by a safety monitoring section 22. The safety monitoring section 22 detects an abnormal state (hazardous event) relating to operation based on signals from a plurality of sensors for detecting respective states of a plurality of elevator equipments, and selectively causes the hoisting machine brake 7 and the safety gear controller 20 to perform a braking operation according to the type of abnormal state. Moreover, upon detection of the abnormal state, the safety monitoring section 22 stops power feeding to the motor 6 from the electric power converter 16.

[0015] The sensors used in the first embodiment include a plurality of landing door switches 23, a car door switch 24, and a governor speed detector 25. Each of the landing door switches 23 detects the opening/closing of a corresponding landing door. The car door switch 24 detects the opening/closing of a car door. The governor speed detector 25 generates a signal according to a rotation speed of a governor sheave 26 which rotates in conjunction with the raising and lowering of the car 1. In place of the signal from the governor speed detector 25 , the signal from the hoisting machine speed detector 15 may be input to the safety monitoring section 22.

[0016] All of the travel controller 18, the main brake controller 17, the deceleration-reducing brake controller 19, the safety gear controller 20, and the safety monitoring section 22 include a computer having an arithmetic processing section (such as a CPU), a storage section (such as aROM, aRAM, or a hard disk), and a signal input/output section. The functions of the travel controller 18, the main brake controller 17, the deceleration-reducing brake controller 19, the safety gear controller 20, and the safety monitoring section 22 can be realized by arithmetic processing with the computer.

[0017] FIG. 2 is a configuration diagram illustrating in detail the relation of the hoisting machine brake 7, the main brake controller 17, and the deceleration-reducing brake controller 19 illustrated in FIG. 1. The hoisting machine brake 7 is a friction brake device including a brake shoe 12 which is brought into contact with and brought away from a brake wheel 10 which is rotated in cooperation with the driving sheave 5, a brake spring 13 for pressing the brake shoe 12 against the brake wheel 10, and a brake coil 14 for bringing the brake shoe 12 away from the brake wheel 10 in opposition to the brake spring 13.

[0018] The main brake controller 17 follows a command from the travel controller 18 to control the hoisting-machine brake 7. Specifically, during a normal operation, upon receipt of a start signal from the travel controller 18, the main brake controller 17 starts energizing the brake coil 14 to release the hoisting machine brake 7. When the car 1 is stopped at a stop floor, the main brake controller 17 receives a stop signal from the travel controller 18 to de-energize the brake coil 14, causing the hoisting machine 7 to perform the braking operation, to maintain a resting state of the car 1.

[0019] When a command for quickly stopping the car 1 is issued from the safety monitoring section 22, the main brake controller 17 also de-energizes the brake coil 14 and causes the hoisting machine brake 7 to perform the braking operation.

[0020] When the deceleration of the car 1, which is estimated based on the signal from the hoisting machine speed detector 15, becomes a predetermined value or larger at this time, the deceleration-reducing brake controller 19 connected to the brake coil 14 in parallel to the main brake controller 17 starts energizing the brake coil 14 of the hoisting machine brake 7 independently of the main brake controller 17. In this manner, the deceleration-reducing brake controller 19 reduces the braking force to reduce the car speed to stop the car 1 while controlling the deceleration of the car to be closer to the predetermined value. As a result, shock at the time of speed reduction when the hoisting machine brake 7 performs the braking operation can be reduced, reducing the effect on passengers.

[0021] FIG. 3 is a circuit diagram illustrating a control circuit of the hoisting machine brake 7 illustrated in FIG. 1. The main brake controller 17 and the deceleration-reducing brake controller 19 are connected in parallel to the brake coil 14. Specifically, if electric power is supplied from at least any one of the main brake controller 17 and the deceleration-reducing brake controller 19, the braking force of the hoisting machine brake 17 is cancelled.

[0022] The main brake controller 17 closes a pair of main contacts 27 to allow the electric power to be supplied from a first power source 28 to the brake coil 14. A first semiconductor switch 29 such as a MOS-FET is connected between the first power source 28 and the main contacts 27. The first semiconductor switch 29 performs high-speed switching to generate an average voltage according to an ON/OFF time ratio (step-down chopper). The first semiconductor switch 29 is controlled by a command signal generated by the computer of the travel controller 18.

[0023] A first freewheeling diode 30 is connected to the first power source 28 in parallel to the brake coil 14. The first freewheeling diode 30 protects the circuit from a back electromotive force generated in the brake coil 14.

[0024] The deceleration-reducing brake controller 19 closes a pair of contacts 31 for controlling deceleration to allow the electric power to be supplied from a second power source 32 to the brake coil 14. A second semiconductor switch 33 such as the MOS-FET and a resistor 34 serving as a current-limiting resistor are connected between the second power source 32 and the contacts 31 for controlling deceleration. The second semiconductor switch 33 performs high-speed switching to generate an average voltage according to an ON/OFF time ratio (step-down chopper). The second semiconductor switch 33 is controlled by a command signal generated by the computer of the deceleration-reducing brake controller 19.

[0025] The resistor 34 limits current flowing through the brake coil 14 even when a turn-on error occurs in the second semiconductor switch 33. A second freewheeling diode 35 is connected to the second power source 32 in parallel to the brake coil 14. The second freewheeling diode 35 protects the circuit from the back electromotive force generated in the brake coil 14.

[0026] A circuit obtained by connecting a diode 36 and a resistor 37 in series is connected in parallel to the brake coil 14. The circuit including the diode 36 and the resistor 37 quickly consumes the back electromotive force generated in the brake coil 14 when the main contacts 27 or the contacts 31 for controlling deceleration are opened.

[0027] FIG. 4 is a configuration diagram illustrating the safety gear 8 illustrated in FIG. 1, and FIG. 5 is a sectional view taken along a line V-V illustrated in FIG. 4. A mounting frame 47 is mounted to the car 1. An upper guide rod 48a and a lower guide rod 48b are mounted to the mounting frame 47. The upper guide rod 48a and the lower guide rod 48b are arranged horizontally to be parallel to each other with a vertical distance therebetween.

[0028] A housing 42 is provided inside the mounting frame 47. Slide guides 42a and 42c, and 42b and 42d are provided to an upper part and a lower part of the housing 42, respectively. The upper guide rod 48a penetrates through the slide guides 42a and 42c, whereas the lower guide rod 48b penetrates through the slide guides 42b and 42d. As a result, the housing 42 is horizontally slidable along the guide rods 48a and 48b with respect to the mounting frame 47.

[0029] A movable rail stopper 41 is mounted on one side of the housing 42 with respect to the car guide rail 9 with a predetermined gap from the car guide rail 9 being ensured. The movable rail stopper 41 is rotatably mounted to a main shaft 43 mounted on the housing 42.

[0030] On an outer peripheral portion of the movable rail stopper 41, which is on the side closer to the car guide rail 9 with respect to a center of rotation Cn, an upper cylindrical surface 41a having a center at a position Pup which is offset upward from the center of rotation Cn, a lower cylindrical surface 41b having a center at a position Pdn which is offset downward from the center of rotation Cn, and a rail contact portion 41c connecting the cylindrical surfaces 41a and 41b are provided. An upper brake shoe 44a is provided to be adjacent to an upper end of the upper cylindrical surface 41a. Further, a lower brake shoe 44b is provided to be adjacent to a lower end of the lower cylindrical surface 41b.

[0031] The center Pup of the upper cylindrical surface 41a is situated nearer to a Y-axis in a second quadrant of an X-Y coordinate having the center Cn as a center, whereas the center Pdn of the lower cylindrical surface 41b is situated nearer to the Y-axis in a third quadrant of the X-Y coordinate.

[0032] On the other side of the housing 42 with respect to the car guide rail 9, a fixed rail stopper 45 is mounted with a predetermined gap from the car guide rail 9 being ensured. The movable rail stopper 41 and the fixed rail stopper 45 are opposed to each other with the car guide rail 9 being interposed therebetween. A pressing element 46 is provided on one side of the fixed rail stopper 45, which is opposite to the car guide rail 9 side. The pressing element 46 includes, for example, a plurality of disc springs, and is fixed to the housing 42.

[0033] A plurality of elastic elements 49a and 49b are provided between the slide guides 42a and 42b and a left end of the mounting frame 47, respectively. As the elastic elements 49a and 49b, for example, coil springs for surrounding the guide rods 48a and 48b are used.

[0034] On one side of the mounting frame 47, which is opposite to the housing 42 side, a retention/release mechanism 50 (FIG. 5) of the elastic elements 49a and 49b is provided. A configuration of the retention/release mechanism 50 is as follows. Specifically, a fixed iron core 52 is fixed to the mounting frame 47. The fixed iron core 52 includes a coil 51 incorporated therein. A movable iron core 53 is provided on one end of the fixed iron core 52. The fixed iron core 52, the coil 51, and the movable iron core 53 constitute an electromagnetic magnet 54.

[0035] In the center of the movable iron core 53, a drawing pin 55 is fixed. The drawing pin 55 penetrates through the fixed iron core 52 in its center. A plurality of adjustment nuts 58 are screwed on the drawing pin 55. By adjusting the positions of the adjustment nuts 58, a gap between the movable iron core 53 and the fixed iron core 52 can be set to have a predetermined value.

[0036] A retention lever 57 which is pivotably through a rotation supporting pin 56 is coupled to the fixed iron core 52. An adjustment bolt 59 for gap distribution is screwed on the side of the housing 42, which is opposite to the car guide rail 9 side. A tip of the retention lever 57 abuts against the adjustment bolt 59 for gap distribution.

[0037] At normal times, the electromagnetic magnet 54 is magnetized by the safety gear controller 20 to maintain a state where the movable iron core 53 is attracted to the fixed iron core 52. Therefore, the drawing pin 55 is retained so as not to move in an axial direction to restrict the pivot of the retention lever 57 in a clockwise direction illustrated in FIG. 5.

[0038] The housing 42 is biased by the elastic elements 49a and 49b toward the side where the movable rail stopper 41 comes into contact with the car guide rail 9. Since the adjustment bolt 59 for gap distribution, which is mounted to the housing 42, abuts against the retention lever 57, displacement of the housing 42 in a direction in which the movable rail stopper 41 comes into contact with the car guide rail 9 is regulated.

[0039] The retaining force of the electromagnetic magnet 54 is set to allow the force of the drawing pin 55 for inhibiting the pivot of the retention lever 57 to overwhelm the biasing force of the elastic elements 49a and 49b on the housing 42.

[0040] Upon reception of an abnormality detection signal from the safety monitoring section 22, the safety gear controller 20 de-energizes the coil 51 of the electromagneticmagnet 54. Therefore, the retention force of the electromagnetic magnet 54 disappears. As a result, the regulation of the displacements of the movable iron core 53 and the drawing pin 55 is cancelled to cause the housing 42 to be displaced in a right-hand direction of FIG. 4 by the pressing force of the elastic elements 49a and 49b. At the same time, the retention lever 57 pivots in a clockwise direction of FIG. 5.

[0041] When the rail contact portion 41c of the movable rail stopper 41 is caused to abut against the car guide rail 9 by the displacement of the housing 42, the movable rail stopper 41 is rotated in a direction according to a running direction (raising or lowering) of the car 1. For example, when the car 1 is being lowered, the movable rail stopper 41 is rotated in a counterclockwise direction of FIG. 4.

[0042] When the movable rail stopper 41 is rotated in the counterclockwise direction, the position of the center Pdn of the lower cylindrical surface 41b shifts toward the car guide rail 9. Therefore, the movable rail stopper 41 itself is displaced together with the housing 42 in a left-hand direction of FIG. 4 while being in contact with the car guide rail 9. After the further rotation of the movable rail stopper 41, the fixed rail stopper 45 comes into contact with the car guide rail 9 to compress the pressing element 46.

[0043] Then, after the further rotation of the movable rail stopper 41, the lower brake shoe 44 comes into contact with the car guide rail 9 to be in a surface abutting state. At this time, the car guide rail 9 is gripped between the lower brake shoe 44b and the fixed rail stopper 45 by a predetermined pressing force of the press ing element 46. Therefore, the car 1 is reduced in speed to be stopped with a desired braking force.

[0044] When the car 1 is being raised, the direction of rotation of the movable rail stopper 41 after coming into contact with the car guide rail 9 is the clockwise direction of FIG. 4. The subsequent operation is substantially the same as that performed when the car 1 is being lowered.

[0045] According to the safety gear 8 as described above, the braking operation can be started by an electric signal earlier than that performed by the safety gear which grips a governor rope of a governor for braking. As a result, operation time can be improved to be comparable to that of the hoisting machine brake 7. Moreover, the car 1 can be braked by a single mechanism regardless of whether the running direction of the car 1 is an upward direction or a downward direction.

[0046] FIG. 6 is a flowchart illustrating an operation of the safety monitoring section 22 illustrated in FIG. 1, for selecting the braking device. The safety monitoring section 22 constantly monitors speed based on the signal from the governor speed detector 25, and continues monitoring when the speed of the car is zero (Step S1). When the car speed is not zero, specifically, when the car 1 is moving, statuses of the landing door switches 23 are verified (Step S2).

[0047] When even one of the landing doors is open, status of the car door switch 24 is verified (Step S3). When the car door is also open, the abnormality detection signal is output to the safety gear controller 20. Specifically, when at least one of the landing doors and the car door are open, the safety gear 8 is selected to be operated while the deceleration is ignored regardless of the car speed.

[0048] When the car door is closed, the abnormality detection signal is output to the main brake controller 17.

Specifically, when at least one of the landing doors is open while the car door is closed, a passenger is expected to be in the car 1. Thus, the deceleration is taken into greater consideration regardless of the speed of the car 1, and therefore, the hoisting machine brake 7 is selected.

[0049] Moreover, even when the landing doors are closed, the safety monitoring section 22 verifies the status of the car door switch 24 (Step S4). When both the landing doors and the car door are closed, the safety monitoring section 22 judges that the elevator apparatus is normal and continues monitoring without outputting the abnormality detection signal.

[0050] When the car door is open while the landing doors are closed, it is verified whether or not the car speed is greater than a predetermined speed. When the car speed is equal to or lower than the predetermined speed, the abnormality detection signal is output to the safety gear controller 20. Specifically, in this case, it is judged that a human body is little affected even if a generated deceleration is large because the car 1 is immediately stopped. Therefore, the safety gear 8 is selected.

[0051] When the car speed is greater than the predetermined speed, the abnormality detection signal is output to the main brake controller 17. Specifically, in this case, the hoisting machine brake 7 is selected taking the deceleration into greater consideration.

[0052] FIG. 7 is an explanatory view illustrating the relation (selection table) between the statuses of various sensors illustrated in FIG. 1 and the braking device selected by the safety monitoring section 22. For the landing door, "open" indicates a state where even one of the landing doors is open. For each of the car door and the landing doors, an open state includes not only a fully-open state of the door but also even a slightly-open state of the door. This is because the car door switch and the landing door switch actually detect a fully-closed state of the door.

[0053] In the elevator apparatus as described above, the suitable braking device is automatically selected according to the type of abnormal state. Therefore, the car can be stoppedwith an appropriate braking force according to the type of abnormal state. As a result, a reduction in deceleration and a reduction in stopping distance can be preferably realized in a well-balanced manner.

Second Embodiment

[0054] Next, FIG. 8 is a configuration diagram illustrating the elevator apparatus according to a second embodiment of the present invention. In FIG. 8, a load state detector 38 serving as a sensor for detecting a load state in the car 1 is provided to the car 1. As the load state detector 38, for example, a scale device located on a car floor, a scale device provided to a cleat section for the main rope 3, a photographic device (such as an ITV camera) located in the car, or the like can be used.

[0055] A signal from the load state detector 38 is input to the safety monitoring section 22. The safety monitoring section 22 judges the presence/absence of a passenger in the car 1 based on the signal from the load state detector 38.

[0056] In the second embodiment, upon detection of the occurrence of an abnormal state based on the signals from the landing door switches 23, the car door switch 24, and the load state detector 38, the safety monitoring section 22 stops the power supply to the motor 6 from the electric power converter 16 to stop the motor 6 and also outputs the abnormality detection signal to the main brake controller 17 or the safety gear controller 20. The other configuration is the same as that of the first embodiment. The signal from the governor speed detector 25 can also be directly input to the safety gear controller 20.

[0057] FIG. 9 is a flowchart illustrating the operation of the safety monitoring section 22 illustrated in FIG. 8, for selecting the braking device. The safety monitoring section 22 outputs the abnormality detection signal to the safety gear controller 20 to cause the safety gear 8 to perform the braking operation when the car 1 is moving and the car door and at least one of the landing doors are open.

[0058] Moreover, when the car 1 is moving and at least one of the landing doors is open while the car door is closed, the presence of a passenger in the car 1 is judged based on the signal from the load state detector 38 (Step S6). Then, when no passenger is in the car 1, the abnormality detection signal is output to the safety gear controller 20 giving priority to the stopping distance to cause the safety gear 8 to perform the braking operation. When a passenger is in the car 1, the abnormality detection signal is output to the main brake controller 17 taking the deceleration into greater consideration to cause the hoisting machine brake 7 to perform the braking operation.

[0059] Further, even when the car 1 is moving and all the landing doors are closed while the car door is open, it is judged whether or not there is a passenger in the car 1 (Step S6). When no passenger is in the car 1, the safety gear 8 is selected. When a passenger is in the car 1, the hoisting machine brake 7 is selected.

[0060] FIG. 10 is an explanatory view illustrating the relation (selection table) between the statuses of the various sensors illustrated in FIG. 8 and the braking device selected by the safety monitoring section 22.

[0061] In the elevator apparatus as described above, the suitable braking device is automatically selected according to the type of abnormal state. Therefore, the car can be stopped with an appropriate braking force according to the type of abnormal state. As a result, the reduction in deceleration and the reduction in stopping distance can be preferably realized in a well-balanced manner.

Third Embodiment

[0062] Next, a third embodiment of the present invention is described. In the third embodiment, upon detection of the occurrence of an abnormal state based on the signals from the landing door switches 23 and the car door switch 24, the safety monitoring section 22 stops the power supply to the motor 6 from the electric power converter 16 to stop the motor 6 and outputs the abnormal detection signal to the main brake controller 17 or the safety gear controller 20. The other configuration is the same as that of the first embodiment.

[0063] FIG. 11 is a flowchart illustrating the operation of the safety monitoring section 22 according to the third embodiment, for selecting the braking device. When the car 1 is moving, the safety monitoring section 22 verifies the statuses of the landing door switches 23 and the status of the car door switch 24 (Step S7 and S8). When the car door and at least one of the landing doors are open, the abnormality detection signal is output to the safety gear controller 20 and the main brake controller 17 to cause the safety gear 8 and the hoisting machine brake 7 to simultaneously perform the braking operation.

[0064] When all the landing doors and the car door are closed, the safety monitoring section 22 judges that the elevator apparatus is normal and continues monitoring without outputting the abnormality detection signal. When any of the landing doors or the car door is open, it is verified whether or not the car door is open (Step S9).

[0065] Then, if the car door is open, the abnormality detection signal is output to the safety gear controller 20 to cause the safety gear 8 to perform the braking operation. If the car door is closed, specifically, when it is a landing door that is open, the abnormality detection signal is output to the main brake controller 17 to cause the hoisting machine brake 7 to perform the braking operation.

[0066] FIG. 12 is an explanatory view illustrating the relation (selection table) between the statuses of the various sensors according to the third embodiment and the braking device selected by the safety monitoring section 22.

[0067] In the elevator apparatus as described above, a suitable braking device is automatically selected according to the type of abnormal state. Therefore, the car can be stopped with an appropriate braking force according to the type of abnormal state. As a result, the reduction in deceleration and the reduction in stopping distance can be preferably realized in a well-balanced manner. Moreover, in comparison with the first and second embodiments, the operation flow is sample. Therefore, the safety monitoring section 22 is suitably constituted by a circuit for processing an analog signal.

Fourth Embodiment

[0068] Next, FIG. 13 is a flowchart illustrating the operation of the safety monitoring section 22 according to a fourth embodiment of the present invention, for selecting the braking device. When the car 1 is moving, the safety monitoring section 22 verifies the status of the car door switch 24 (Step S10). Then, if the car door is open, the safety monitoring section 22 outputs the abnormality detection signal to the safety gear controller 20 to cause the safety gear 8 to perform the braking operation.

[0069] If the car door is closed, it is verified whether or not the landing doors are open (Step S11). Then, if at least one of the landing doors is open, the abnormality detection signal is output to the main brake controller 17 to cause the hoisting machine brake 7 to perform the braking operation. On the other hand, when all the landing doors and the car door are closed, the safety monitoring section 22 judges that the elevator apparatus is normal and continues monitoring without outputting the abnormality detection signal.

[0070] FIG. 14 is an explanatory view illustrating the relation (selection table) between the statuses of the various sensors according to the fourth embodiment and the braking device selected by the safety monitoring section 22.

[0071] In the elevator apparatus as described above, a suitable braking device is automatically selected according to the type of abnormal state. Therefore, the car can be stoppedwith an appropriate braking force according to the type of abnormal state. As a result, the reduction in deceleration and the reduction in stopping distance can be preferably realized in a well-balanced manner. Moreover, in comparison with the first and second embodiments, the operation flow is simple. Therefore, the safety monitoring section 22 is suitably constituted by the circuit for processing the analog signal. Further, in comparison with the third embodiment, an event where the safety gear 8 and the hoisting machine brake 7 simultaneously perform the braking operation can be eliminated. Therefore, the reduction in deceleration can be realized.

Fifth Embodiment

[0072] Next, FIG. 15 is a configuration diagram illustrating the elevator apparatus according to a fifth embodiment of the present invention. In FIG. 15, in the vicinity of both an upper terminal position and a lower terminal position of the hoistway, a terminal operation switch 39 serving as a sensor is provided. Each of the terminal operation switches 39 is located at a position the longest stopping distance in the upward or downward direction away from the upper or lower limit position of a safely stoppable area in the hoistway, the longest stopping distance being that when the safety gear 8 operates with the main rope 3 being connected to the car 1. Each of the terminal operation switches 39 outputs an ON signal when the car 1 is positioned closer to the terminal of the hoistway from the terminal operation switch 39.

[0073] In the fifth embodiment, upon detection of the occurrence of an abnormal state while the terminal operation switch 39 is in an ON state, the safety monitoring section 22 stops the power supply from the electric power converter 16 to the motor 6 to stop the motor 6 and outputs the abnormality detection signal to the safety gear controller 20. The other configuration is the same as that of the first embodiment. In FIG. 15, the illustration of the landing door switches 23 and signal lines extending therefrom is omitted.

[0074] FIG. 16 is a flowchart illustrating the operation of the safety monitoring section 22 illustrated in FIG. 15, for selecting the braking device. When it is judged that the abnormality detection signal is to be output to the main brake controller 17 in the first embodiment, it is then judged whether or not the terminal operation switch 39 is ON (Steps S12 and S13) in the selecting operation according to the fifth embodiment. Then, when the terminal operation switch 39 is ON, the abnormality detection signal is output to the safety gear controller 20 to cause the safety gear 8 to perform the braking operation. When the terminal operation switch 39 is OFF, the abnormality detection signal is output to the main brake controller 17 to cause the hoisting machine brake 7 to perform the braking operation.

[0075] In the elevator apparatus as described above, a suitable braking device is automatically selected according to the type of abnormal state. Therefore, the car can be stoppedwith an appropriate braking force according to the type of abnormal state. As a result, the reduction in deceleration and the reduction in stopping distance can be preferably realized in a well-balanced manner. Moreover, in the vicinity of terminal landings, a quick stop taking the stopping distance into greater consideration can be performed.

[0076] The function of the safety monitoring section 22 is realized by a computer in the first to fifth embodiments, but the function of the safety monitoring section 22 may also be realized by an analog circuit.

Moreover, the deceleration-reducing brake controller 19 does not necessarily need to be used in the first to fifth embodiments.

Further, the sensors are not limited to the landing door switches 23, the car door switch 24, the governor speed detector, the landing state detector 38, and the terminal operation switches 39.

Further, the braking devices are not limited to the hoisting machine brake 7 and the safety gear 8. The braking device may also be a rope brake for gripping the main rope, a car brake mounted on the car independently of the safety gear, or the like.

The selectable braking devices may also be three or more types.

Claims

1. An elevator apparatus comprising:

   a car raised and lowered in a hoistway;
   a plurality of types of braking devices for decelerating and stopping the car;
   a plurality of sensors for detecting the state of a plurality of elevator equipments; and
   a safety monitoring section for detecting an abnormal state relating to an operation based on signals from the sensors and causing the braking devices to selectively perform a braking operation according to the type of abnormal state.

2. An elevator apparatus according to Claim 1, wherein the sensors include a landing door switch for detecting opening and closing of a landing door and a car door switch for detecting opening and closing of a car door.

3. An elevator apparatus according to Claim 2, wherein the sensors include a speed detector for detecting the speed of in the car.

4. An elevator apparatus according to Claim 2, wherein the sensors include a load state detector for detecting a load state in the car.

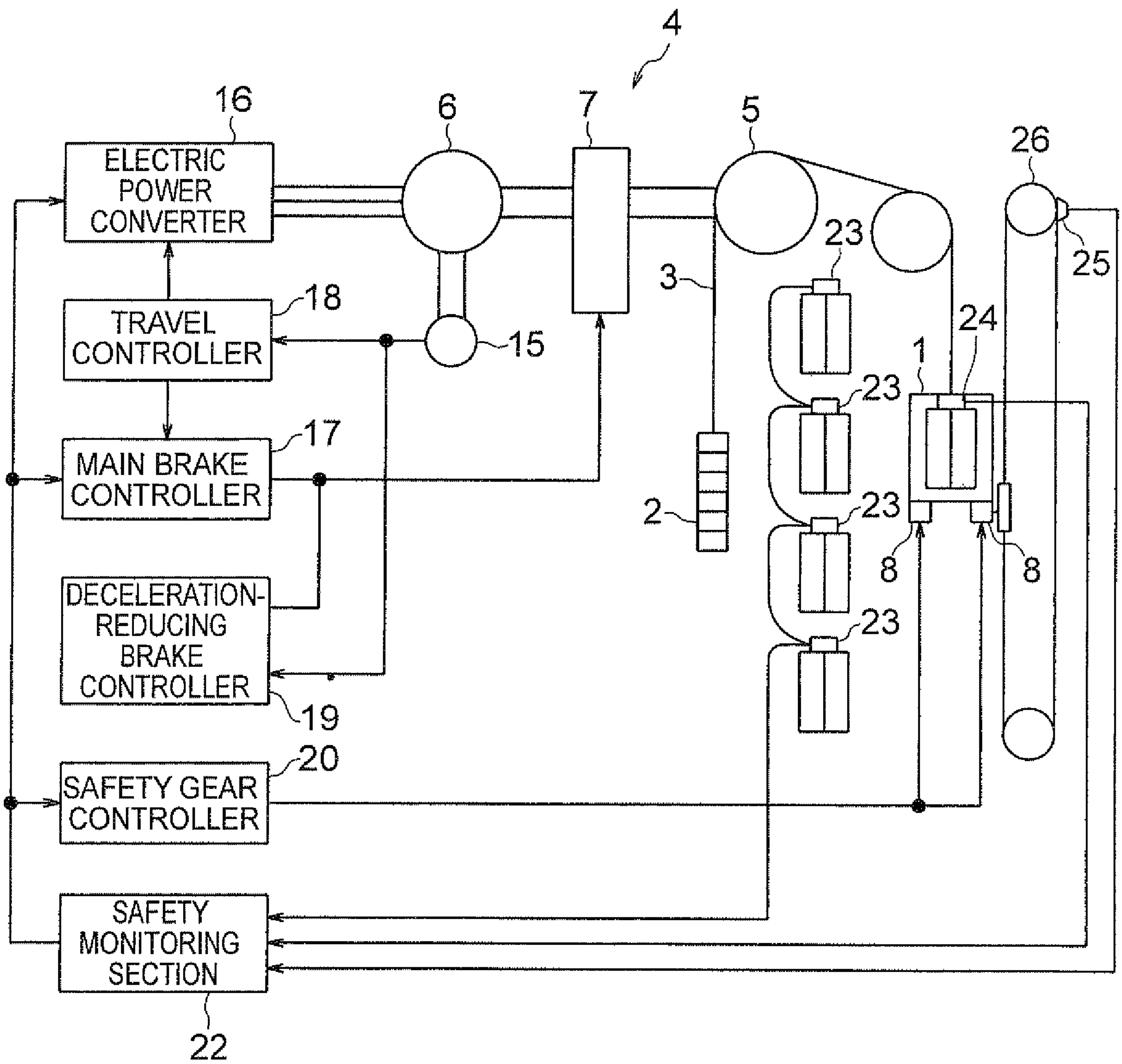
5. An elevator apparatus according to Claim 1, wherein the braking devices include a safety gear capable of performing the braking operation even when the car is running in any of an upward direction and a downward direction and a friction brake for frictionally braking the running of the car.

6. An elevator apparatus according to Claim 5, further comprising a deceleration-reducing brake controller for controlling a braking force of the friction brake to allow a deceleration of the car to be a predetermined value or lower.

7. An elevator apparatus according to Claim 1, wherein:

   the sensors include a terminal operation switch provided in a vicinity of a terminal position; and
   the safety monitoring section causes the braking device having the greatest braking force to operate upon detection of the abnormal state when the car is positioned closer to a terminal of the hoistway from the terminal operation switch.

FIG. 1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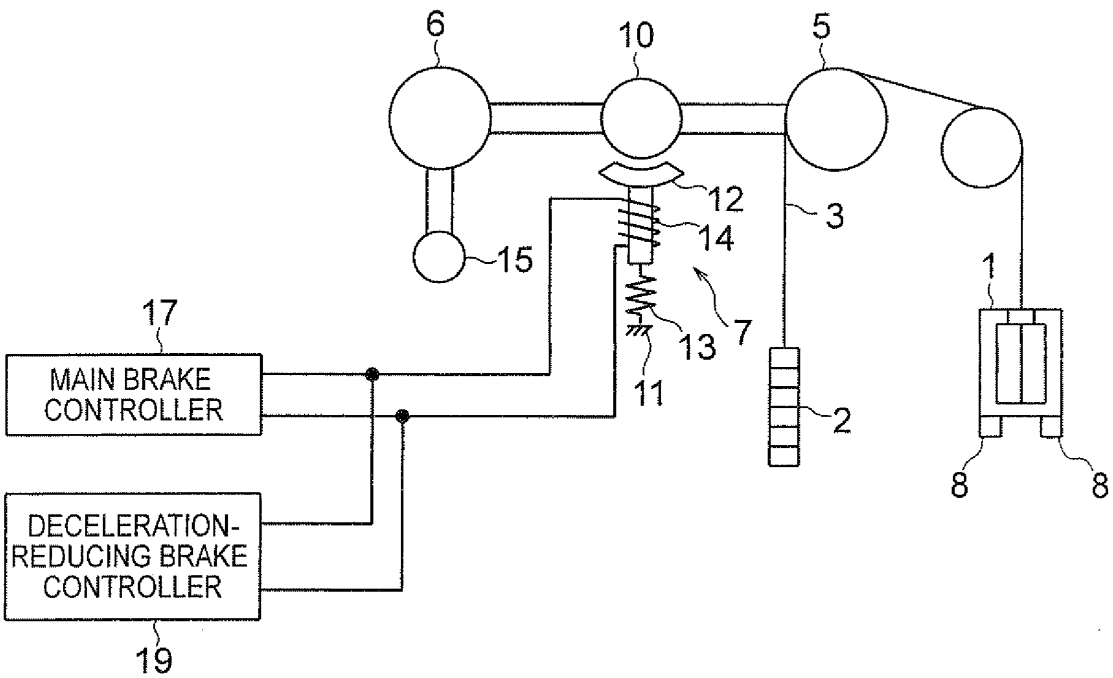
16
ELECTRIC POWER CONVERTER
6
7
5
26
23
25
3
TRAVEL CONTROLLER
18
15
24
1
23
MAIN BRAKE CONTROLLER
17
2
23
8
8
DECELERATION-REDUCING BRAKE CONTROLLER
23
19
SAFETY GEAR CONTROLLER
20
SAFETY MONITORING SECTION
22

FIG. 2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10
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15
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17
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MAIN BRAKE
CONTROLLER
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DECELERATION-
REDUCING BRAKE
CONTROLLER
19

FIG. 3

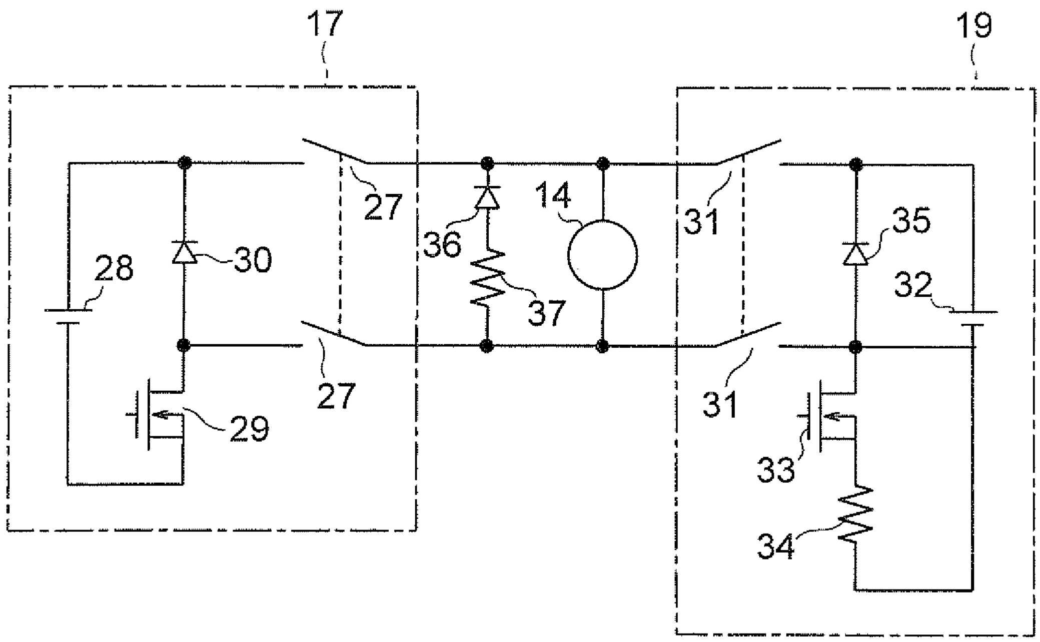
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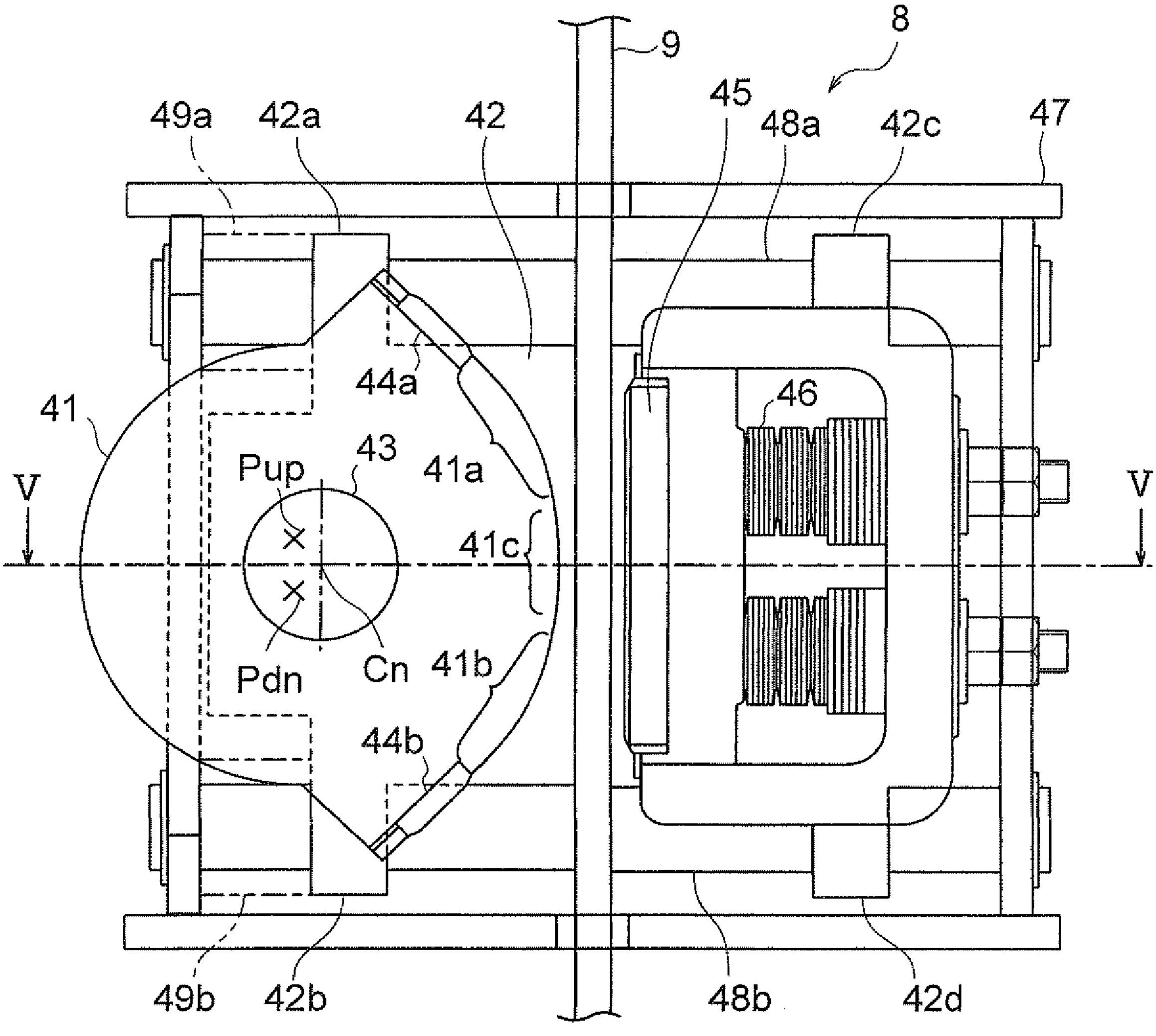
FIG. 4



9
8
49a
42a
42
45
48a
42c
47
44a
46
41
43
Pup
41a
V
V
41c
Cn
Pdn
41b
44b
49b
42b
48b
42d

FIG. 5

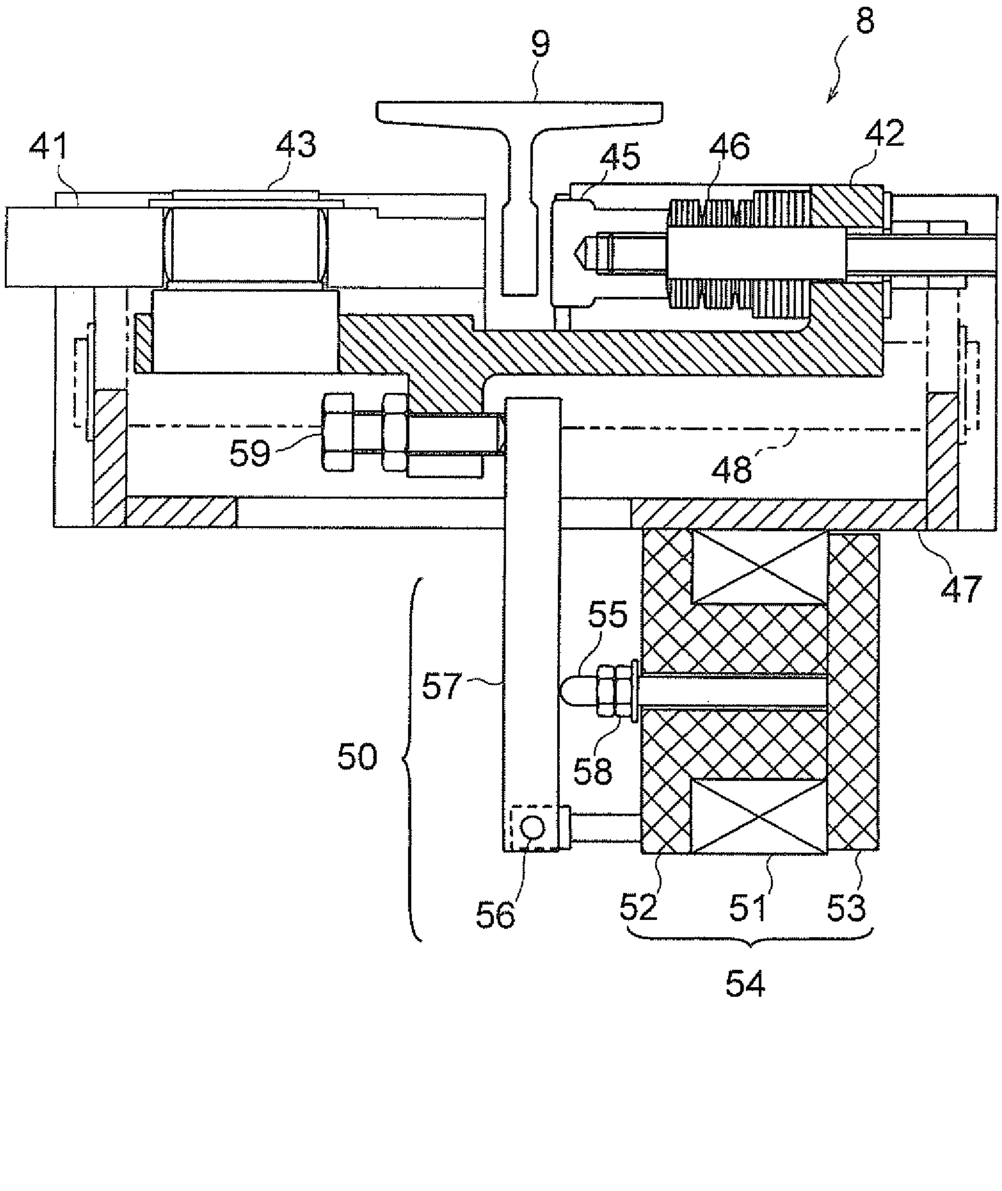


FIG. 6

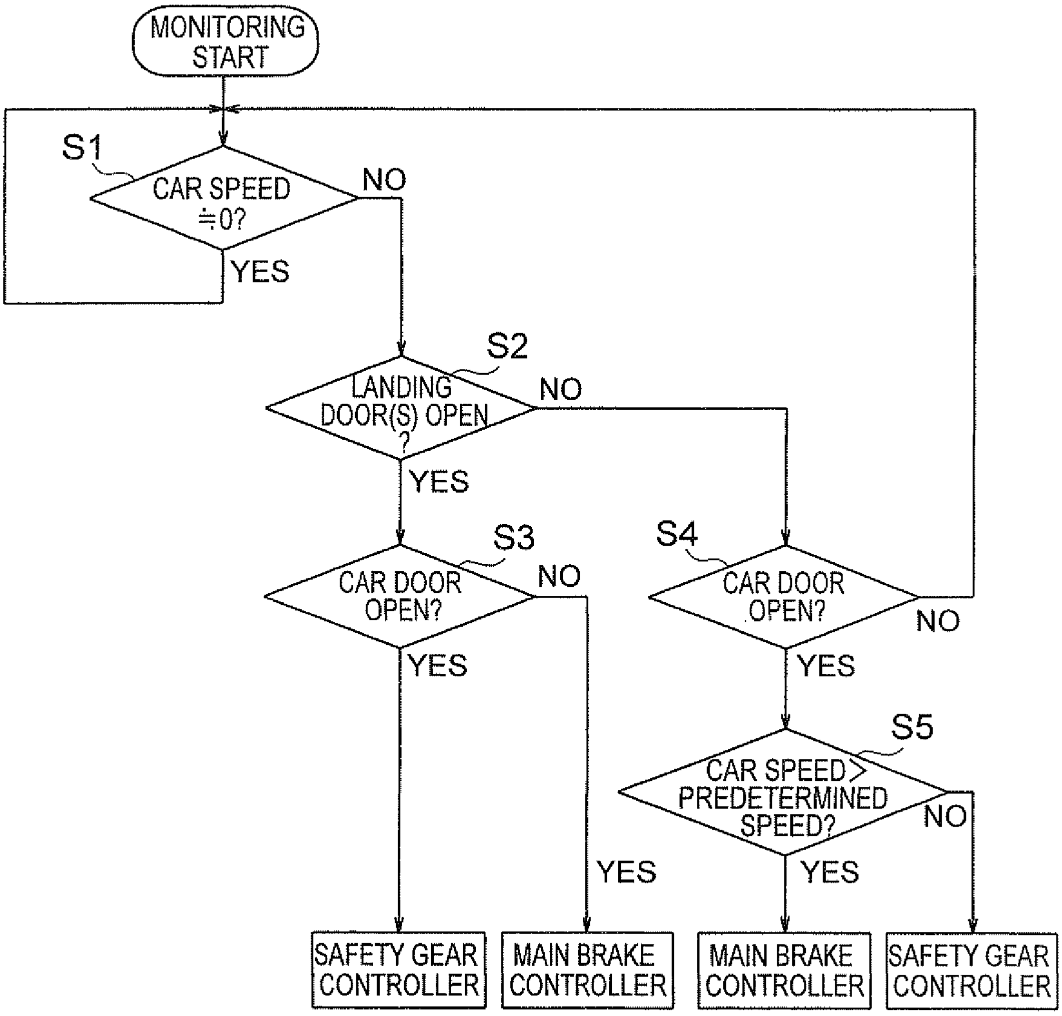
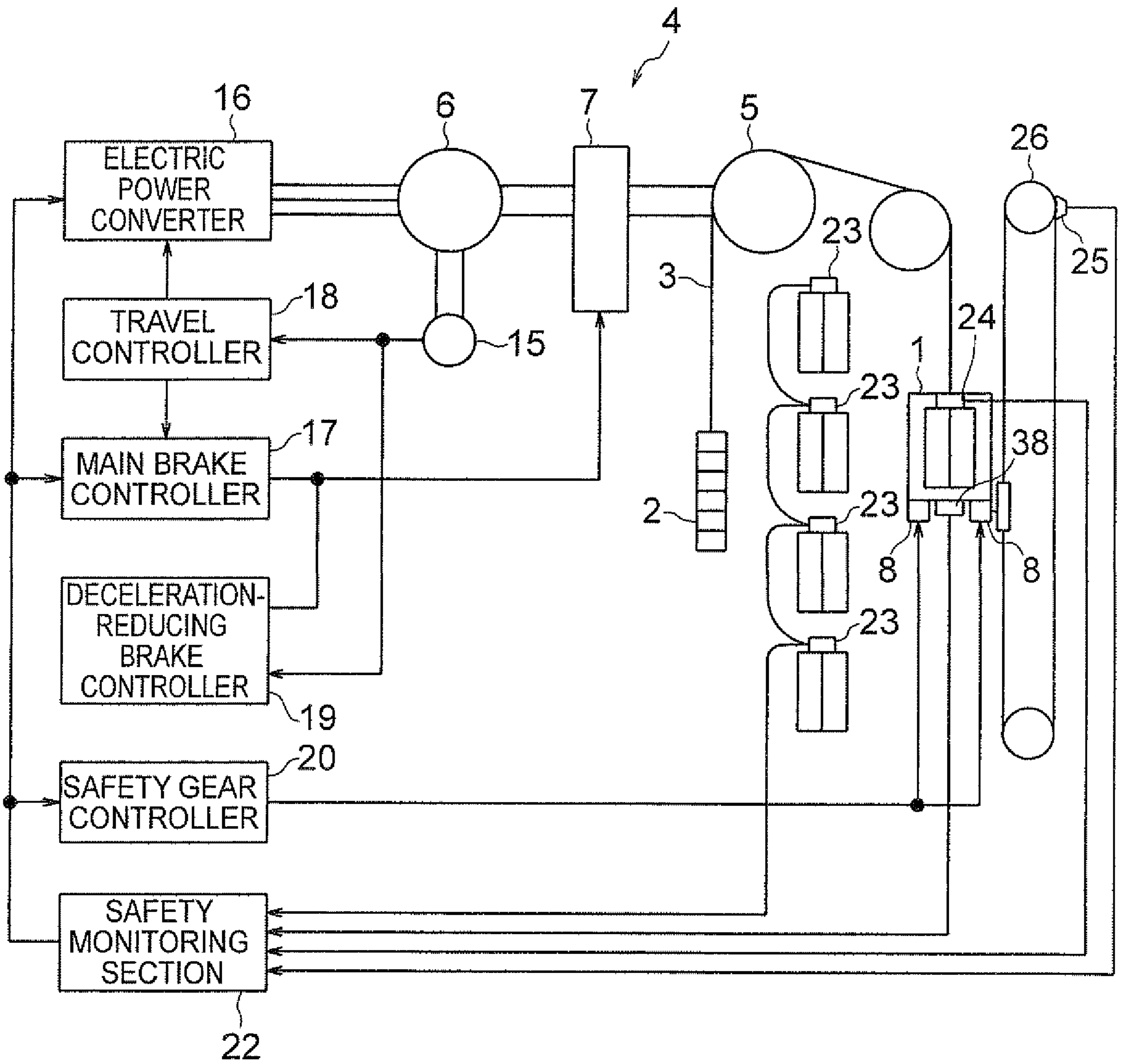


FIG. 7

LANDING DOOR(S)	OPEN	OPEN	OPEN	OPEN	CLOSED	CLOSED
CAR DOOR	OPEN	OPEN	CLOSED	CLOSED	OPEN	OPEN
CAR SPEED	PREDETER-MINED SPEED OR LARGER	PREDETER-MINED SPEED OR LESS	PREDETER-MINED SPEED OR LARGER	PREDETER-MINED SPEED OR LESS	PREDETER-MINED SPEED OR LARGER	PREDETER-MINED SPEED OR LESS
SELECTED BRAKING DEVICE	SAFETY GEAR	SAFETY GEAR	HOISTING MACHINE BRAKE	HOISTING MACHINE BRAKE	HOISTING MACHINE BRAKE	SAFETY GEAR

FIG. 8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ELECTRIC POWER CONVERTER
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7
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26
25
23
3
TRAVEL CONTROLLER
18
15
24
1
MAIN BRAKE CONTROLLER
17
38
2
8
DECELERATION-REDUCING BRAKE CONTROLLER
19
SAFETY GEAR CONTROLLER
20
SAFETY MONITORING SECTION
22

FIG. 9

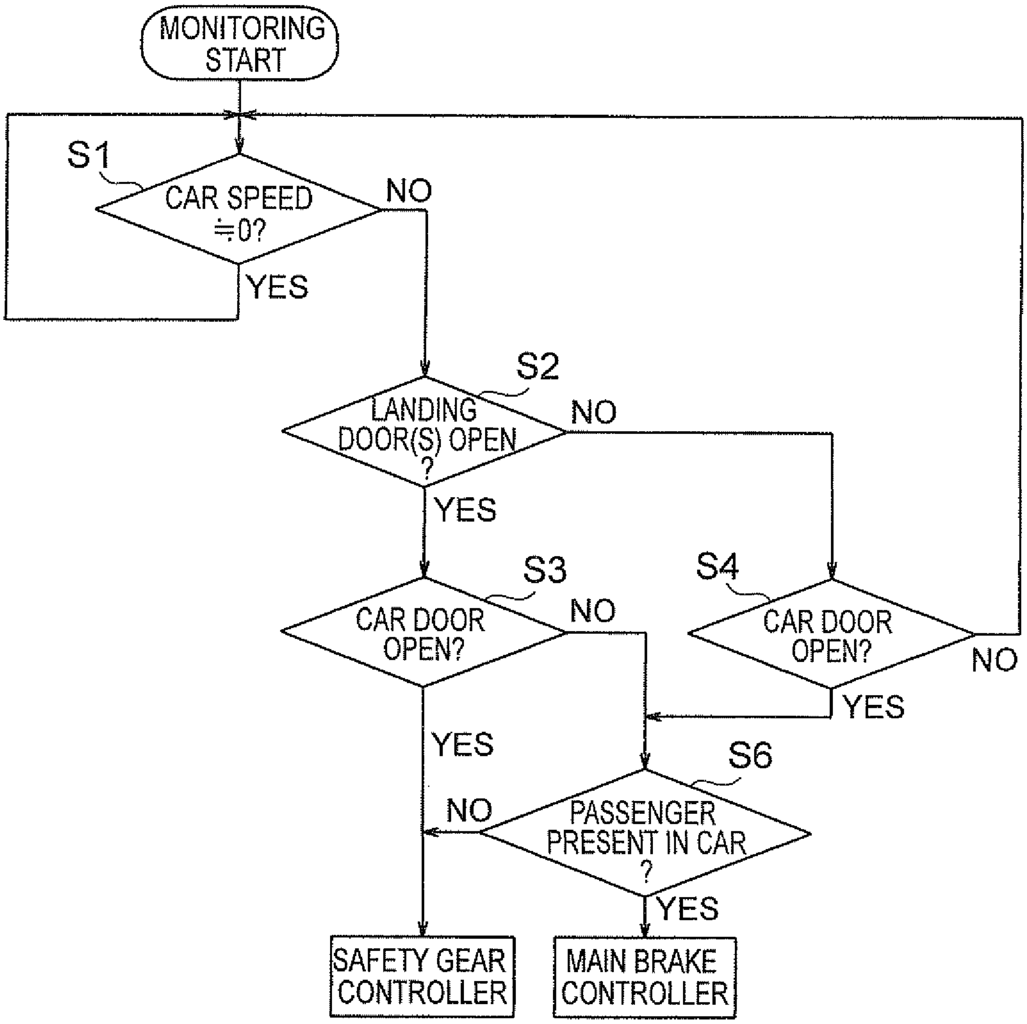

MONITORING START
S1
CAR SPEED ≒0?
NO
YES
S2
LANDING DOOR(S) OPEN ?
NO
YES
S3
CAR DOOR OPEN?
NO
YES
S4
CAR DOOR OPEN?
NO
YES
S6
PASSENGER PRESENT IN CAR ?
NO
YES
SAFETY GEAR CONTROLLER
MAIN BRAKE CONTROLLER

FIG. 10

LANDING DOOR(S)	OPEN	OPEN	OPEN	OPEN	CLOSED	CLOSED
CAR DOOR	OPEN	OPEN	CLOSED	CLOSED	OPEN	OPEN
LOAD STATE	YES	NO	YES	NO	YES	NO
SELECTED BRAKING DEVICE	SAFETY GEAR	SAFETY GEAR	HOISTING MACHINE BRAKE	SAFETY GEAR	HOISTING MACHINE BRAKE	SAFETY GEAR

FIG. 11

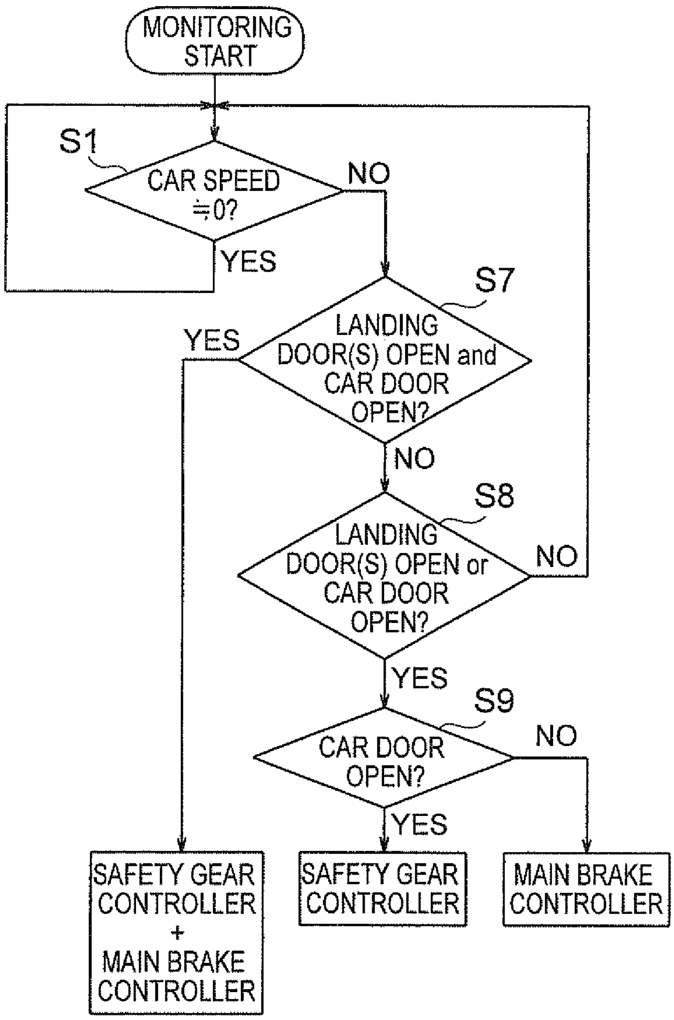


FIG. 12

LANDING DOOR(S)	OPEN	OPEN	CLOSED
CAR DOOR	OPEN	CLOSED	OPEN
SELECTED BRAKING DEVICE	SAFETY GEAR + HOISTING MACHINE BRAKE	HOISTING MACHINE BRAKE	SAFETY GEAR

FIG. 13

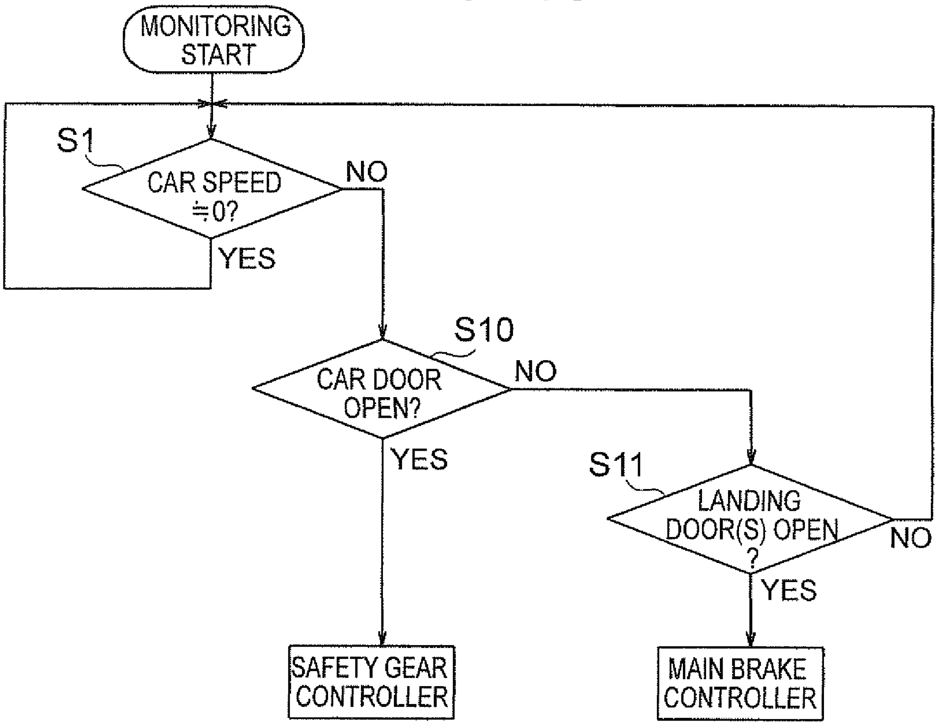
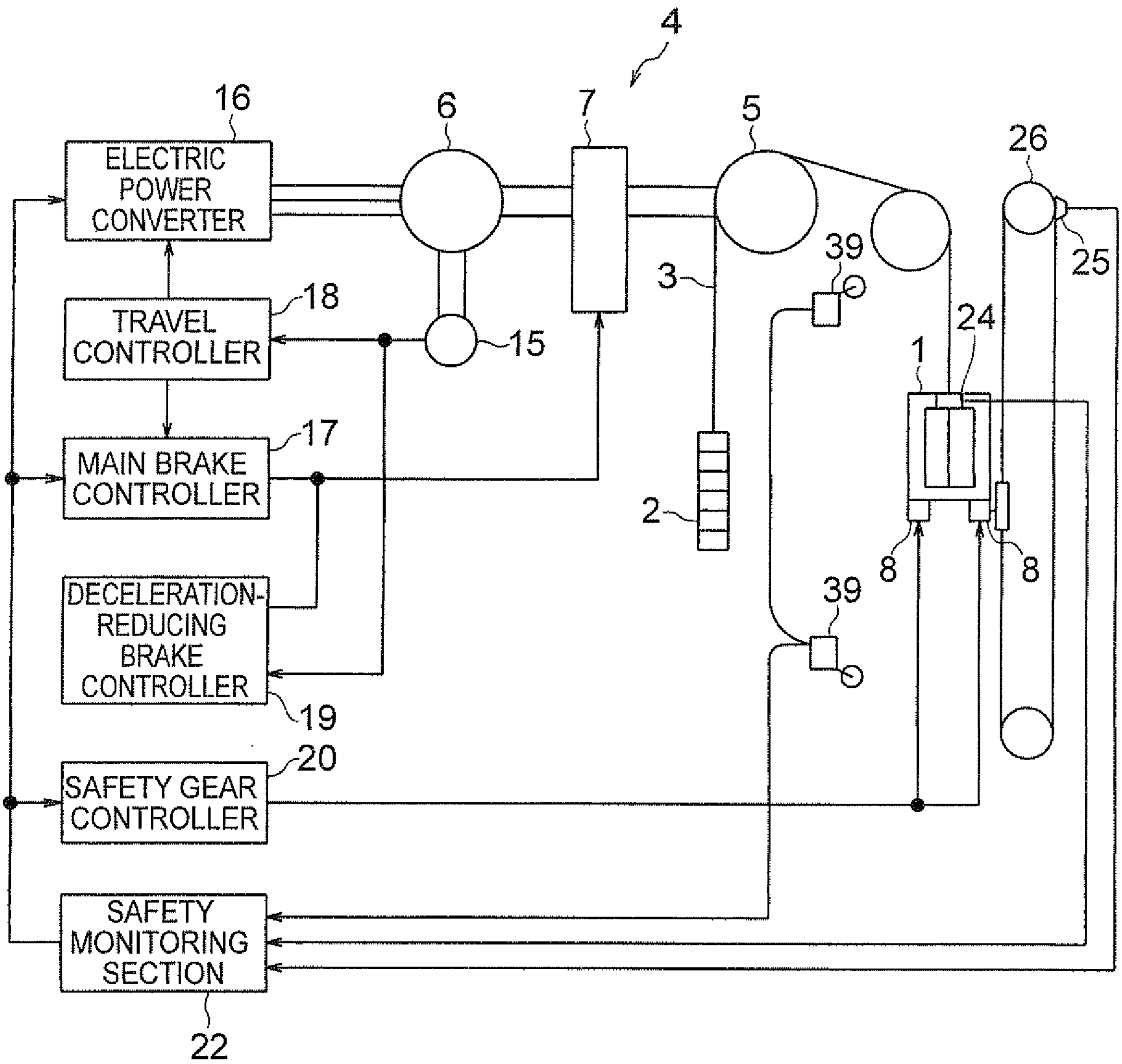


FIG. 14

LANDING DOOR(S)	OPEN	OPEN	CLOSED
CAR DOOR	OPEN	CLOSED	OPEN
SELECTED BRAKING DEVICE	SAFETY GEAR	HOISTING MACHINE BRAKE	SAFETY GEAR

FIG. 15



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ELECTRIC POWER CONVERTER
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TRAVEL CONTROLLER
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MAIN BRAKE CONTROLLER
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8
DECELERATION-REDUCING BRAKE CONTROLLER
39
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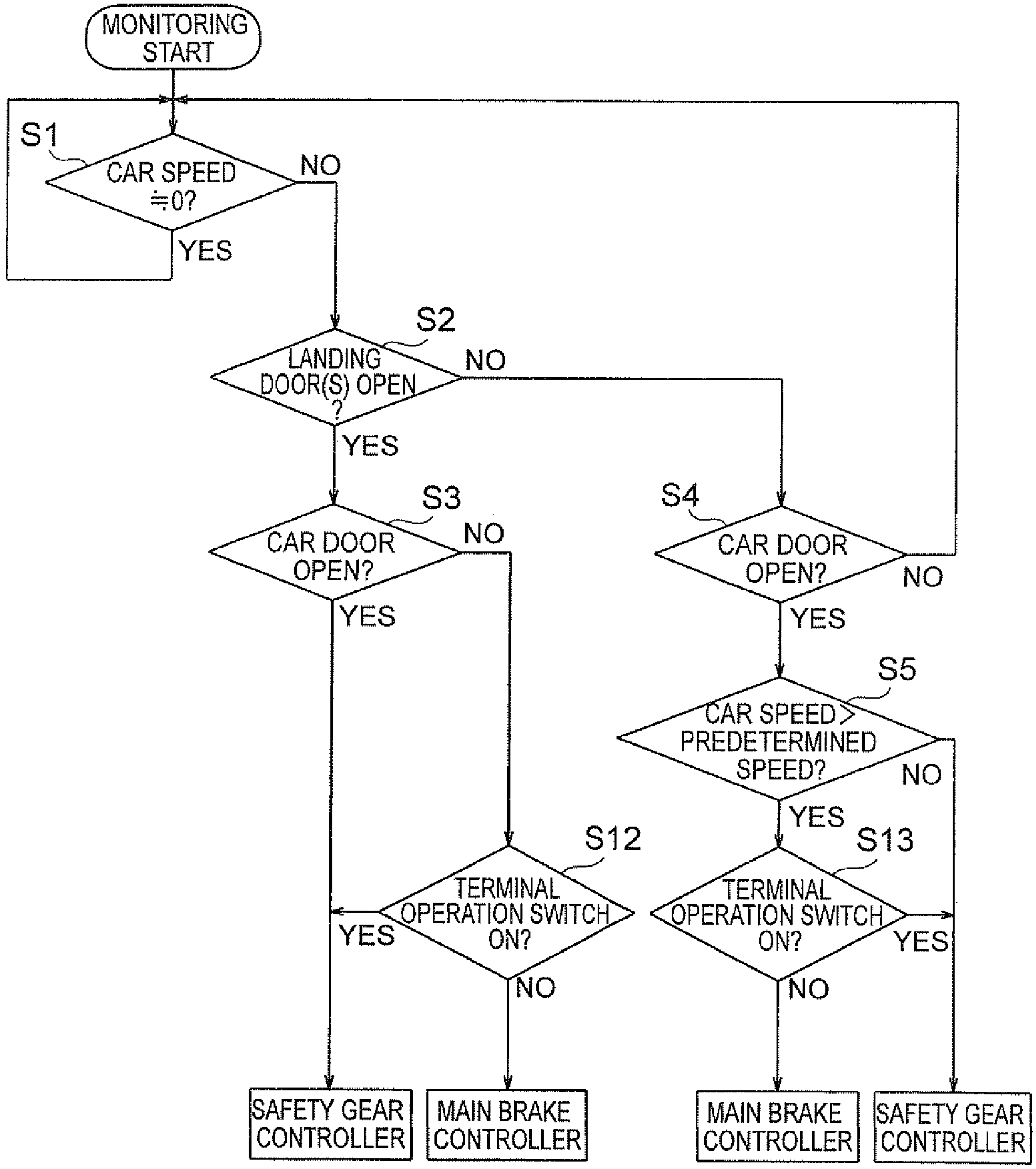
20
SAFETY GEAR CONTROLLER
SAFETY MONITORING SECTION
22

FIG. 16


MONITORING START
S1
CAR SPEED ≒0?
NO
YES
S2
LANDING DOOR(S) OPEN ?
NO
YES
S3
CAR DOOR OPEN?
NO
YES
S4
CAR DOOR OPEN?
NO
YES
S5
CAR SPEED > PREDETERMINED SPEED?
NO
YES
S12
TERMINAL OPERATION SWITCH ON?
YES
NO
S13
TERMINAL OPERATION SWITCH ON?
YES
NO
SAFETY GEAR CONTROLLER
MAIN BRAKE CONTROLLER
MAIN BRAKE CONTROLLER
SAFETY GEAR CONTROLLER

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/050953

A. CLASSIFICATION OF SUBJECT MATTER
B66B1/32(2006.01)i, *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)
B66B1/00-B66B20/00

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	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

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 2004/083091 A1 (Mitsubishi Electric Corp.), 30 September, 2004 (30.09.04), & EP 1604935 A1	1-3 4-7
Y	JP 2006-306517 A (Mitsubishi Electric Corp.), 09 November, 2006 (09.11.06), (Family: none)	4,6-7
Y	JP 2006-347771 A (Inventio AG.), 28 December, 2006 (28.12.06), & US 2007/0007083 A1 & CN 1880208 A & AU 2006202693 A1	5

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

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"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
12 October, 2007 (12.10.07)	23 October, 2007 (23.10.07)

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

Form PCT/ISA/210 (second sheet) (April 2007)

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Patent documents cited in the description

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