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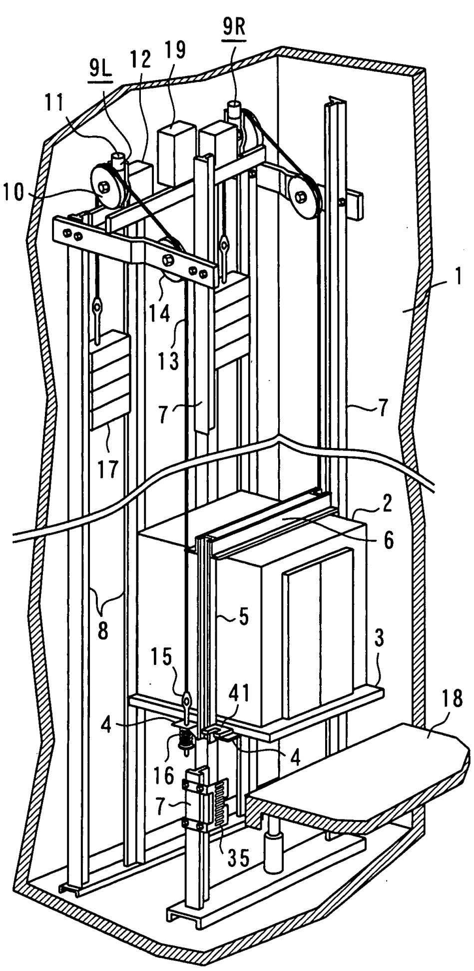
(54) ELEVATOR CONTROLLER

(57) In an elevator control device there is a plurality of hoisting machines (9) provided apart from each other. Main ropes (13) are engaged to the car (2) and are passed around the corresponding hoisting machines (9), and the car (2) is driven to ascend and descend. The tension of each main rope (13) at a standstill of the car (2) before start is detected, and the car (2) is driven to ascend and descend by increasing or decreasing the outputs of the corresponding hoisting machines (9) in accordance with the above-mentioned detected values. Thus, even in the case where the load is unevenly loaded in the car (2) and the tensions of the main ropes (13) differ, the hoisting machines (9) drive the car (2) with suitable outputs, so the car (2) does not incline.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to an elevator control device which drives an elevator car to ascend and descend by means of a plurality of hoisting machines.

Background Art

[0002] As conventional elevators are driven by means of one hoisting machine, in accordance with the increase in load, the capacity of the hoisting machine also increases. Therefore, large hoisting machines are required for large elevators, and large lifting machines are necessary for installation of the hoisting machines.
[0003] For example, in Japanese non-examined laid-open patent publication No. Hei 6-64863, there is disclosed an elevator having a pulley arranged on top of the car, and raising the car with the main rope passed around this pulley, and driven by two small-sized hoisting machines.
[0004] Figure 17 shows a conventional elevator driven by two hoisting machines, of which the contents are equal to what is disclosed in Japanese non-examined laid-open patent publication No. Hei 6-64863.
[0005] That is, a pulley 201 is fixed on a car 2, a main rope 13 is passed around the pulley 201 and the car 2 is raised, and then, the main rope 13 is passed around hoisting machines 9L and 9R and the car 2 is pulled down and engaged to counter weights 17L and 17R. Each of the hoisting machines 9L and 9R are equivalents which comprise a sheave 10L, 10R, a brake 11L, 11R, and an electric motor 12L, 12R, which are of the same specifications. Numerals 202, 203L, 203R, 204L and 204R denote pulleys that guide the main ropes 13.
[0006] By using 2 hoisting machines 9L and 9R, miniaturization of the hoisting machines is aimed, and the torque sharing between the hoisting machines 9L and 9R is equalized by rotation of the pulley 201 whenever a difference between the speed of the hoisting machine 9L and hoisting machine 9R occurs.
[0007] However, as shown by the chain lines in Figure 17, if by some cause the pulley 201 rotates clockwise, the main rope 13 will be moved from the side of the hoisting machine 9R to the side of the hoisting machine 9L. By this movement of the main rope 13, the counter weight 17R suspended from the hoisting machine 9R will be pulled up, and the counter weight 17L suspended from the hoisting machine 9L will be pulled down, and will be in a state as shown by numerals 17'L and 17'R. If the car 2 is made to ascend in this state, the counter weight 17'L will interfere with the bottom part of the hoistway. Also, if the car 2 is made to descend, the counter weight 17'R will interfere with the ceiling part of the hoistway.
[0008] That is, there was a problem that if the pulley 201 rotated the main rope 13 would be moved, and the relative positions of the car 2 and the counter weights 17L and 17R would change, thus shortening the travel of the car 2.
[0009] Further, the brakes 11L and 11R are the most important safety devices, and for this importance, when two hoisting machines 9L and 9R are used, it is preferable that the car could be stopped if at least one of the brakes 11L or 11R functions.
[0010] However, according to Figure 17, there was a problem that the car 2 could not be stopped unless both of the brakes 11L and 11R functioned.
[0011] Also, in Japanese non-examined laid-open patent publication No. Hei 7-25553, there is disclosed an elevator control device in which the relative positional deviation of the main rope 13 becomes zero by detecting the rotation angle of the pulley 201 and feeding it back to the speed instruction input side of one of the electric motors 12L or 12R. According to this elevator, the relative positions of the car 2 and the counter weights 17L and 17R could be maintained in the normal condition by equalizing the torque sharing between the hoisting machines 9L and 9R and also preventing the relative positional deviation of the main rope 13.
[0012] However, even in this elevator, there is no difference between that disclosed in Japanese non-examined laid-open patent publication No. Hei 6-64863 in the respect that the car 2 is suspended by the main rope 13 via the pulley 201. Therefore, similarly, there was the problem that the car 2 could not be stopped if one of the brakes 11L or 11R did not function.
[0013] The present invention has as its object the provision of an elevator control device that can make the car ascend and descend stably by solving the above-mentioned problems and also by correcting the relative positional deviation of the main rope should it occur, in an elevator in which miniaturization of the hoisting machines is aimed by driving the car by a plurality of hoisting machines.

Disclosure of the Invention

[0014]

1. The present invention relates to an elevator control device wherein a car is driven to ascend and descend by engaging main ropes separately to a plurality of positions of a car ascending and descending the hoistway, and by raising and passing the main ropes around a plurality of hoisting machines which are installed corresponding to the main ropes, the tension of the main ropes at standstill before start is detected at each position of engagement of the main ropes, and the car is made to ascend and descend by increasing or decreasing the output of the corresponding hoisting machine according to the above-described detected values. Accordingly, even in the case where the load is un-

evenly loaded in the car and the tension of the main ropes differ at each of the engagement positions, the hoisting machines drive the car with suitable outputs, so relative movement of the main ropes can be prevented, and extreme inclination of the car can be avoided.

2. Also, in the present invention, the above-mentioned tensions that are detected at each of the engagement positions of the main ropes at standstill before start are summed up, and the sum is treated as the in-car load. For example, the crowdedness of the car is calculated from this sum. For this reason, there is no necessity to install a separate detector for detecting the load.

3. Moreover, in the present invention, in the elevator control device wherein a car is driven to ascend and descend by engaging main ropes separately to a plurality of positions of a car ascending and descending the hoistway, and by raising and passing the main ropes around a plurality of hoisting machines which are installed corresponding to the main ropes, the difference between the floor and the car platform when the car lands on the destination floor is detected at each of the engagement positions of the main ropes, and in the case where the detected value exceeds a predetermined value, the engagement positions of the main ropes are separately moved vertically by the corresponding hoisting machines in order to decrease the landing difference. Accordingly, even if a relative movement occurs in the main ropes by the hoisting machines and the car platform inclines, this will be adjusted by the leveling operation, so the relative movement of the main ropes does not increase progressively.

4. Further, in the present invention, in the elevator control device wherein the car is driven to ascend and descend by a plurality of hoisting machines, the travel distance is calculated for each hoisting machine, and the hoisting machines are operated to stop when the difference between the calculated values exceeds a predetermined value. Accordingly, it is possible to prevent the car platform from inclining extremely.

5. Moreover, in the present invention, the above-mentioned travel distance is calculated by measuring the rotation angle speed of the hoisting machines, and in the case where the difference between the calculated values exceeds a predetermined value, the hoisting machines are operated to stop. Accordingly, it is possible to stop the hoisting machines not only when the main ropes actually move relatively, but also when an irregularity in the rotation of the hoisting machines occurs and a difference in the rotational angular speed occurs, so it is possible to detect unevenness in abrasion of the hoisting machines and to deal with it in an early stage.

6. Further, in the present invention, in the elevator control device wherein the car is driven to ascend and descend by a plurality of hoisting machines, the power of the electric motor of each hoisting machine is measured separately, and when the difference in the measured values exceeds a predetermined value, the hoisting machines are operated to stop. For this reason, operation in a state where the load is in the case where the load is loaded extremely on one of the electric motors, e.g., a state in which the car platform is extremely inclined, can be avoided.

7. Moreover, in the present invention, the elevator control device wherein a car is driven to ascend and descend by engaging main ropes separately to a plurality of positions of a car ascending and descending the hoistway, and by raising and passing the main ropes around a plurality of hoisting machines which are installed corresponding to the main ropes, the travel distance from the departure floor to the destination floor is precalculated and given to each hoisting machine as a common target travel distance, the remaining distance from the present position to the destination floor is calculated at each of the engagement positions of the main ropes, the corresponding hoisting machines are controlled separately and with a speed suitable for the remaining distance as the speed instruction. For this reason, speed control suitable for the target travel distance becomes possible, and the car can land accurately on the destination floor.

8. Further, in the elevator control device wherein a car is driven to ascend and descend by engaging main ropes separately to a plurality of positions of a car ascending and descending the hoistway and by raising and passing the main ropes around a plurality of hoisting machines which are installed corresponding to the main ropes, at the time when a speed instruction is given, the speed instruction is calculated according to the passage of time and the hoisting machines are controlled together, and to the destination floor from the point of deceleration set at a predetermined distance before the destination floor, speeds that are suitable for the remaining distance are calculated at each of the engagement positions of the main ropes, and the corresponding hoisting machines are controlled separately. Accordingly, as the detecting area of the car position is reduced compared to when detecting the car position in the whole area of the hoistway, it is possible to simplify the car position detecting device by the area proportionate to the area reduced, and also as it is controlled with a speed instruction corresponding to the remaining distance from the deceleration point, landing can be operated accurately without harming ride comfort.

Brief Description of the Drawings

[0015]

Figure 1 is a perspective view showing the whole elevator system including the preferred elevator control device in accordance with the first embodiment of the present invention.
Figure 2 is similarly a block diagram showing an electric circuit.
Figure 3 is similarly a longitudinal section showing the main parts of the tension detector 21.
Figure 4 is similarly an explanatory diagram showing the operation state of the tension detector 21.
Figure 5 is similarly a perspective view showing the car position detector 35 and 41.
Figure 6 is similarly an elevational view showing the car 2 at landing.
Figure 7 is similarly an elevational view showing the car 2 at landing.
Figure 8 is similarly an explanatory diagram showing the speed instruction Vo according to the remaining distance during call response operation.
Figure 9 is similarly an explanatory diagram showing the speed instruction LVo according to the remaining distance during leveling operation.
Figure 10 is similarly a flowchart showing the motion of call response operation.
Figure 11 is similarly a flowchart showing the motion of leveling operation.
Figure 12 is a block diagram showing an electric circuit of the preferred elevator control device in accordance with the second embodiment of the present invention.
Figure 13 is an explanatory diagram showing the car position detector 41 in accordance with the second embodiment of the present invention.
Figure 14 is an explanatory diagram showing the speed instruction according to time Vao and the speed instruction according to remaining distance Vdo during call response operation in accordance with the second embodiment of the present invention.
Figure 15 is a flowchart showing the motion of call response operation in accordance with the second embodiment of the present invention.
Figure 16 is a perspective view showing the whole elevator in accordance with the third embodiment of the present invention.
Figure 17 is a conceptual drawing of a conventional elevator with a plurality of hoisting machines.

Best Mode for Carrying out the Invention

[0016] To describe the present invention in more detail, the invention will be described by referring to the accompanying drawings. In the drawings, the same numerals are given to the same parts or the corresponding parts, and repeated explanation will be appropriately simplified or omitted.

[0017] Also, in the embodiments described hereafter, the elevator comprises two hoisting machines, on the right side and on the left side, and concerns elevator control similar to control of an elevator that is disclosed in Japanese non-examined laid-open patent publication No. 2001-261257. To elements concerning the left side, an 'L' is given at the end of the numeral, to elements concerning the right side, an 'R' is given at the end of the numeral, and when both the right side and the left side are explained together without being distinguished, the 'L' and the 'R' are omitted.

First Embodiment

[0018] Figures 1 through 11 show the first embodiment of the elevator control device comprising a plurality of hoisting machines in accordance with the present invention. Especially in the first embodiment, two hoisting machines are provided in a top part of the hoistway, the travel distance from the departure floor to the destination floor is given to each hoisting machine as a common target travel distance, and the hoisting machines are controlled separately at a speed suitable for the remaining distance in the distance from the present position to the destination floor.

[0019] Figure 1 is a perspective view showing the whole elevator control device. In this figure, numeral 1 denotes a hoistway, 2 denotes a car, 3 denotes a car platform, 4 denotes a bottom beam to support the car platform 3 from below, 5 denotes side jambs provided vertically on both the right and left sides of the car 2, and 6 denotes a top jamb provided laterally on top of the car 2. Numeral 7 denotes a pair of guide rails fixed vertically on the side walls of the hoistway on both sides of the car 2, and 8 denotes guide rails for the counter weights which are fixed vertically on the wall behind the rear wall of the car 2, and two pairs of guide rails are provided in parallel on both the right and left sides. Numeral 9 denotes a pair of hoisting machines that are provided on the right and left apart from one another in a top part of the hoistway, and comprises sheaves 10, brakes 11 to stop the sheaves 10, and electric motors 12 to drive the sheaves 10. Numeral 13 denotes a right-and-left pair of main ropes of which one end is passed around the sheaves 10 and engaged to the bottom beam 4 of the car 2, 14 denotes deflector sheaves that guide the main ropes 13 to the car 2, 15 denotes shackle rods that are fixed to an end of each of the main ropes 13, 16 denotes shackle springs that lie between the bottom beam 4 and each of the shackle rods 15, and 17 denotes counter weights that are engaged to the other end of the main ropes 13 and are provided separately on both the right and left sides. Numeral 18 denotes a floor on which the car 2 lands, and 19 denotes a control panel which controls each of the hoisting machines 9. Numeral 35 denotes a right-and-left pair of grid plates that are fixed to the guide rails 7 with the longitudinal direction arranged vertically and have slits, as shown in Figure 5. Numeral 41 denotes U-shaped photosensors which are attached to the bottom beam 4 of the car 2 with the opening facing the side walls of the hoistway, and which output pulse signals of the intermittent light transmitted through the grid plates 35 which are loosely inserted into the above-mentioned opening. The grid plates 35 and the photosensors 41 function as car position detectors.

[0020] The weight of the counter weights 17 is set to be balanced at a weight when 40 to 60 percent of the normal load is loaded on the car 2. Here, setting the weight to be balanced at a weight of 50 percent of the load, and the load Wf to equally act on both the right and left hoisting machines 9, a load torque according to the unbalance load Wf/4 is applied to both of the sheaves 10. Accordingly, if one of the brakes 11 does not function, the unbalance load is concentrated on the other brake 11. Therefore, a load according to the unbalance load 2X(Wf/4) is applied to the other brake 11, however, as the brakes 11 are set as to generate a braking torque of 250 to 300 percent of the load torque of the normal unbalance load Wf/4, it is possible to stop the car 2 of which the load is Wf with one brake.

[0021] Figure 2 is a block diagram showing an electric circuit of an elevator control device. In the figure, numeral 21 denotes a tension detector that is attached to the bottom surface of the bottom beam 4 of the car 2 and detects the tension of each of the main ropes 13 by detecting the expansion and contraction of the shackle springs 16, and the details thereof are shown in Figure 3. Numeral 51 denotes a car operating panel, and 52 denotes a hall button provided on each floor 18. Numeral 53 denotes an encoder that generates pulse signals as the hoisting machines 9 rotate.

[0022] Numeral 60 denotes an operation managing device, and comprises a call registration circuit 60a which registers calls from the car operating panel 51 and the hall buttons 52, a target travel distance calculating circuit 60b which calculates the travel distance with the distance to the destination floor as the target travel distance Do, an operation command circuit 60c which commands operation to the destination floor, a leveling command circuit 60e which commands leveling operation, and an in-car load detecting circuit 60f which calculates the load in the car 2 by summing up the tension of both of the main ropes 13 when the car 2 is at a standstill before start.

[0023] Numeral 61L shows equipment that is related to the travel of the car 2 in the left side, as shown by the chain line in the figure, and 61R similarly shows equipment related to the travel of the car 2 in the right side. Both equipments 61L and 61R are of the same equipment structure, thus explanation will be made without distinguishing the two. Numeral 62 denotes an operation contact which closes by commands from the operation command circuit 60c or the leveling command circuit 60e, and supplies electric power from the power converter 77 to the electric motor 12. Numeral 63 denotes a car speed calculating means to calculate the car speed Vm of the car 2 from the number of pulse signals generated per unit hour by the encoder 53. Numeral 64 denotes a travel distance calculator which calculates the travel distance Dm from the departure floor to the present position of the car 2 by integrating the car speed Vm.

[0024] Numeral 65 denotes a subtracter which calculates the remaining distance Dr to the destination floor by subtracting the travel distance Dm from the target travel distance Do, and 66 denotes a position controller which outputs a speed instruction Vo suitable for the remaining distance Dr. The details of the speed instruction Vo is shown in Figure 8. Numeral 67 denotes a switch which connects terminals a and c by commands from the operation command circuit 60c and connects terminals b and c by commands from the leveling command circuit 60e. Numeral 68 denotes a subtracter which calculates the speed difference between the speed instruction Vo and the car speed Vm, and 69 denotes a speed controller which outputs a torque command To suitable for the speed difference.

[0025] Numeral 71 denotes a switch which connects terminals b and c prior to the start of the car 2 and connects terminals a and c along with the closure of the operation contact 62, 72 denotes a static torque calculator which calculates the static torque Ts from the tension detected by the tension detector 21 of the main rope 13 at a standstill immediately before start, 73 denotes an adder which adds the static torque Ts to the torque command To, 74 denotes a load torque calculator which calculates the load torque Tm from the tension of the main rope 13 via the switch 71, 75 denotes a subtracter which calculates the torque difference between the sum of the torque order To and the static torque Ts, and the load torque Tm, 76 denotes a torque controller which outputs a current instruction Io suitable for the torque difference, 77 denotes a power converter which supplies electric power to the electric motor 12 according to the current instruction Io and the output current, and 78 denotes a current transformer which detects output current from the power converter 77.

[0026] Numeral 79 denotes a leveling zone memory in which the leveling zones LZU and LZD that are set above and under the floor 18 are recorded. The details of the leveling zones LZU and LZD are shown in Figure 5. Numeral 80 is a car position calculator which calculates the car position LDm by counting the pulse signals from the photosensor 41, and 81 denotes a subtracter which calculates the remaining distance LDr to the floor 18 by subtracting the car position LDm from the leveling zone LZU or LZD, and 82 denotes a leveling controller which outputs a speed instruction LVo suitable for the remaining distance LDr. The details of the speed instruction LVo is shown in Figure 9.

[0027] Numeral 85 denotes a travel distance comparator which compares the travel distance Dm of the right and left hoisting machines 9, 86 denotes a current comparator which compares the current values of the right and left hoisting machines 9 by being inputted the current values via the current transformer 78, and 87 denotes a safety circuit which stops the right and left hoisting machines 9 when the difference in the travel distance Dm compared by the travel distance comparator 85 exceeds a predetermined value or when the difference in the current values compared by the current comparator 86 exceeds a predetermined value.

[0028] Figure 3 is a longitudinal section showing the main parts of the tension detector 21. Usually, a plurality of ropes are used for both the right and left main ropes 13, however, here, it shall be taken that the tension of one main rope 13 is detected. 22 denotes a bobbin, 23 denotes a primary winding wound around the center part of the bobbin 22, 24 and 25 denote secondary windings wound around the bobbin 22 at both sides of the primary winding 23, which are connected differentially. Numeral 26 denotes a movable iron core loosely inserted into the bobbin 22, and is engaged to the shackle rod 15 via the bracket 27, and moves vertically in accordance with the expansion and contraction of the shackle spring 16. That is, the tension detector 21 comprises a differential transformer, and the primary winding 23 is connected to the AC power source 28 of the voltage e1, and the voltages e2a and e2b are outputted to the secondary windings 24 and 25. The difference of the two voltages eo=e2a-e2b is outputted to the output terminal 29, and the when the movable iron core 26 is in the center of the bobbin 22, the voltage difference becomes eo=0.

[0029] As for the setting of the tension detector 21, firstly, the tensions of the main ropes 13 are measured in the state when there is no load in the car 2. Then, the position of the movable iron core of both the right and left tension detectors 21 is set so that the output eo becomes zero when the smaller one of the tensions acts. Accordingly, the output eo of the tension detector 21 becomes a value which is in proportion to the difference of the value where the smaller of the tensions of the right and left main ropes 13 when there is no load is the standard.

[0030] Figure 4 shows the operation state of the above-mentioned tension detector 21. That is, the tension detectors 21 are fixed to the right and left sides of the car 2, and operate separately from each other and output the outputs eoL and eoR. When the car 2 is at a standstill, the static torques TsL and TsR are calculated by the corresponding static torque calculators 72L and 72R according to the above-mentioned outputs eoL and eoR.

[0031] As shown in the figure, if the passenger 2a rides on the car particularly on the right side, the tension of the right main rope 13R becomes larger than that of the left main rope 13L. Therefore, as the right shackle spring 16R becomes more compressed than the left shackle spring 16L, the value of the output eoR becomes larger that that of the output eoL, and this applies also to the static torque TsR.

[0032] Figure 5 is a perspective view showing the car position detector which comprises a grid plate 35 and a photosensor 41, and the grid plate 35 which has the longitudinal direction arranged vertically has slits 36 punched at a fixed pitch d, and on one side has a landing zone notch 37 which is formed from the center in the equal lengths LU, LD in the longitudinal direction. Numeral 38 denotes a bracket to attach the grid plate 35 to the guide rail 7.

[0033] On the inner side surface of one of the arms of the body of the photosensor 41, there are fixed projectors 42p and 43p vertically at a predetermined distance, and a fixed projector 44p in the depth direction, and on the other arm, there are fixed photoray receivers 42r, 43r and 44r in the facing positions. The photoreceivers 42r and 43r function as car position encoders which output pulse signals by the intermittence of the photorays by the grid plate 35 from the projectors 42p and 43p. The photoreceiver 44r detects the leveling zones LZU and LZD by the insulation of the photoray from the projector 44p by the grid plate 35, and detects the landing zones LU and LD by the passing of the photoray. Accordingly, the photoreceiver 44r functions as a landing zone detector.

[0034] Here, the grid plate 35 is attached to the guide rail 7 via the bracket 38 so that the center of the grid plate 35 accords with the center of the photosensor 41 which is fixed to the bottom beam 4, when the car platform 3 and the floor 18 meet.

[0035] Figure 6 shows the car 2 at a landing state. That is, the car position detectors which comprise the photosensor 41 and the grid plate 35 are fixed on the right and left sides of the car 2, and operate separately detecting the position of the car platform 3. As shown in the figure, it shall be taken that the car platform 3 is inclined from left to right at an angle of α to the floor 18, and that the right photoreceiver 44rR is within the landing zones LU and LD but the left photoreceiver 44rL is outside and above the landing zone LU. The leveling will be operated only at the left side, and landing will be operated by lowering only the left side of the car 2 so that the photoreceiver 44rL comes within the landing zones LU and LD.

[0036] Figure 7 similarly shows the car 2 at a landing state. That is, the leveling will be operated only when both the right and left photoreceivers 44rL and 44rR are within the leveling zones LZU and LZD. As shown in the figure, when the car platform 3 stops inclined above the floor 18, and the right photoreceiver 44rR is within the leveling zone LZU but the left photoreceiver 44rL is outside and above the leveling zone LZU, leveling will not be operated.

[0037] Figure 8 shows the speed instruction Vo outputted from the position controller 66 at call response operation. The figure shows the calculation of the speed instruction Vo in accordance with the remaining travel distance Dr to the destination floor, and when an operation order is issued at time t0, a speed instruction vo1 is outputted as an initial value. If the travel distance calculator 64 outputs a distance Dm1 when the elevator is operated to ascend and descend according to this speed instruction vo1, the remaining distance Dr to the destination floor becomes Dr=(Do-Dm1), Do being the target travel distance. According to this remaining distance Dr, a speed instruction vo2 is outputted. Similarly, if the elevator travels the distance Dm2 from the departure floor according to this speed instruction vo2, the remaining distance will be Dr=(Do-Dm2), and a speed instruction vo3 is outputted according to this remaining distance Dr. If the time t3, which is the time the elevator traveled the distance Dm3 traveled from the departure floor according to the speed instruction vo3, is taken as the present position of the car 2, a new speed instruction Vo will be given according to the remaining distance Dr=(Do-Dm3) from this position, and when it reaches the rated speed Vmax, it becomes a stable value.

[0038] When the remaining distance Dr becomes equal to the deceleration distance, the speed instruction Vo thereafter decelerated is outputted corresponding to the remaining distance Dr, and the elevator lands at the destination floor according to this speed instruction Vo.

[0039] Figure 9 shows the speed instruction LVo during leveling operation. The speed instruction LVo in the leveling operation is outputted from the leveling controller 82, and after outputting the initial value LVmax, it outputs a speed instruction LVo which gradually decreases according to the remaining distance LDr from the subtracter 81. In the leveling zones LZU and LZD, the photosensor 41 is engaged to the grid plate 35. By this engagement, the car position calculator 80 detects the travel direction of the car 2 from the order of movement of the photoreceivers 42r and 43r, and calculates the position LDm of the car 2 from the number of the pulse signals from the photoreceivers 42r or 43r. Accordingly, in descending operation, the position LDm of the car 2 is detected with the upper part reference position Pu as the starting point, and in ascending operation, the position LDm of the car 2 is detected with the lower part reference position Pd as the starting point. When the car platform 3 goes out of the landing zones LU and LD and the photoray to the photosensor 44r is blocked off, the leveling is operated in accordance with the speed instruction LVo.

[0040] Explanation of the call response operation will be made according to Figure 10. As the below-mentioned is operation common to both the equipment 61L of the left side and the equipment 61R of the right side, explanation will be made without distinguishing the two.

[0041] When a hall call or a car call is registered with the call registration circuit 60a, the procedure moves from step S11 to step S12, and an operation command is given from the operation command circuit 60c to respond to the call. In step S13, the travel distance from the departure floor to the destination floor is calculated by the travel distance calculating circuit 60b, and is outputted as a target travel distance Do common to both the equipment 61L of the left side and the equipment 61R of the right side. In step S14, the output from the tension detector 21 is inputted to the static torque calculator 72 by connecting the switch 71 to terminal b, and after the static torque Ts is calculated and memorized from the tension of the main rope 13 at a standstill before start, the switch 71 is connected to terminal a. In step S15, also the switch 67 is connected to terminal a. In step S16, the operation contact 62 is closed and the brake 11 is released, and electric power is supplied to the electric motor 12.

[0042] In step S17, the pulse signals from the encoder 53 are inputted to the car speed calculation means 63 and the car speed Vm is calculated, further, the travel distance Dm from the departure floor to the present position of the car 2 is calculated by integration of the car speed Vm by the travel distance calculator 64. In step S18, the remaining distance Dr to the destination floor is calculated by subtraction of the travel distance Dm from the target travel distance Do by the subtracter 65. In step S19, a speed instruction Vo suitable for the remaining distance Dr is outputted from the position controller 66. In step S20, the speed difference ΔV between the speed instruction Vo and the car speed Vm is calculated by the subtracter 68. In step S21, the torque command To is calculated by the speed controller 69 according to the speed difference ΔV. In step S22, the torque command To and the static torque Ts are summed up by the adder 73. In step S23, the torque difference ΔT between the sum of the torque command To and the static torque Ts, and the load torque Tm, is calculated by the subtracter 75. In step 524, the current command Io according to the torque difference ΔT is calculated by the torque controller 76. In step S25, electric power is supplied by the power converter 77 to the electric motor 12 according to the current command Io.

[0043] In step S26, when the arrival to the destination floor of the car 2 is detected by the car position detector which comprises a grid plate 35 and a photosensor 41, the procedure moves to step S27, and the operation contact 62 is opened, the brake 11 is operated, the electric motor 12 is de-energized, and the procedure returns to step S11, and operates the next call response operation. If the car 2 has not arrived to the destination floor in step S26, the procedure returns to step S17 and repeats the procedure of steps S17 through S26, and drives the car 2 to the destination floor.

[0044] Explanation of the leveling operation will be made according to Figure 11. As the below-mentioned is operation common to both the equipment 61L of the left side and the equipment 61R of the right side, explanation will be made without distinguishing the right and left sides unless necessary.

[0045] In step S31, it is carried on to step S32 only when both the right and left photoreceivers 44r detect the leveling zones LZU and LZD, in a case such as in Figure 6. As shown in Figure 7, in the case where there is a photoreceiver 44r that does not detect the leveling zones LZU and LZD, leveling operation is not carried out. This is because leveling operation is inappropriate when the difference between the floor 18 and the car platform 3 is large. In step S32, in the case where both the right and left photoreceivers 44r detect the inside of the leveling zones LU and LD, leveling operation is not carried out. This is because there is no necessity for leveling operation. As shown on the left side of Figure 6, in the case where there is a photoreceiver 44r which does not detect the leveling zones LU and LD, in step S33, the leveling command circuit 60e of the side which the leveling zones LU and LD are not detected operates.

[0046] After the output from the tension detector 21 is inputted to the static torque calculator 72 by connecting the switch 71 to terminal b in step S34, and the static torque Ts is calculated and memorized from the tension of the main rope 13 at a standstill before start, the switch 71 is connected to terminal a. In step S35, also the switch 67 is connected to terminal b. In step S36, the brake 11 is released by closing the operation contact 62, and electric power is supplied to the electric motor 12. In step S37, the leveling controller 82 outputs an initial value LVmax as the speed instruction LVo of the leveling operation. In step S38, the car position LDm is read from the car position calculator 80. This car position LDm is calculated and memorized in advance by the car position calculator 80 from the pulse signals of the photosensor 41 which has the upper part reference position Pu or the lower part reference position Pd as the starting point when the car 2 lands on the destination floor during call response operation. In step S39, the leveling zones LZU and LZD are read from the leveling zone memory 79, and the remaining distance LDr to the floor 18 is calculated by subtraction of the leveling zones LZU and LZD and the car position LDm by the subtracter 81. In step S40, as shown in Figure 9, the leveling controller 82 outputs a speed instruction LVo which decreases gradually in accordance with the remaining distance LDr. In step S41, the speed difference ΔV between the speed instruction LVo and the car speed Vm is calculated by the subtracter 68.

[0047] Step S42 is a similar procedure as steps S21 through S25 in Figure 10: the torque command To is calculated by the speed controller 69 according to the speed difference Δ V; the torque command To and the static torque Ts are summed up by the adder 73; the torque difference ΔV between the sum of the torque command To and the static torque Ts, and the load torque Tm, is calculated by the subtracter 75; the current command Io is calculated by the torque controller 76 in accordance with the torque difference ΔV; and the car 2 is driven to ascend and descend by supply of electric power to the electric motor 12 by the power converter 77 based on the current command Io.

[0048] When entry of the car platform 3 to the landing zones LU and LD is detected by the photoreceiver 44r in step S43, the procedure moves to step S44, where the leveling operation is completed by operating the brake 11 by releasing the operation contact 62 and also de-energizing the electric motor 12. In step S43, If the car platform 3 is judged that it has not reached the landing zones LU and LD, it returns to step S38, and the procedure from step S38 through step S43 is repeated and leveling operation is carried out.

[0049] According to the above-mentioned first embodiment of the present invention, as the car 2 is driven to ascend and descend by main ropes 13 engaged to both the right and left sides of the car 2 with hoisting machines 9 around which the ropes are passed, and which are provided corresponding to the main ropes 13 and pulling the car up, even in the case where one of the brakes does not function, it is possible to stop the car 2 of the load Wf with the other brake 11.

[0050] Moreover, as it is made to detect the tension of the main ropes 13 at a standstill before start of the car 2, and to drive the car 2 to ascend and descend by increasing or decreasing the torque of the corresponding hoisting machines 9 separately according to the detected values, even if the tension of the main ropes 13 differ due to the load being loaded particularly on one side of the car 2, the hoisting machines 9 drive the car 2 with suitable torques, so it is possible to prevent relative movement of the main ropes 13 and to avoid the car platform 3 from inclining extremely.

[0051] Further, as a tension detector 21 is provided for each of the main ropes 13, and an in-car load detecting circuit 60f regarding as the in-car load the sum of the outputs of both the tension detectors at a standstill before start of the car 2 is provided, it is possible to calculate the congestion degree etc. by detecting the load in the car 2 without installation of other detectors.

[0052] Moreover, as it is made to operate leveling separately with the corresponding hoisting machine 9 when the difference between the floor 18 and the car platform 3 exceeds the upper landing zone LU or the lower landing zone LD at arrival of the car 2 to the destination floor, even if relative movement occurs to the main ropes 13 due to the hoisting machines 9 and the car platform 3 inclines, the inclination is adjusted by leveling operation, so the relative movement of the main ropes 13 does not increase progressively.

[0053] Further, as the travel distances Dm are calculated for each of the hoisting machines 9 and are compared by the travel distance comparator 85, and the hoisting machines are made to stop by operating the safety circuit 87 if the difference exceeds a predetermined value, it is possible to prevent the car platform 3 from inclining extremely.

[0054] Especially, as the encoder 53 measures the rotational angular speed ω of the hoisting machines 9, and the above-mentioned travel distance Dm is calculated from this measured value, the hoisting machines can be stopped not only when the main ropes 13 actually move relatively, but also when the travel distances Dm differ from each other due to occurrence of unevenness in the rotation of the hoisting machines 9, so it is possible to detect and to cope with dispersion in the wear of the sheave 10 in the early stage.

[0055] Moreover, as the currents of the electric motor 12 of each of the hoisting machines 9 are measured separately and are compared by the current comparator 86, and the hoisting machines 9 are stopped when the difference exceeds the predetermined value by operation of the safety circuit 87, it is possible to prevent operation in a state where a load is placed extremely on one of the electric motors, e.g. when the car 2 is extremely inclined.

[0056] Furthermore, by giving a common target travel distance Do to both of the hoisting machines 9 by precalculating the travel distance from the departure floor to the destination floor, and by calculating the remaining distance Dr from the present position to the destination floor separately for each hoisting machine 9 and controlling the corresponding hoisting machines 9 separately with speeds suitable for the remaining distances Dr as speed instructions Vo, control suitable for the target travel distance Do becomes possible, and it is possible to make the elevator land accurately.

[0057] In the above-mentioned first embodiment of the present invention, the load bias to the hoisting machine 9 is compared by the current comparator 86 by detecting the electric motor current via the current transformer 78, however, it is not limited only to this, and it is also acceptable to detect the load bias by comparing the load torques applied to the two hoisting machines 9.

Second Embodiment

[0058] Figures 12 through 15 show the second embodiment of the elevator control device comprising a plurality of hoisting machines in accordance with the present invention.

[0059] In this second embodiment, at the time a speed instruction is given, the speed instruction is calculated according to the passing of time and the hoisting machines are controlled together, and from the point of deceleration to the destination floor, the hoisting machines are controlled separately with speed instructions suitable for the remaining distance.

[0060] Figure 12 is a block diagram showing an electric circuit of the elevator control device; numeral 91 denotes a right-and-left pair of grid plates which are fixed to the guide rails 7 with the longitudinal direction arranged vertically and which have slits 36 arranged from the upper and lower deceleration points PPu and PPd to the floor position, as shown in detail in Figure 13. Numeral 100 denotes an operation managing device which comprises a call registration circuit 60a, an operation command circuit 60c, a leveling command circuit 60e, an in-car load detecting circuit 60f, and also a deceleration command circuit 60d which commands deceleration when the photosensor 41 is engaged to the grid plate 91 and detects a deceleration point set at a predetermined distance before the destination floor. Numeral 101 denotes a speed per time calculator which controls both of the hoisting machines 9 together by computing the speed instruction Vao in accordance with the lapse of time when an operation command is given from the operation command circuit 60c.

[0061] As shown by the chain line in the figure, numeral 102L denotes equipment related to the travel of the left main rope 13L on the left side of the car 2, and similarly, numeral 102R denotes equipment related to the travel on the right side of the car 2. Both the equipments 102L and 102R are of the same equipment structure, thus explanation will be made without distinguishing the two. Numeral 103 denotes a deceleration controller that generates a speed instruction Vdo as shown in Figure 14, by calculating the speed suitable for the remaining distance GDr from the deceleration point to the destination floor for each hoisting machine 9. Numeral 104 denotes a switch which has the terminals a and d connected by the command from the operation command circuit 60c, the terminals b and d connected by the command of the deceleration command circuit 60d, and the terminals c and d connected by the command of the leveling command circuit 60e.

[0062] Numeral 105 denotes a part which comprises the same elements as the elements to which are given the numerals 71 through 77 in Figure 2. Numeral 106 denotes a car position calculator which calculates the car position GDm by counting the pulse signals from the photosensor 41, and 107 denotes a deceleration distance memory in which is recorded the deceleration distance GZU and GZD from the deceleration point to the floor 18 recorded. Numeral 108 denotes a subtracter which calculates the remaining distance GDr by subtracting the car position GDm, which has the deceleration point as the starting point, from the deceleration distance GZU or GZD.

[0063] Figure 13 is a perspective view showing the car position detector which comprises a grid plate 91 and a photosensor 41 , and in the grid plate 91 which has the longitudinal direction arranged vertically, there are slits 36 punched at a fixed pitch d from the upper and lower deceleration points PPu and PPd to the floor 18, and also on one side, there is a landing zone notch 37 formed at the equal lengths LU, LD in the longitudinal direction, the floor 18 being the center, and also a shielding part 92 to specify the leveling zones LZU and LZD, the floor 18 being the center, is formed above and below the landing zone notch 37.

[0064] That is, the grid plate 91 specifies the deceleration distances GZU and GZD to the floor 18 with the upper deceleration point PPu or the lower deceleration point PPd being the starting point, specifies the leveling zones LZU and LZD which have the upper reference position Pu or the lower reference position Pd as the starting point, and also specifies the landing zones LU and LD.

[0065] Figure 14 shows the speed instruction Vao outputted from the speed per time calculator 101, and the speed instruction Vdo outputted from the deceleration controller 103.

[0066] When an operation command is given from the operation command circuit 60a at time t20, the speed instruction Vao increases the speed progressively as the predetermined time Δt passes, and when it reaches the rated speed Vmax, it becomes a stable value.

[0067] If the photosensor 41 is engaged to the grid plate 91 at time t21, the terminals b and d of the switch 104 are connected by operation of the deceleration command circuit 60d, and a speed instruction Vdo for deceleration is outputted. Accordingly, the car position calculator 106 calculates the car position GDm, with the upper deceleration point PPu as the starting point during descending operation, and with the lower deceleration point PPd as the starting point during ascending operation. When the remaining distance GDr is calculated by the subtracter 108 by subtracting the car position GDm from the deceleration distance GZU or GZD, the deceleration controller 103 calculates a speed suitable for the remaining distance GDr. This speed is outputted as a speed instruction Vdo via the switch 104.

[0068] The hall call operation motion of the second embodiment of the present invention will be explained referring to Figure 15. As the below-mentioned is operation common to both the equipment 102L of the left side and the equipment 102R of the right side, explanation will be made without distinguishing the two.

[0069] When a hall call or a car call is registered with the call registration circuit 60a, the procedure is moved from step S51 to step S52, and an operation command is given from the operation command circuit 60c to respond to the call. After calculating and memorizing the static torque Ts from the tension of the main rope 13 at a standstill before start by connecting the switch 71 to terminal b in step S53, the switch 71 is connected to terminal a. In step S54, the switch 104 is connected to terminal a. In step S55, the operation contact 62 is closed and the brake 11 is released, and electric power is supplied to the electric motor 12.

[0070] In step S56, a speed instruction Vao is outputted from the speed per time calculator 101 by the operation command from the operation command circuit 60c. In step S57, the speed difference ΔV between the speed instruction Vao and the car speed Vm is calculated by the subtracter 68. Step S58 is a similar procedure as that shown in Steps S21 through S25 in Figure 10, and calculates a torque command To according to the speed difference ΔV, and energizes the electric motor 12 so as to output a torque which is an addition of the static torque Ts to the torque command To, to make the car 2 ascend and descend. In step S59, whether or not a deceleration command is outputted from the deceleration command circuit 60d is checked by engaging the photosensor 41 to the grid plate 91. In the case where a speed instruction is not yet outputted, the procedure returns to step S56, and steps 56 through 59 are repeated.

[0071] In the case where a deceleration command is outputted in step S59, the terminals b and d of the switch 104 are connected in step S60. In step S61, the car position GDm, which has the deceleration point PPu or PPd as the starting point, is read from the car position calculator 106. In step S62, the deceleration distance GZU or GZD is read from the deceleration distance memory 107, and the remaining distance GDr to the floor 18 is read by subtraction of the car position GDm from the deceleration distance GZU or GZD by the subtracter 108. In step S63, as shown in Figure 14, the deceleration controller 103 outputs a speed instruction Vdo which progressively decreases according to the remaining distance GDr. In step S64, the speed difference ΔV between the speed instruction Vdo and the car speed Vm is calculated by the subtracter 68. Step S65 is a similar procedure as that shown in steps S1 through S25 in Figure 10, and calculates the torque command To according to the speed difference ΔV, and performs deceleration operation by energizing the electric motor 12 by outputting a torque which is the sum of the static torque Ts added to the torque command To. In step S66, when the photosensor 44r detects entry of the car platform 3 into the landing zones LU and LD, the procedure moves on to step S67, and call response operation is finished by operating the brake 11 by releasing the operation contact 62 along with de-energizing the electric motor 12. In step S66, if the car platform 3 is judged that it has not reached the landing zones LU and LD, the procedure returns to step S61, and call response operation is performed by repeating the procedure from step S61 through step S66.

[0072] The leveling operation is the same as that shown in Figure 11, thus explanation is omitted.

[0073] According to the second embodiment described above, from the departure floor to the deceleration points PPu and PPd, the speed instruction Vao is outputted according to the lapse of time from the speed per time calculator 101, therefore, calculation of the speed instruction Vao is easy. In addition to this, both the right and left hoisting machines 9L and 9R are controlled together by the same speed instruction Vao, so it is unlikely that the difference in the travel distance between the two would occur.

[0074] Also, as the position of the car 2 from both the main ropes 13 is detected directly by the photosensor 41 and the grid plate 91 from the deceleration points PPu and PPd to the destination floor 18, accurate position control can be realized.

Third Embodiment

[0075] Figure 16 shows a third embodiment in accordance with the present invention.

[0076] In the aforementioned first and second embodiments, the counter weights 17 are separately suspended at the right and left sides, however, in this third embodiment, a common counter weight is suspended by a left main rope 13L and a right main rope 13R. That is, the two ends of the main ropes 13L and 13R are engaged to a common car 2 and a common counter weight 17A.

[0077] Also in the above-mentioned third embodiment 3, the weight of the counter weight 17A is set in the similar way as in the first embodiment, therefore, even in the case where one of the brakes does not function, it is possible to stop the car 2 of the load of Wf with only the other brake 11. Especially, in this third embodiment, as the counter weight is common to both of the main ropes 13L and 13R, only one pair of counter weight guide rails 8 is necessary, thus making the installation work reduced.

Industrial Applicability

[0078] As described above, the elevator control device in accordance with the present invention which comprises a plurality of hoisting machines, is suitable for a control device for elevators which need to have a plurality of hoisting machines installed in a small space. Moreover, it is suitable for a control device for elevators which have a limit to lifting of heavy loads at the time of installation.

Claims

1. An elevator control device for driving a car to ascend and descend with main ropes that are raised being separately engaged to a plurality of positions of said car and that are passed around a plurality of hoisting machines installed corresponding to said main ropes, **characterized in that** tensions of each of said main ropes at a standstill of the car are detected separately by tension detectors, and said car is driven to ascend and descend by increasing and decreasing outputs from the corresponding said hoisting machines according to the detected values.

2. The elevator control device according to claim 1, **characterized by** comprising in-car load detecting means for detecting the in-car load by summing up the tension of each main rope at a standstill with the tension detectors.

3. An elevator control device for driving a car to ascend and descend with main ropes that are raised being separately engaged to a plurality of positions of said car and that are passed around a plurality of hoisting machines installed corresponding to said main ropes, **characterized in that** difference of floor and car platform at landing of said car to the destination floor is detected at each position of engagement of said main ropes, and in the case where the detected value exceeds a predetermined value, leveling is operated with separate vertical motion of said engagement positions of main ropes by the corresponding said hoisting machines to decrease said difference.

4. An elevator control device wherein a car is driven to ascend and descend with main ropes that are raised being separately engaged to a plurality of positions of said car and that are passed around a plurality of hoisting machines installed corresponding to said main ropes, **characterized in that** each hoisting machine comprises a travel distance calculator for calculating travel distance, and a safety circuit for stopping said hoisting machines in the case where difference of said calculated value exceeds a predetermined value.

5. The elevator control device according to claim 4, **characterized in that** the travel distance calculator is a rotation angle measuring instrument for measuring a rotation angle of the hoisting machines.

6. An elevator control device for driving a car to ascend and descend with main ropes that are raised being separately engaged to a plurality of positions of said car and that are passed around a plurality of hoisting machines installed corresponding to said main ropes, **characterized in that** the powers of electric motors for driving said hoisting machines are measured separately for each hoisting machine, and by comprising a safety circuit for stopping said hoisting machines in the case where difference of measured values exceed a predetermined value.

7. An elevator control device for driving a car to ascend and descend with main ropes that are raised being separately engaged to a plurality of positions of said car and that are passed around a plurality of hoisting machines installed corresponding to said main ropes, **characterized by** comprising:

    target travel distance calculation means for precalculating and giving to said hoisting machines as a common target travel distance the travel distance from the departure floor to the destination floor;
    travel distance measuring means for measuring the travel distance from said departure floor to present position of said car at each of said positions of engagement;
    remaining distance calculating means for calculating the remaining distance to said destination floor at each of said positions of engagement of main ropes by subtracting said measured value from said target travel distance; and travel position controlling means for outputting

speed suitable for said remaining distance for each of corresponding said hoisting machines as speed instructions;

wherein corresponding said hoisting machines are controlled separately by said speed instructions.

8. An elevator control device for driving a car to ascend and descend with main ropes that are raised being separately engaged to a plurality of positions of said car and that are passed around a plurality of hoisting machines installed corresponding to said main ropes, **characterized by** comprising:

time rate calculating means for calculating speed instruction according to lapse of time;
deceleration point detecting means for detecting at each of said positions of engagement deceleration points set at a predetermined distance before the destination floor; and
distance and speed calculating means for outputting speed suitable for the remaining distance from the present position of said car to the destination floor as speed instructions at each of said positions of engagement of main ropes;

wherein said hoisting machines are controlled together by speed instruction calculated by said distance and speed calculating means when speed instruction is given to said hoisting machines, and said time rate calculating means is switched to said distance and speed calculating means in each of the corresponding said hoisting machines and corresponding said hoisting machines are controlled separately by the speed instruction calculated by said distance and speed calculation means from said deceleration points to said destination floor when said deceleration point calculation means detects said deceleration point.

FIG. 1

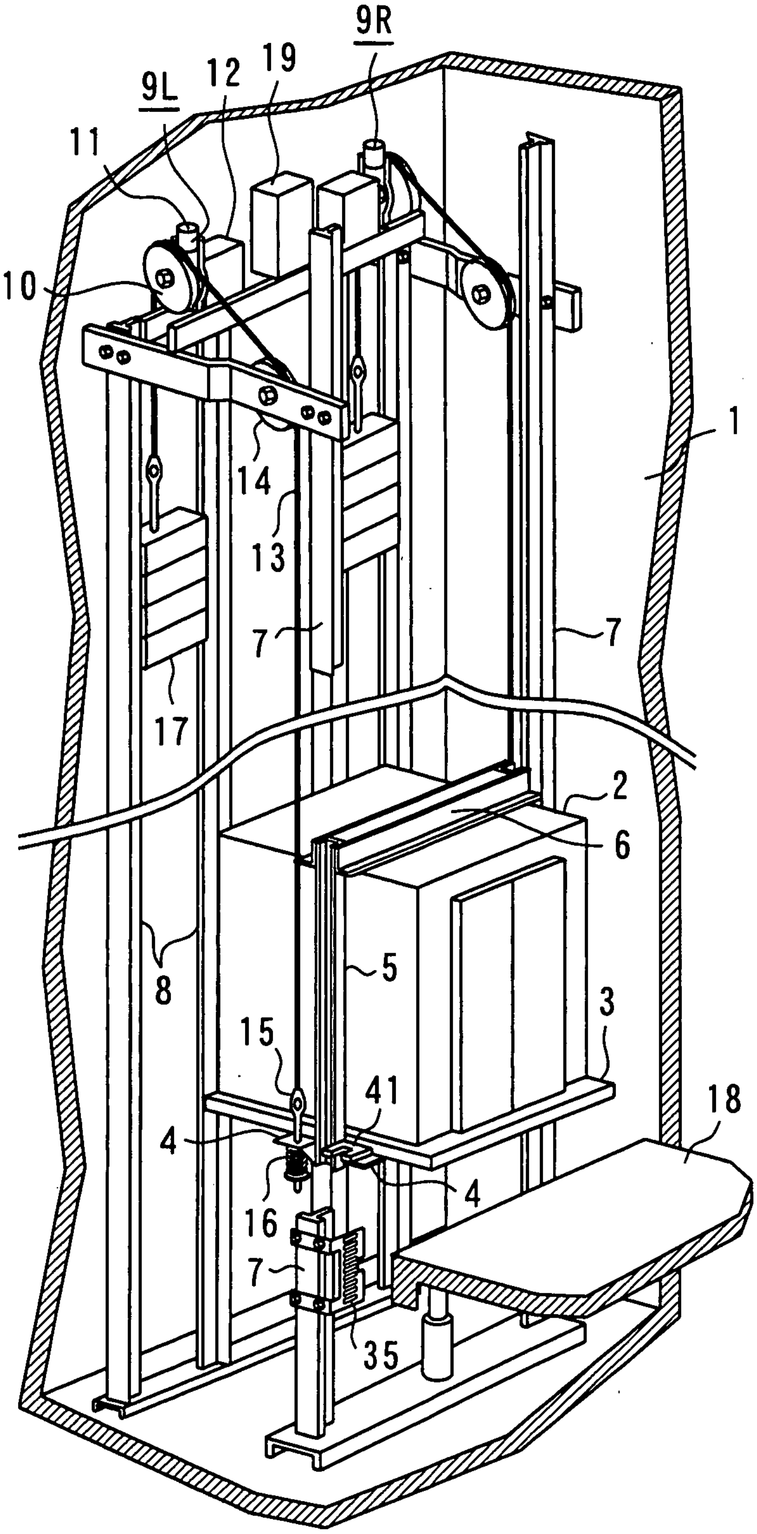


FIG. 2

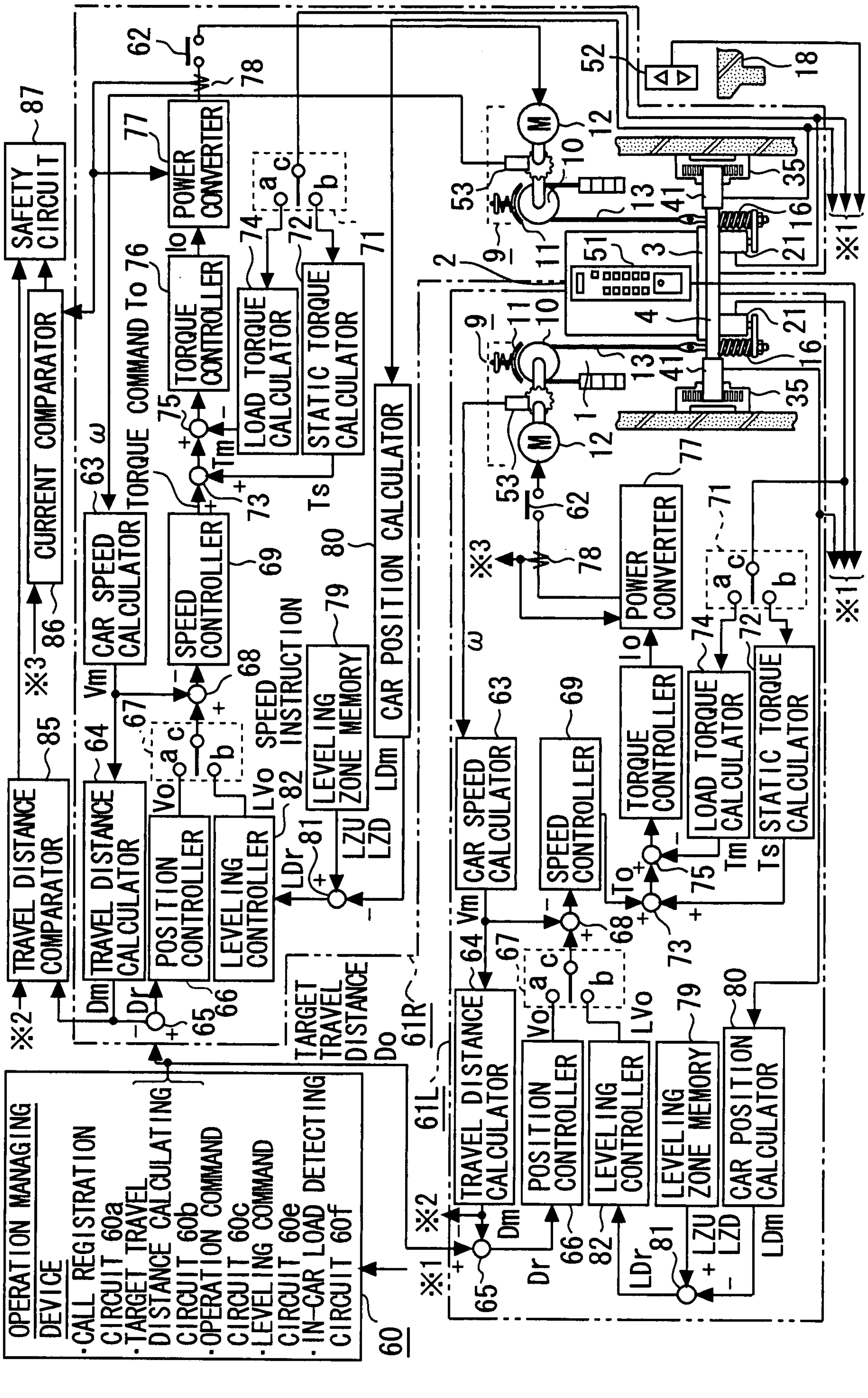

SAFETY CIRCUIT
CURRENT COMPARATOR
TRAVEL DISTANCE COMPARATOR
TRAVEL DISTANCE CALCULATOR
POSITION CONTROLLER
LEVELING CONTROLLER
CAR SPEED CALCULATOR
SPEED CONTROLLER
LEVELING ZONE MEMORY
CAR POSITION CALCULATOR
POWER CONVERTER
TORQUE CONTROLLER
LOAD TORQUE CALCULATOR
STATIC TORQUE CALCULATOR
TORQUE COMMAND To 76
SPEED INSTRUCTION
TARGET TRAVEL DISTANCE Do
OPERATION MANAGING DEVICE
·CALL REGISTRATION CIRCUIT 60a
·TARGET TRAVEL DISTANCE CALCULATING CIRCUIT 60b
·OPERATION COMMAND CIRCUIT 60c
·LEVELING COMMAND CIRCUIT 60e
·IN-CAR LOAD DETECTING CIRCUIT 60f
60
61L
61R

FIG. 3

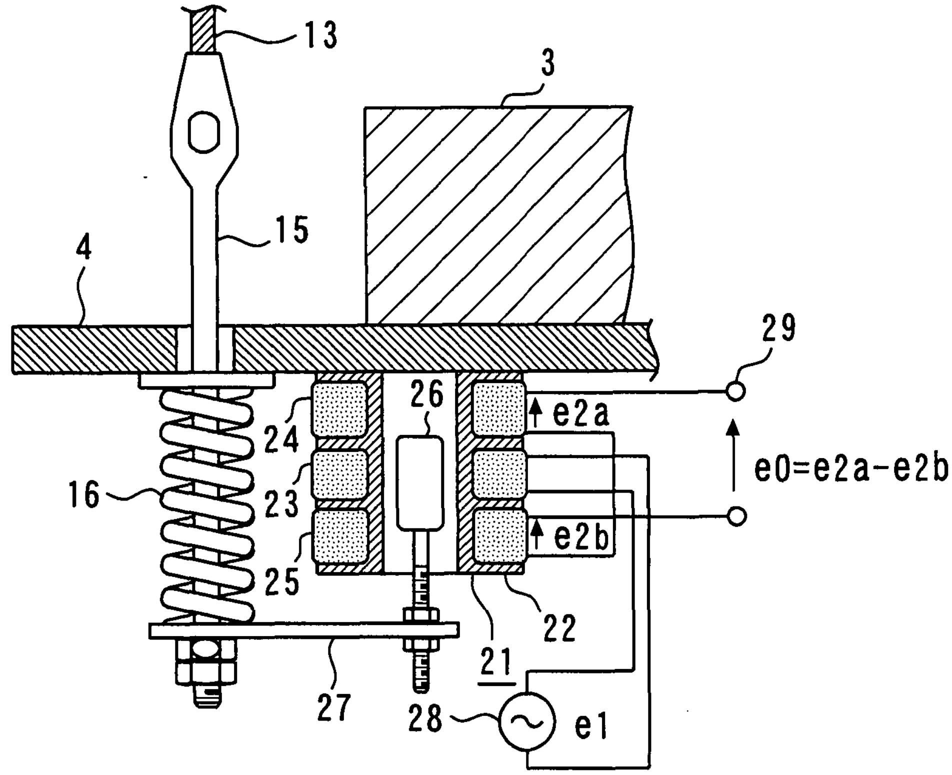

13
3
15
4
29
26
24
e2a
23
e0=e2a-e2b
16
e2b
25
22
21
27
28
e1

FIG. 4

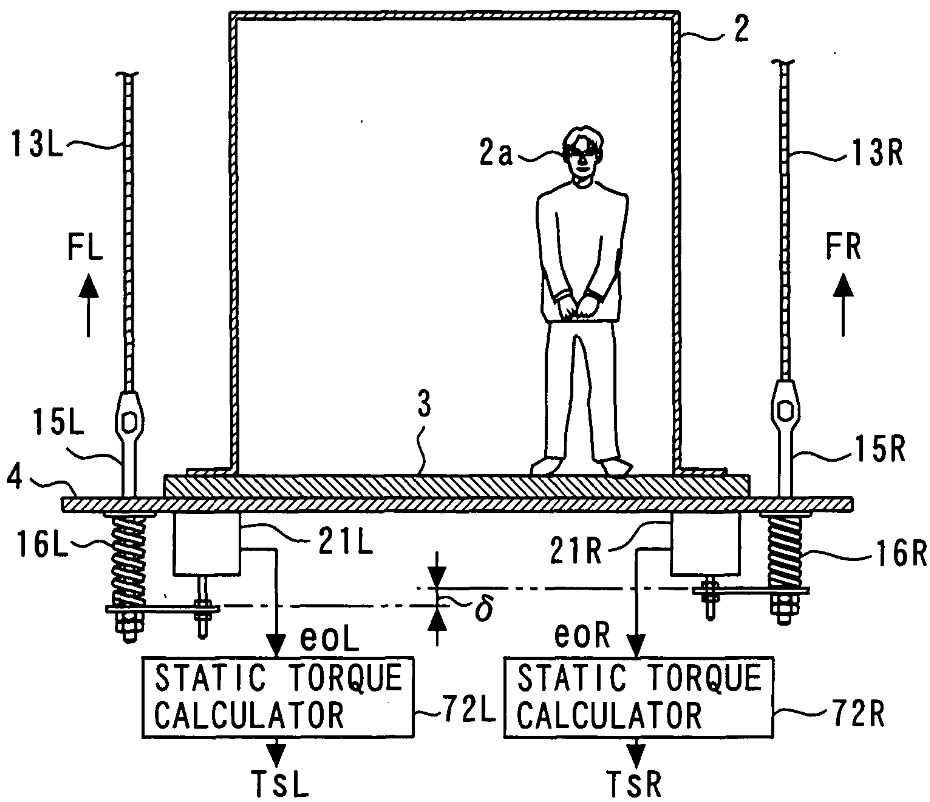

2
13L
2a
13R
FL
FR
15L
3
15R
4
16L
21L
21R
16R
δ
eoL
eoR
STATIC TORQUE CALCULATOR
72L
STATIC TORQUE CALCULATOR
72R
TsL
TsR

FIG. 5

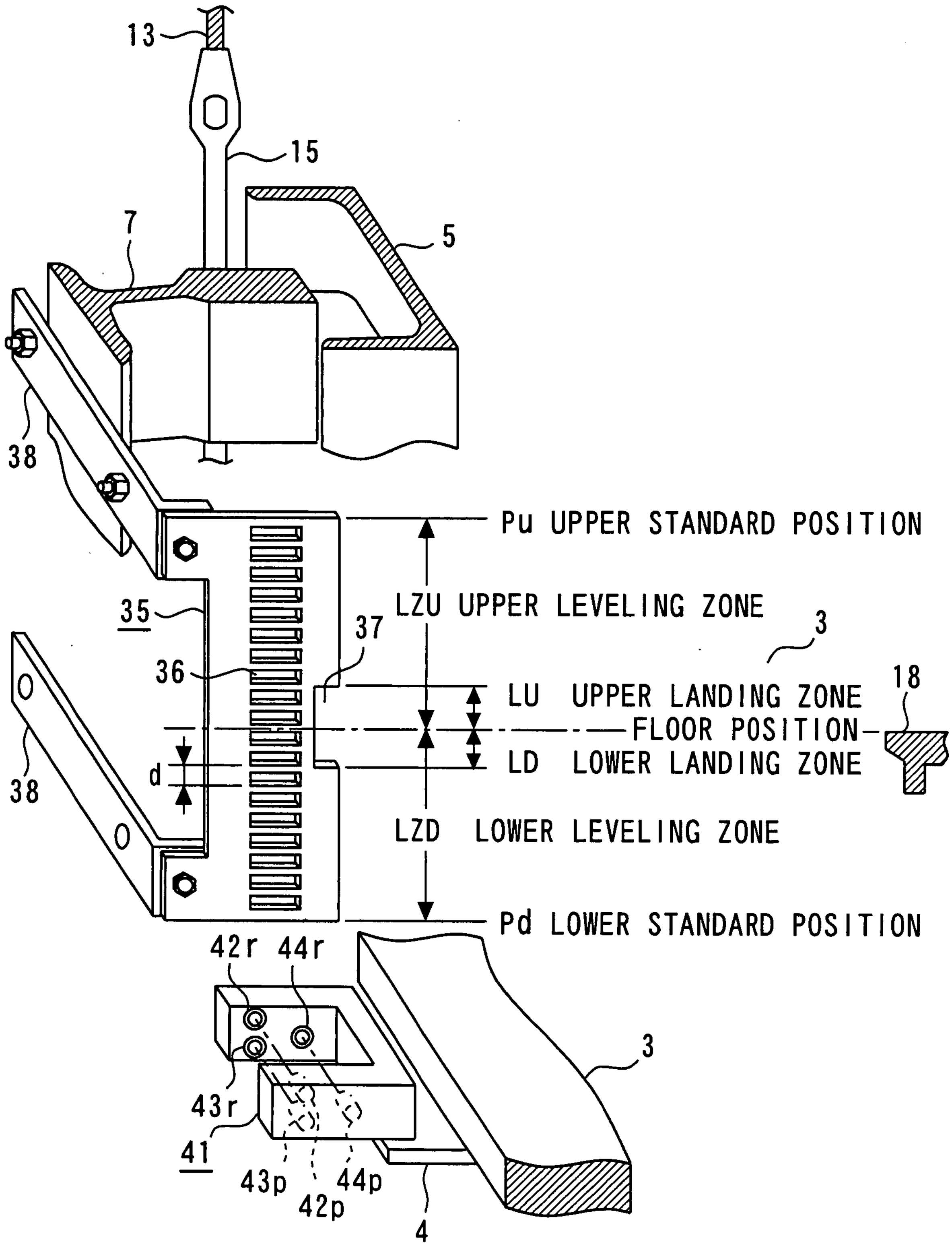

13
15
5
7
38
Pu UPPER STANDARD POSITION
LZU UPPER LEVELING ZONE
35
37
3
36
LU UPPER LANDING ZONE
18
FLOOR POSITION
LD LOWER LANDING ZONE
d
38
LZD LOWER LEVELING ZONE
Pd LOWER STANDARD POSITION
42r
44r
3
43r
41
43p
44p
42p
4

FIG. 6

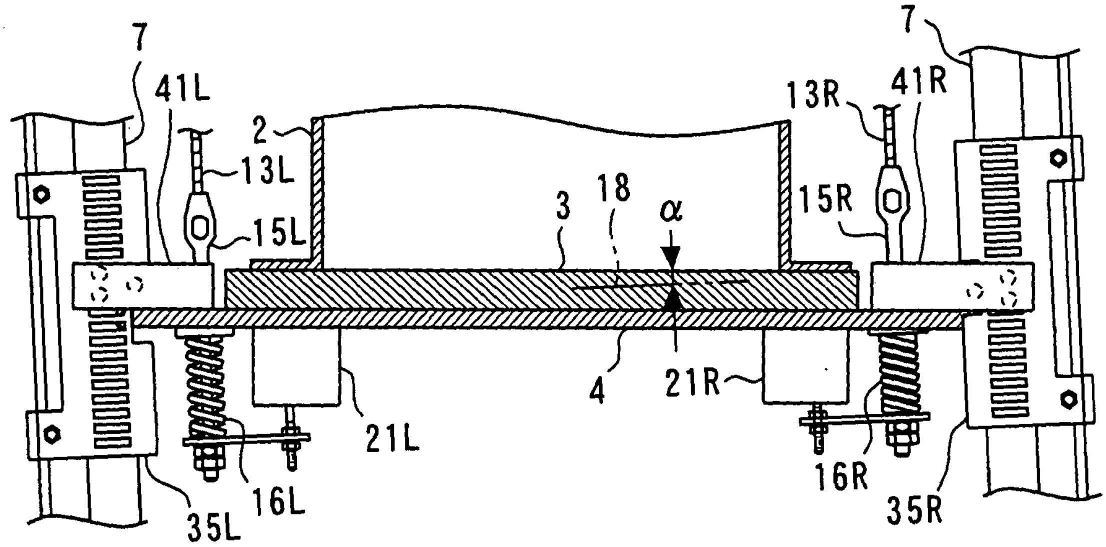

7
41L
13L
15L
2
3
18
α
13R
41R
15R
7
4
21R
21L
16L
35L
16R
35R

FIG. 7

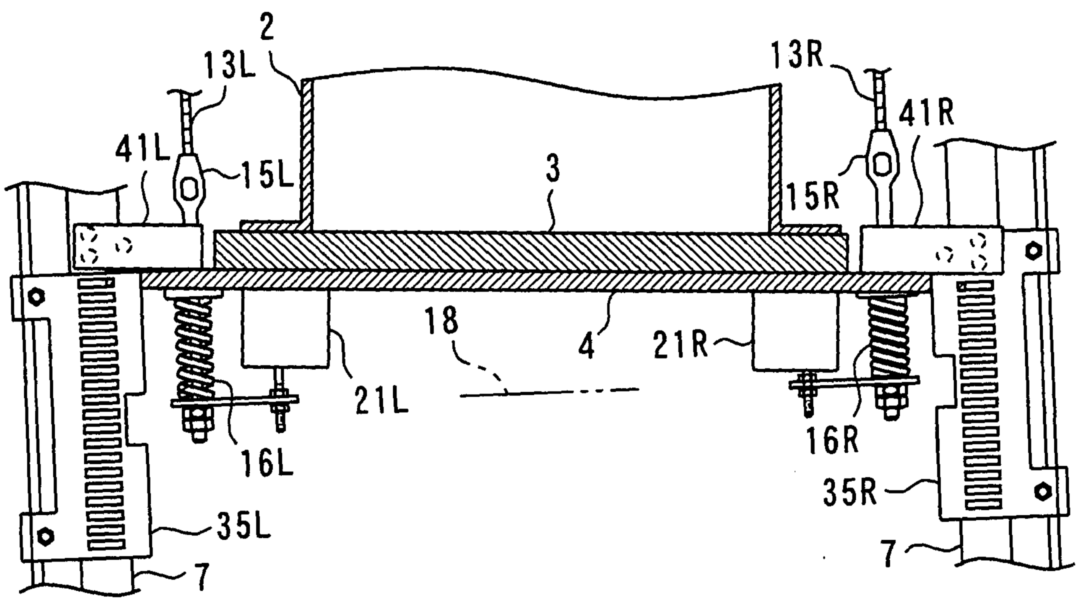

2
13L
41L
15L
3
13R
41R
15R
18
4
21R
21L
16L
16R
35L
35R
7
7

FIG. 8

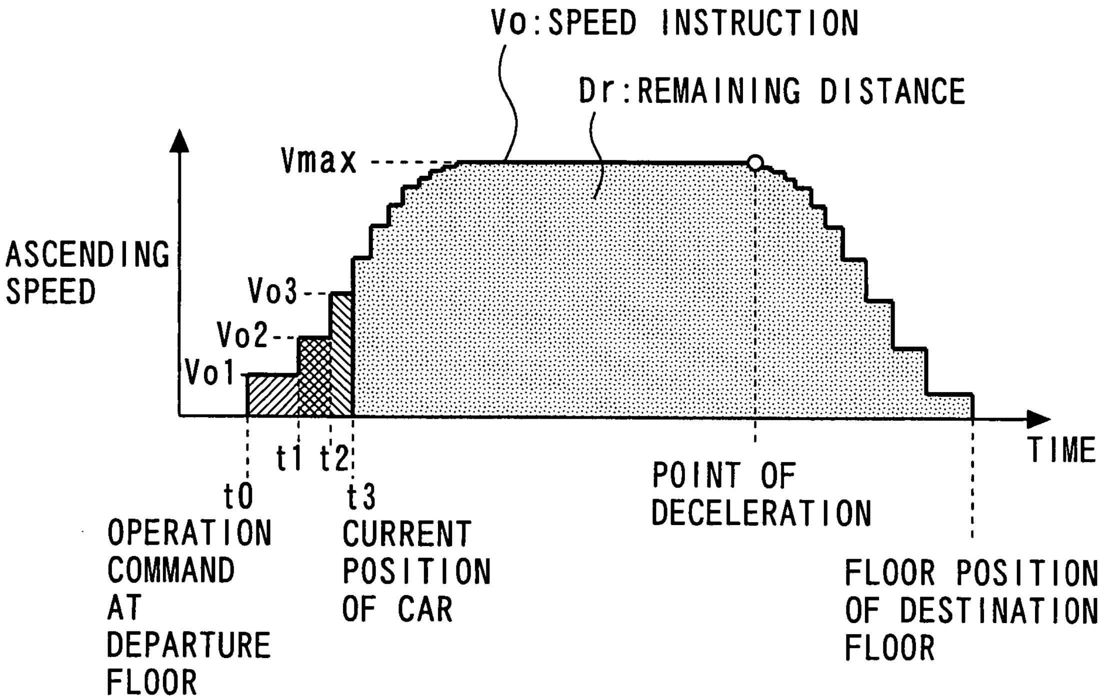

Vo:SPEED INSTRUCTION
Dr:REMAINING DISTANCE
Vmax
ASCENDING SPEED
Vo3
Vo2
Vo1
t1 t2
t0
t3
TIME
POINT OF DECELERATION
OPERATION COMMAND AT DEPARTURE FLOOR
CURRENT POSITION OF CAR
FLOOR POSITION OF DESTINATION FLOOR

FIG. 9

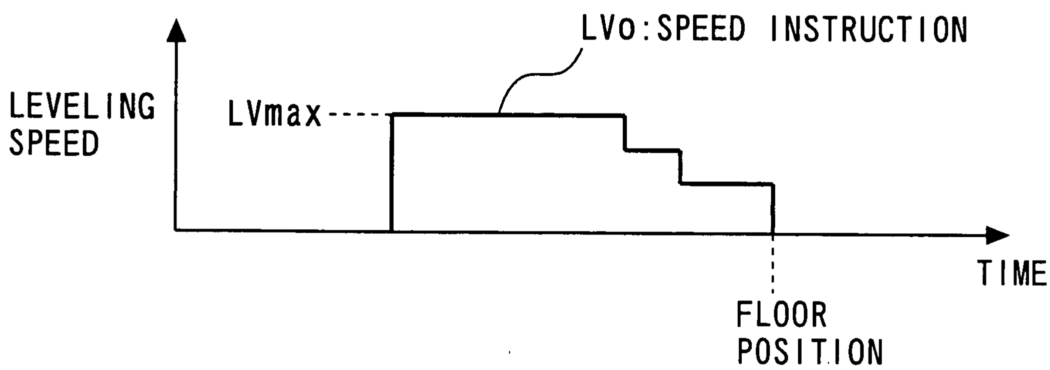

LVo:SPEED INSTRUCTION
LEVELING SPEED
LVmax
TIME
FLOOR POSITION

FIG. 10

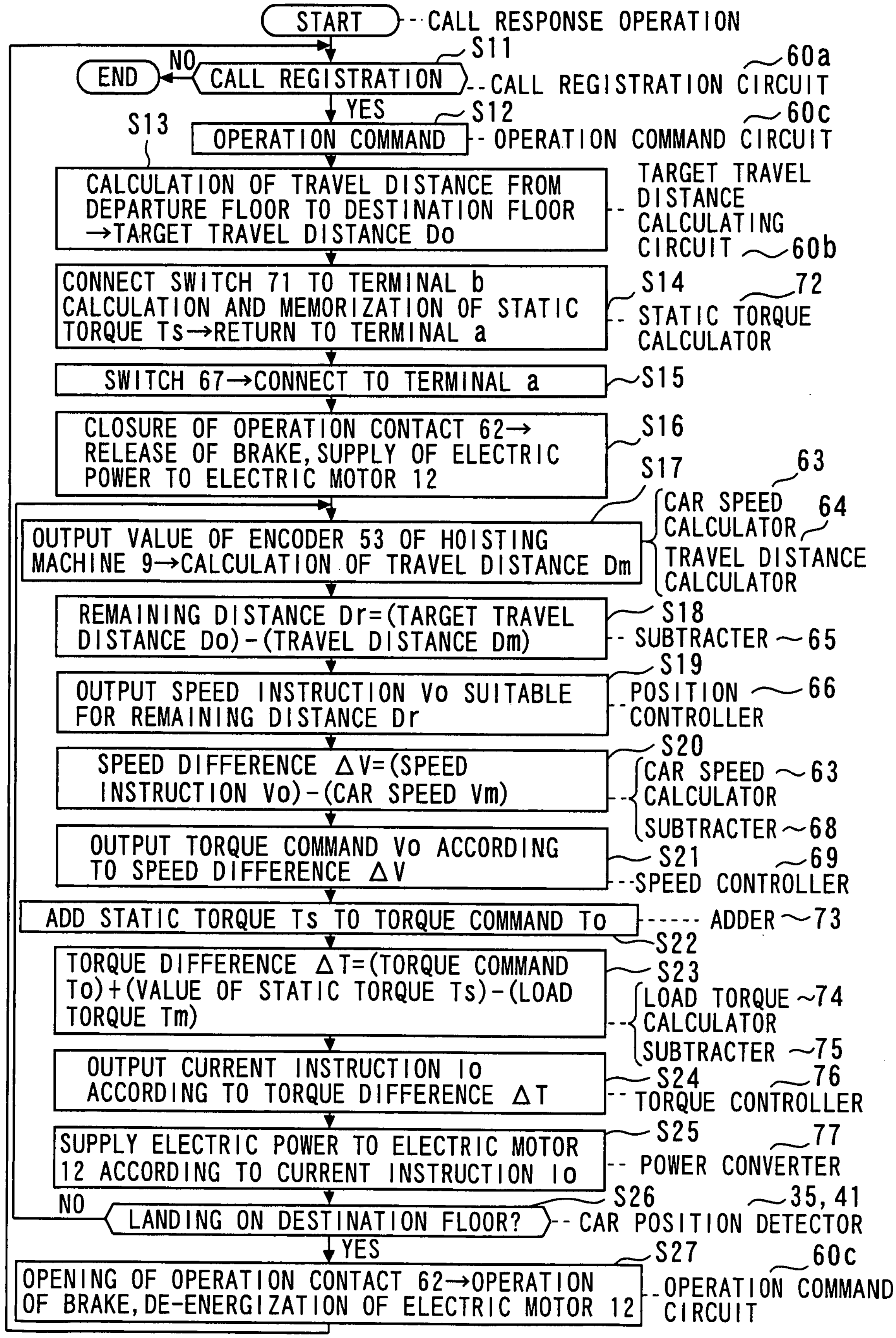

START
CALL RESPONSE OPERATION
S11
NO
END
CALL REGISTRATION
CALL REGISTRATION CIRCUIT
60a
YES
S12
S13
OPERATION COMMAND
OPERATION COMMAND CIRCUIT
60c
CALCULATION OF TRAVEL DISTANCE FROM DEPARTURE FLOOR TO DESTINATION FLOOR →TARGET TRAVEL DISTANCE Do
TARGET TRAVEL DISTANCE CALCULATING CIRCUIT
60b
CONNECT SWITCH 71 TO TERMINAL b CALCULATION AND MEMORIZATION OF STATIC TORQUE Ts→RETURN TO TERMINAL a
S14
72
STATIC TORQUE CALCULATOR
SWITCH 67→CONNECT TO TERMINAL a
S15
CLOSURE OF OPERATION CONTACT 62→ RELEASE OF BRAKE, SUPPLY OF ELECTRIC POWER TO ELECTRIC MOTOR 12
S16
S17
63
CAR SPEED CALCULATOR
64
TRAVEL DISTANCE CALCULATOR
OUTPUT VALUE OF ENCODER 53 OF HOISTING MACHINE 9→CALCULATION OF TRAVEL DISTANCE Dm
REMAINING DISTANCE Dr=(TARGET TRAVEL DISTANCE Do)-(TRAVEL DISTANCE Dm)
S18
SUBTRACTER 65
OUTPUT SPEED INSTRUCTION Vo SUITABLE FOR REMAINING DISTANCE Dr
S19
POSITION CONTROLLER
66
SPEED DIFFERENCE ΔV=(SPEED INSTRUCTION Vo)-(CAR SPEED Vm)
S20
CAR SPEED CALCULATOR
63
SUBTRACTER
68
OUTPUT TORQUE COMMAND Vo ACCORDING TO SPEED DIFFERENCE ΔV
S21
69
SPEED CONTROLLER
ADD STATIC TORQUE Ts TO TORQUE COMMAND To
ADDER 73
S22
TORQUE DIFFERENCE ΔT=(TORQUE COMMAND To)+(VALUE OF STATIC TORQUE Ts)-(LOAD TORQUE Tm)
S23
LOAD TORQUE CALCULATOR
74
SUBTRACTER
75
OUTPUT CURRENT INSTRUCTION Io ACCORDING TO TORQUE DIFFERENCE ΔT
S24
76
TORQUE CONTROLLER
SUPPLY ELECTRIC POWER TO ELECTRIC MOTOR 12 ACCORDING TO CURRENT INSTRUCTION Io
S25
77
POWER CONVERTER
NO
LANDING ON DESTINATION FLOOR?
S26
35, 41
CAR POSITION DETECTOR
YES
S27
60c
OPENING OF OPERATION CONTACT 62→OPERATION OF BRAKE, DE-ENERGIZATION OF ELECTRIC MOTOR 12
OPERATION COMMAND CIRCUIT

FIG. 11

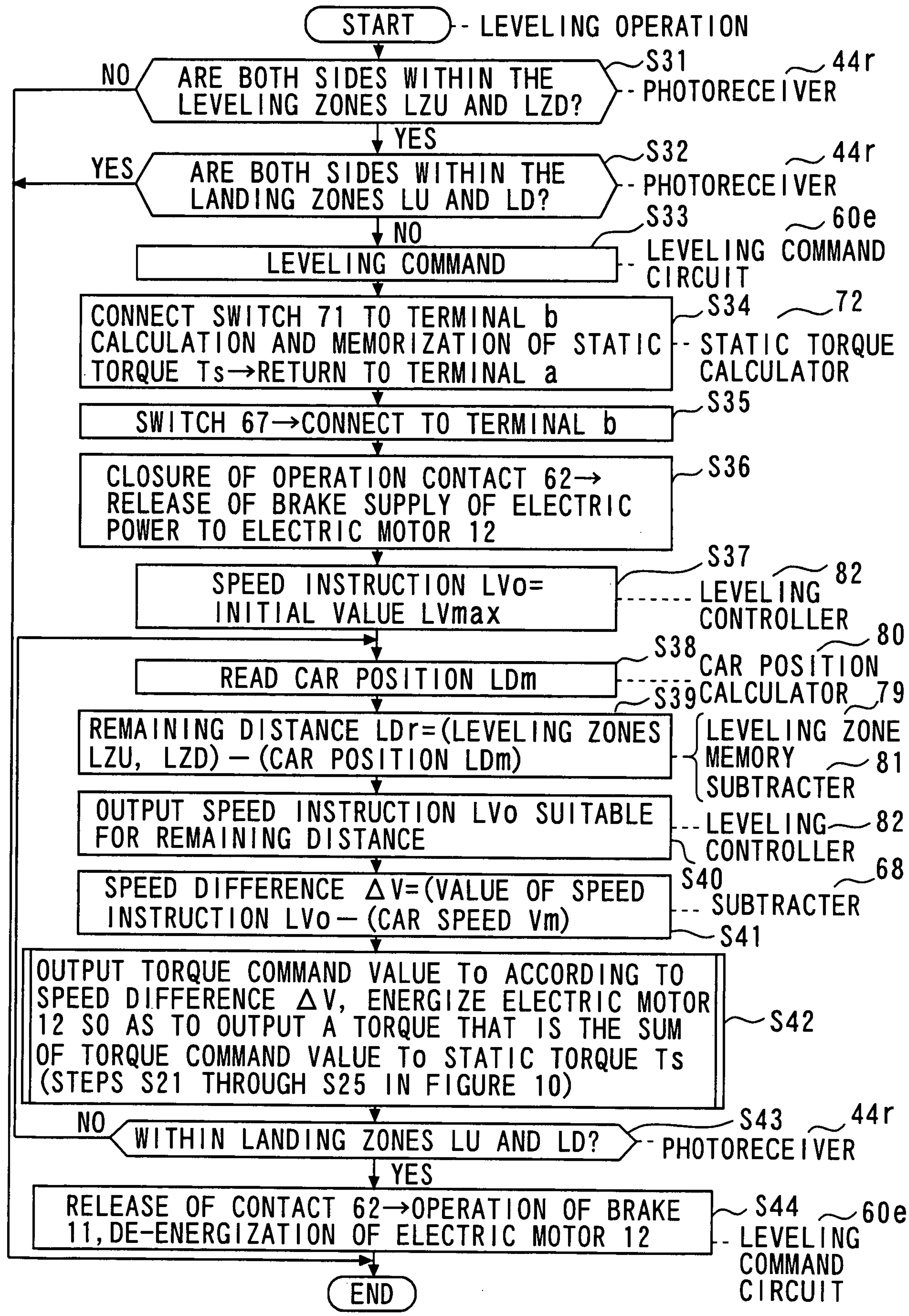

START
LEVELING OPERATION
ARE BOTH SIDES WITHIN THE LEVELING ZONES LZU AND LZD?
S31
44r
PHOTORECEIVER
NO
YES
ARE BOTH SIDES WITHIN THE LANDING ZONES LU AND LD?
S32
44r
PHOTORECEIVER
YES
NO
LEVELING COMMAND
S33
60e
LEVELING COMMAND CIRCUIT
CONNECT SWITCH 71 TO TERMINAL b CALCULATION AND MEMORIZATION OF STATIC TORQUE Ts→RETURN TO TERMINAL a
S34
72
STATIC TORQUE CALCULATOR
SWITCH 67→CONNECT TO TERMINAL b
S35
CLOSURE OF OPERATION CONTACT 62→ RELEASE OF BRAKE SUPPLY OF ELECTRIC POWER TO ELECTRIC MOTOR 12
S36
SPEED INSTRUCTION LVo= INITIAL VALUE LVmax
S37
82
LEVELING CONTROLLER
READ CAR POSITION LDm
S38
80
CAR POSITION CALCULATOR
S39
79
REMAINING DISTANCE LDr=(LEVELING ZONES LZU, LZD)−(CAR POSITION LDm)
LEVELING ZONE MEMORY
81
SUBTRACTER
OUTPUT SPEED INSTRUCTION LVo SUITABLE FOR REMAINING DISTANCE
LEVELING CONTROLLER
82
S40
68
SPEED DIFFERENCE ΔV=(VALUE OF SPEED INSTRUCTION LVo−(CAR SPEED Vm)
SUBTRACTER
S41
OUTPUT TORQUE COMMAND VALUE To ACCORDING TO SPEED DIFFERENCE ΔV, ENERGIZE ELECTRIC MOTOR 12 SO AS TO OUTPUT A TORQUE THAT IS THE SUM OF TORQUE COMMAND VALUE To STATIC TORQUE Ts (STEPS S21 THROUGH S25 IN FIGURE 10)
S42
NO
WITHIN LANDING ZONES LU AND LD?
S43
44r
PHOTORECEIVER
YES
RELEASE OF CONTACT 62→OPERATION OF BRAKE 11,DE-ENERGIZATION OF ELECTRIC MOTOR 12
S44
60e
LEVELING COMMAND CIRCUIT
END

FIG. 12

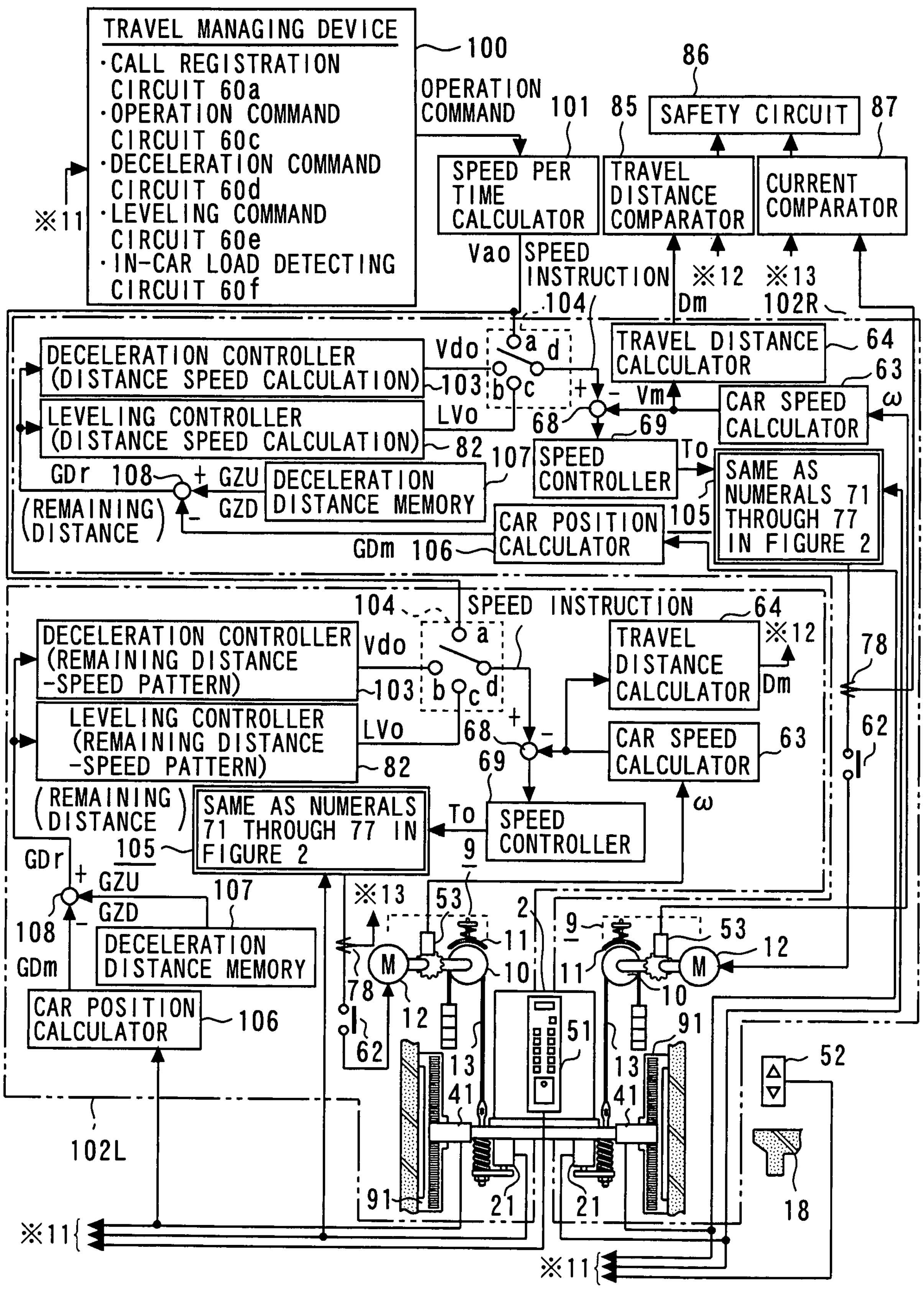

TRAVEL MANAGING DEVICE
·CALL REGISTRATION CIRCUIT 60a
·OPERATION COMMAND CIRCUIT 60c
·DECELERATION COMMAND CIRCUIT 60d
·LEVELING COMMAND CIRCUIT 60e
·IN-CAR LOAD DETECTING CIRCUIT 60f
100
OPERATION COMMAND
101
SPEED PER TIME CALCULATOR
85
TRAVEL DISTANCE COMPARATOR
86
SAFETY CIRCUIT
87
CURRENT COMPARATOR
Vao
SPEED INSTRUCTION
104
※12
※13
Dm
102R
※11
DECELERATION CONTROLLER (DISTANCE SPEED CALCULATION)
Vdo
a
d
103
b
c
LEVELING CONTROLLER (DISTANCE SPEED CALCULATION)
LVo
82
TRAVEL DISTANCE CALCULATOR
64
63
CAR SPEED CALCULATOR
ω
Vm
68
69
SPEED CONTROLLER
To
SAME AS NUMERALS 71 THROUGH 77 IN FIGURE 2
GDr
108
GZU
GZD
107
DECELERATION DISTANCE MEMORY
(REMAINING DISTANCE)
CAR POSITION CALCULATOR
105
GDm
106
104
SPEED INSTRUCTION
64
DECELERATION CONTROLLER (REMAINING DISTANCE -SPEED PATTERN)
Vdo
a
103
b
c
d
TRAVEL DISTANCE CALCULATOR
※12
Dm
78
LEVELING CONTROLLER (REMAINING DISTANCE -SPEED PATTERN)
LVo
82
68
69
CAR SPEED CALCULATOR
63
62
(REMAINING DISTANCE)
SAME AS NUMERALS 71 THROUGH 77 IN FIGURE 2
105
To
SPEED CONTROLLER
9
ω
GDr
GZU
107
GZD
108
GDm
DECELERATION DISTANCE MEMORY
CAR POSITION CALCULATOR
106
※13
53
2
9
53
M
11
10
12
78
12
62
13
41
51
13
41
91
52
102L
91
21
21
18
※11
※11

FIG. 13

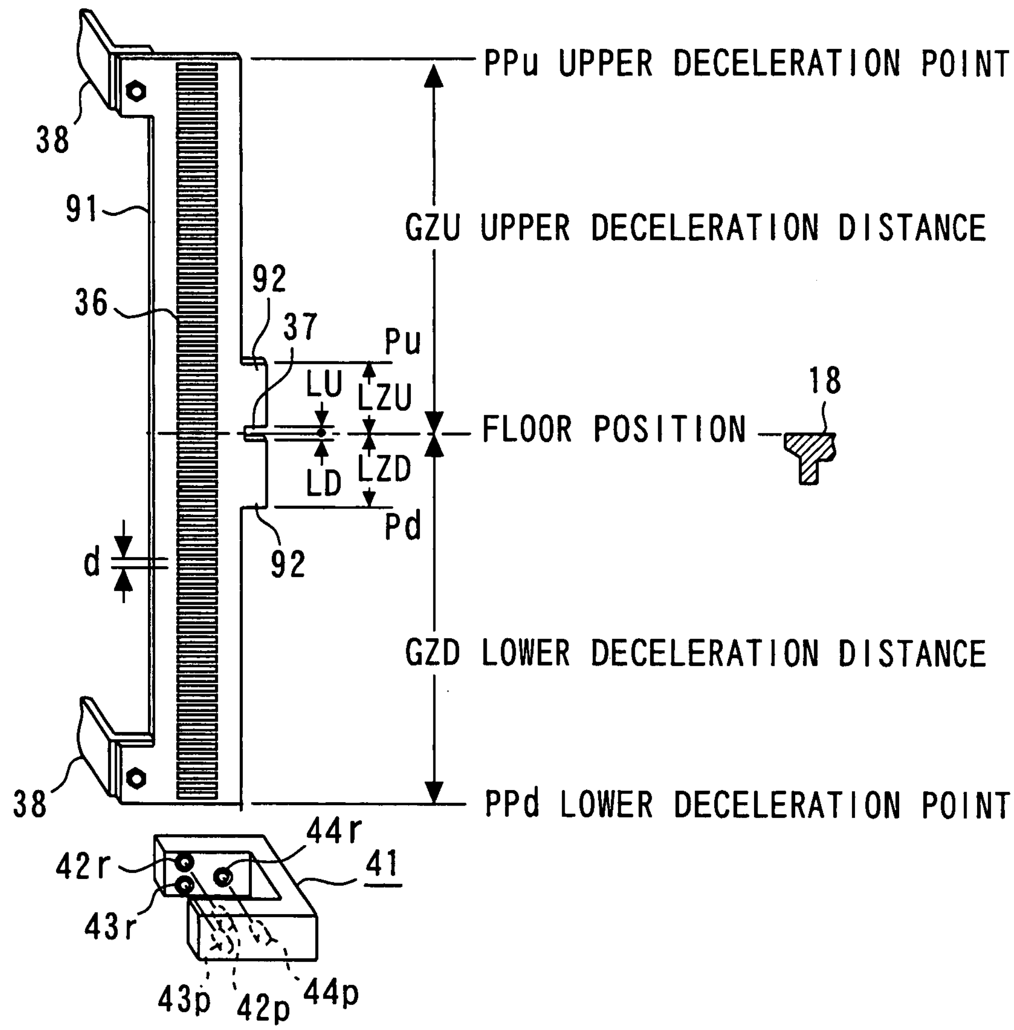

PPu UPPER DECELERATION POINT
38
91
GZU UPPER DECELERATION DISTANCE
92
36
37
Pu
LU
LZU
18
FLOOR POSITION
LD
LZD
Pd
92
d
GZD LOWER DECELERATION DISTANCE
38
PPd LOWER DECELERATION POINT
44r
42r
41
43r
43p
42p
44p

FIG. 14

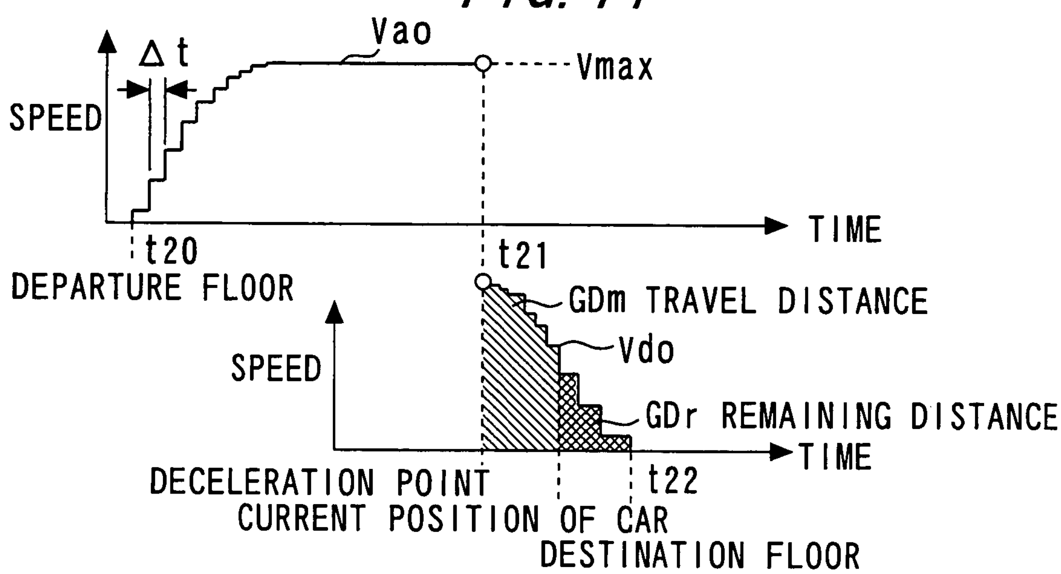

Vao
Δ t
Vmax
SPEED
TIME
t20
DEPARTURE FLOOR
t21
GDm TRAVEL DISTANCE
Vdo
SPEED
GDr REMAINING DISTANCE
TIME
DECELERATION POINT
t22
CURRENT POSITION OF CAR
DESTINATION FLOOR

FIG. 15

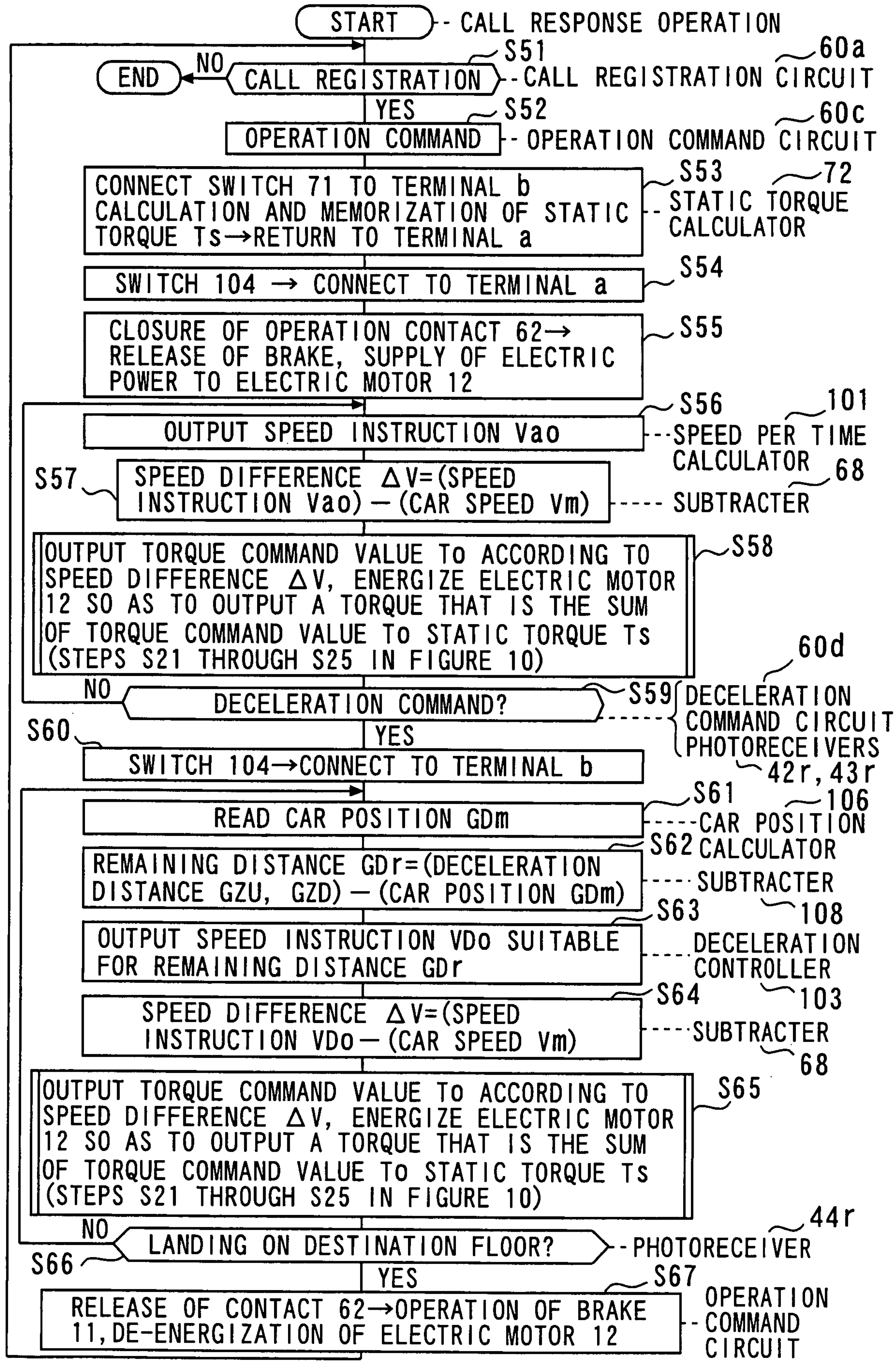

START
CALL RESPONSE OPERATION
S51
60a
END
NO
CALL REGISTRATION
CALL REGISTRATION CIRCUIT
YES
S52
60c
OPERATION COMMAND
OPERATION COMMAND CIRCUIT
S53
72
CONNECT SWITCH 71 TO TERMINAL b CALCULATION AND MEMORIZATION OF STATIC TORQUE Ts→RETURN TO TERMINAL a
STATIC TORQUE CALCULATOR
S54
SWITCH 104 → CONNECT TO TERMINAL a
S55
CLOSURE OF OPERATION CONTACT 62→ RELEASE OF BRAKE, SUPPLY OF ELECTRIC POWER TO ELECTRIC MOTOR 12
S56
101
OUTPUT SPEED INSTRUCTION Vao
SPEED PER TIME CALCULATOR
S57
68
SPEED DIFFERENCE ΔV=(SPEED INSTRUCTION Vao) − (CAR SPEED Vm)
SUBTRACTER
S58
OUTPUT TORQUE COMMAND VALUE To ACCORDING TO SPEED DIFFERENCE ΔV, ENERGIZE ELECTRIC MOTOR 12 SO AS TO OUTPUT A TORQUE THAT IS THE SUM OF TORQUE COMMAND VALUE To STATIC TORQUE Ts (STEPS S21 THROUGH S25 IN FIGURE 10)
60d
NO
DECELERATION COMMAND?
S59
DECELERATION COMMAND CIRCUIT
PHOTORECEIVERS
42r, 43r
S60
YES
SWITCH 104→CONNECT TO TERMINAL b
S61
106
READ CAR POSITION GDm
CAR POSITION CALCULATOR
S62
REMAINING DISTANCE GDr=(DECELERATION DISTANCE GZU, GZD) − (CAR POSITION GDm)
SUBTRACTER
S63
108
OUTPUT SPEED INSTRUCTION VDo SUITABLE FOR REMAINING DISTANCE GDr
DECELERATION CONTROLLER
S64
103
SPEED DIFFERENCE ΔV=(SPEED INSTRUCTION VDo − (CAR SPEED Vm)
SUBTRACTER
68
S65
OUTPUT TORQUE COMMAND VALUE To ACCORDING TO SPEED DIFFERENCE ΔV, ENERGIZE ELECTRIC MOTOR 12 SO AS TO OUTPUT A TORQUE THAT IS THE SUM OF TORQUE COMMAND VALUE To STATIC TORQUE Ts (STEPS S21 THROUGH S25 IN FIGURE 10)
44r
NO
LANDING ON DESTINATION FLOOR?
PHOTORECEIVER
S66
YES
S67
RELEASE OF CONTACT 62→OPERATION OF BRAKE 11, DE-ENERGIZATION OF ELECTRIC MOTOR 12
OPERATION COMMAND CIRCUIT

FIG. 16

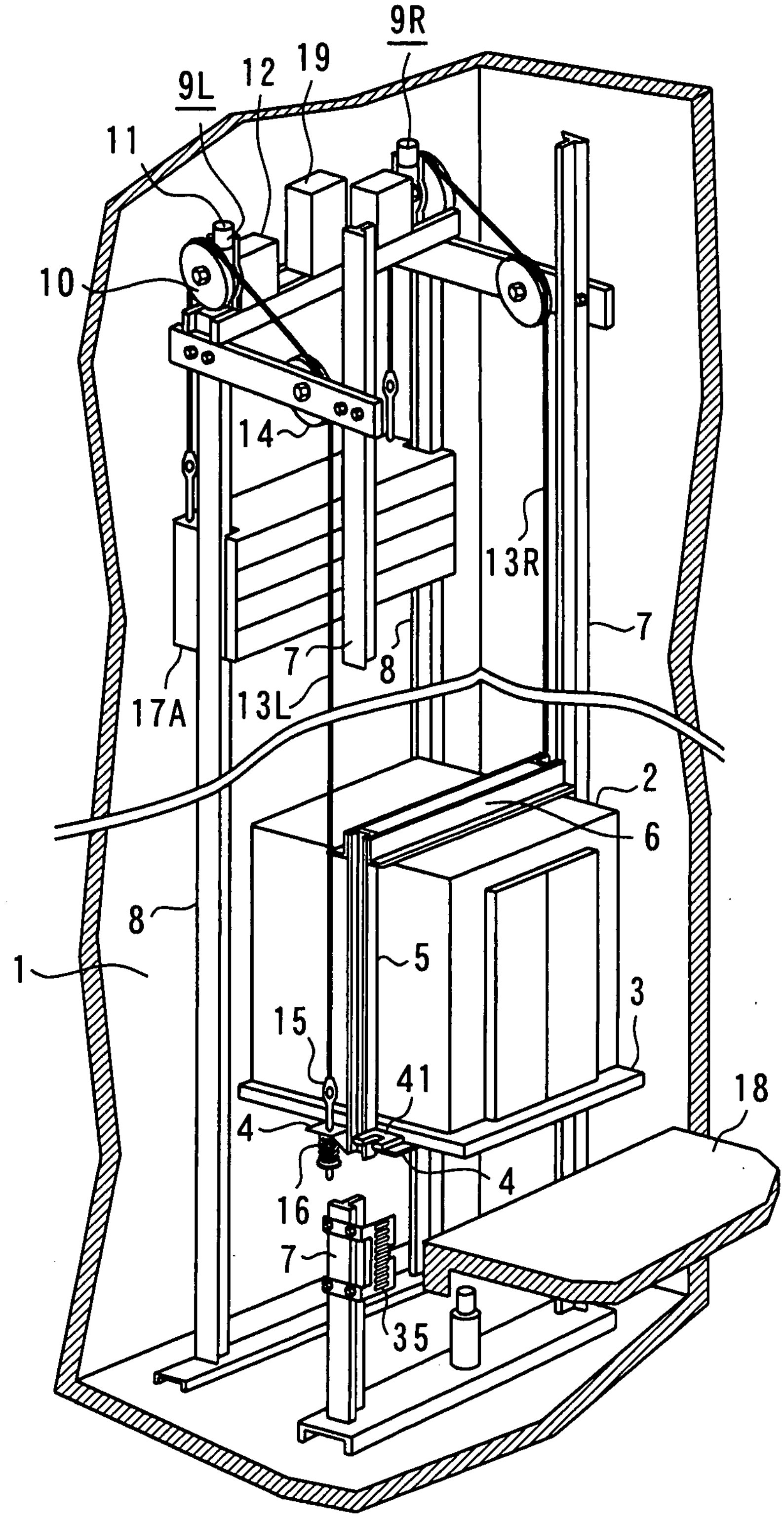
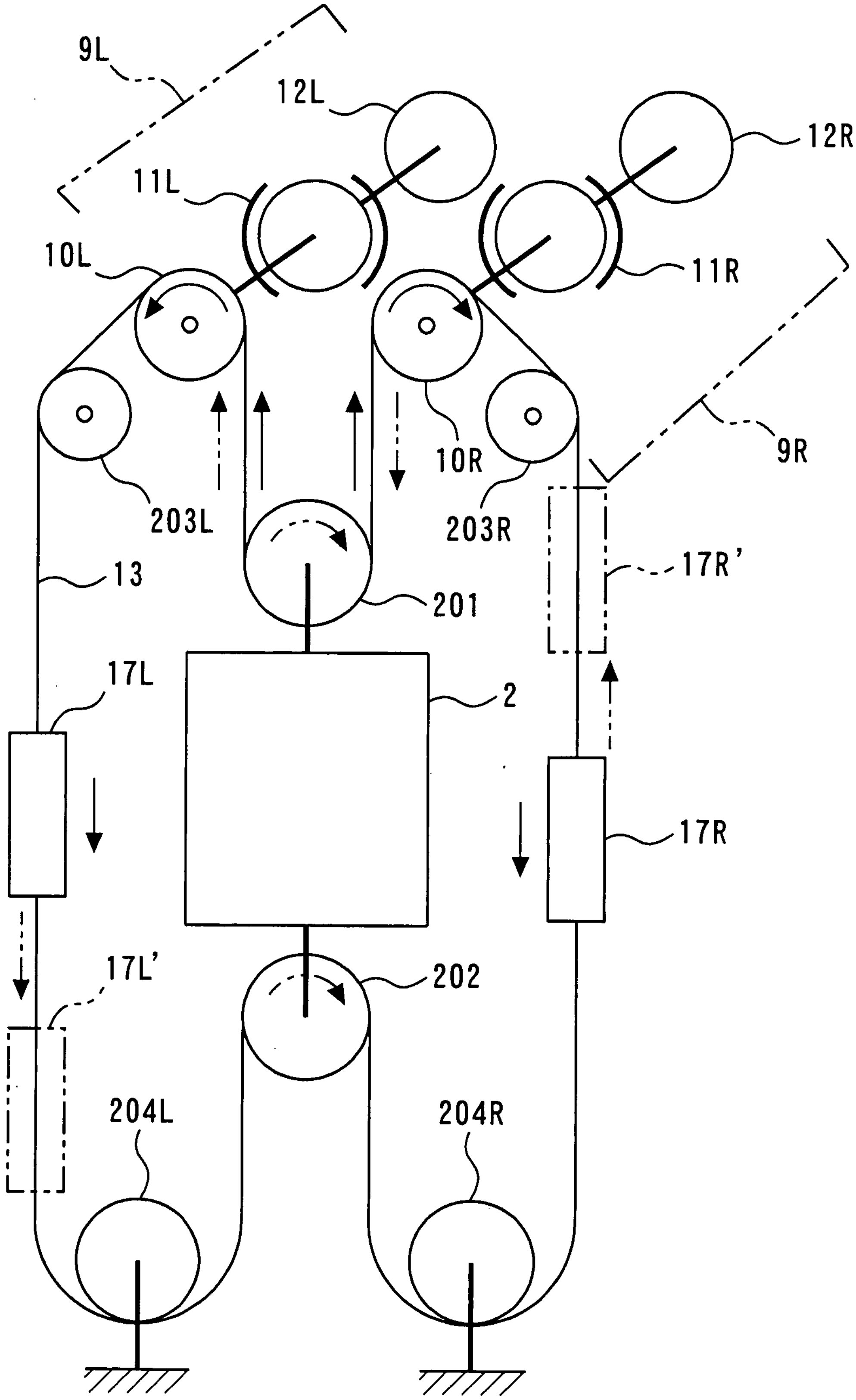


FIG. 17


9L
12L
12R
11L
10L
11R
10R
9R
203L
203R
13
17R'
201
17L
2
17R
17L'
202
204L
204R

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/09267

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B66B1/44, B66B5/02, B66B7/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] B66B1/00-B66B11/08, B66C13/22, B66D1/40

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	1996-2003
Kokai Jitsuyo Shinan Koho	1971-2003	Toroku Jitsuyo Shinan Koho	1994-2003

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2001-261257 A (Mitsubishi Electric Corp.), 26 September, 2001 (26.09.01), (Family: none)	1-6 7-8
Y A	JP 5-70057 A (Hitachi Building System Eng.& Service Co., Ltd.), 23 March, 1993 (23.03.93), (Family: none)	1-6 7-8
Y A	JP 2000-272849 A (Mitsui Miike Machinery Co., Ltd.), 03 October, 2000 (03.10.00), (Family: none)	1-6 7-8
Y	JP 8-301539 A (Hitachi, Ltd.), 19 November, 1996 (19.11.96), (Family: none)	1-2

[X] 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 document 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 03 June, 2003 (03.06.03)	Date of mailing of the international search report 17 June, 2003 (17.06.03)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/09267

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2001-233553 A (Toshiba Corp.), 28 August, 2001 (28.08.01), (Family: none)	3
Y	JP 8-217378 A (Mitsubishi Electric Corp.), 27 August, 1996 (27.08.96), (Family: none)	4-5
Y	JP 2000-86151 A (Central Japan Railway Co., Hitachi Kiden Kogyo, Ltd.), 28 March, 2000 (28.03.00), (Family: none)	6
A	JP 7-25553 A (Mitsubishi Electric Corp.), 27 January, 1995 (27.01.95), (Family: none)	1-8

Form PCT/ISA/210 (continuation of second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/09267

Box I Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

I. Claims 1-3, 7-8 relate to an elevator controller adapted to individually control winches.

II. Claims 4-6 relate to an elevator controller provided with a safety circuit to stop a winch.

And these two groups of inventions cannot be accepted as being a group of inventions so linked as to form a single general inventive concept.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (1)) (July 1998)