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

(11) **EP 1 780 160 A1**

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

(43) Date of publication:
02.05.2007 Bulletin 2007/18

(21) Application number: **04730711.1**

(22) Date of filing: **30.04.2004**

(51) Int Cl.:
B66B 5/06 *(2006.01)* ***B66B 3/00*** *(2006.01)*

(86) International application number:
PCT/JP2004/006325

(87) International publication number:
WO 2005/105649 (10.11.2005 Gazette 2005/45)

(84) Designated Contracting States:
DE FR NL

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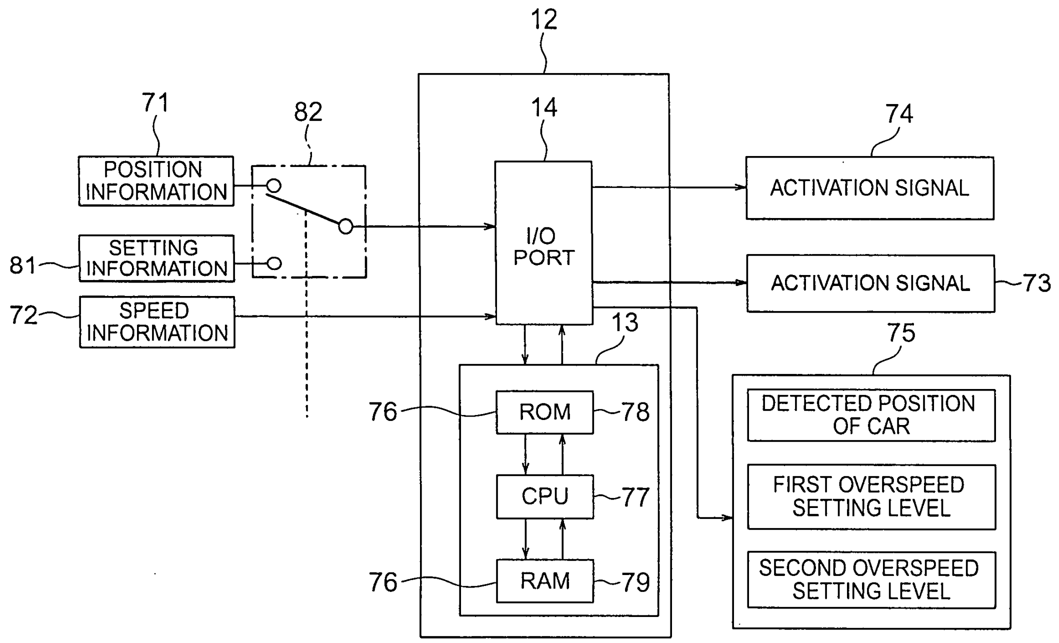
(54) **ABNORMAL-STATE BRAKING SYSTEM OF ELEVATOR**

(57) A control device stores, in correspondence with the position of a car, an overspeed setting level that is set to become smaller in the vicinity of a terminal end portion of a hoistway toward the terminal end portion. When the detected speed of the car exceeds the overspeed setting level at the position of the car as detected by an encoder, an activation signal is outputted from the control device. Emergency braking is applied on the car as a brake device or a safety device is activated upon the input of the activation signal. The control device is electrically connected with a display that displays the position of the car obtained based on information from the encoder, and the value of the overspeed setting level at that position of the car.

FIG. 8



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Description

Technical Field

[0001] The present invention relates to an emergency braking system for an elevator, which brakes a car when the speed of the car becomes abnormal.

Background Art

[0002] As a conventional method of testing the operation of a governor of an elevator, in JP-A 08-324907, there has been proposed a method of operating the governor by rotating a governor sheave while lifting a governor rope above the governor sheave. In this method, an electric drill is pressed against the governor sheave, and the governor sheave is rotated by the rotation force of the electric drill. A tachometer is pressed against the governor sheave in advance to measure the rotational speed of the governor sheave. In this way, the governor is forcibly operated, and the rotational speed of the governor sheave when the governor is operated is checked by the tachometer.

[0003] Further, to meet the recent demand for elevator space saving, JP-A 2001-354372 discloses an elevator apparatus with which the speed of a car at which a safety device is activated is made progressively lower in the vicinity of the terminal end portion of a hoistway, thereby shortening the braking distance upon emergency stop in the vicinity of the terminal end portion of the hoistway. Accordingly, the vertical length of the hoistway can be reduced. In this elevator apparatus, the speed of the car at which the safety device is activated varies according to the position of the car, so the operation test on the governor must be performed while changing the position of the car.

[0004] However, in the above-described method with which the governor sheave is rotated by the electric drill, only the rotational speed of the governor sheave is measured, so the position of the car must be checked each time the position of the car is changed, making the operation test on the governor rather troublesome.

Disclosure of the Invention

[0005] The present invention has been made with a view toward solving the above-mentioned problems, and therefore it is an object of the invention to provide an emergency braking system for an elevator with which an operation test on a braking portion for braking a car can be easily performed with accuracy.

[0006] According to the present invention, an emergency braking system for an elevator includes: a detection portion that detects a position and a speed of a car; a control portion having a storage portion storing an overspeed setting level which, within a predetermined section of a hoistway adjoining a terminal end portion of the hoistway, is set to become smaller toward the terminal end portion, the control portion outputting an activation signal when a detected speed of the car exceeds the overspeed setting level at a detected position of the car obtained based on information from the detection portion; a braking portion for braking the car, the braking portion being activated upon input of the activation signal; and a display portion that displays the detected position and the overspeed setting level at the detected position based on information from the control portion.

Brief Description of the Drawings

[0007]

Fig. 1 is a structural view schematically showing an elevator apparatus according to Embodiment 1 of the present invention.

Fig. 2 is a block diagram showing the control device of Fig. 1.

Fig. 3 is a graph showing the car speed abnormality determination references stored in the storage portion of Fig. 2.

Fig. 4 is a front view showing the safety device of Fig. 1.

Fig. 5 is a perspective view showing the connecting portions of the safety device of Fig. 4.

Fig. 6 is a structural view showing the rope catching device of Fig. 1.

Fig. 7 is a sectional view showing the electromagnetic actuator of Fig. 6.

Fig. 8 is a block diagram showing the control device of an emergency braking system for an elevator according to Embodiment 2 of the present invention.

Fig. 9 is an explanatory diagram showing a method of controlling the control device of an emergency braking system for an elevator according to Embodiment 3 of the present invention.

Fig. 10 is a structural view showing a rope catching device of an emergency braking system for an elevator according to Embodiment 5 of the present invention.

Fig. 11 is a structural view showing a rope catching device of an emergency braking system for an elevator according to Embodiment 6 of the present invention.

Fig. 12 is a structural view showing a rope catching device of an emergency bra king system for an elevator according to Embodiment 7 of the present invention.

Fig. 13 is a structural view showing a state in which the rope catching device of Fig. 12 has been activated.

Fig. 14 is a front view showing a rope catching device of an emergency braking system for an elevator according to Embodiment 8 of the present invention.

Best Mode for carrying out the Invention

[0008] Hereinbelow, preferred embodiments of the present invention will be described with reference to the drawings.

Embodiment 1

[0009] Fig. 1 is a structural view schematically showing an elevator apparatus according to Embodiment 1 of the present invention. Referring to Fig. 1, a pair of car guide rails 2 are provided in a hoistway 1. A car 3 is raised and lowered in the hoistway 1 while being guided by the car guide rails 2. Arranged at an upper end portion of the hoistway 1 is a hoisting machine 4 that is a drive device for raising and lowering the car 3 and a counterweight 6. A main rope 5 is wound around a drive sheave 4a of the hoisting machine 4. The car 3 and the counterweight 6 are suspended in the hoistway 1 by the main rope 5. The hoisting machine 4 is provided with a brake device (not shown) that is a braking portion for braking the rotation of the drive sheave 4a.

[0010] A safety device (braking portion) 7 for braking the car 3 with respect to the car guide rails 2 is mounted in the car 3 so as to be opposed to the car guide rails 2. The safety device 7 is arranged below the car 3. Emergency braking is applied on the car 3 upon activation of the safety device 7.

[0011] Further, a rotatable governor sheave 8 is provided at an upper end portion of the hoistway 1. Wound around the governor sheave 8 is a governor rope 9 that moves in synchronism with the raising and lowering of the car 3. Both end portions of the governor rope 9 are connected to the safety device 7. Provided at a lower end portion of the hoistway 1 is a tension pulley 10 around which the governor rope 9 is wound.

[0012] The governor sheave 8 is provided with an encoder 11 as a detection portion for detecting the position and speed of the car 3. Further, in the hoistway 1, there is provided an emergency braking system control device 12 (hereinafter simply refereed to as the "control device 12") that is a control portion for controlling the operation of the emergency braking system for an elevator. The encoder 11 is electrically connected to the control device 12. In the control device 12, the position and speed of the car 3 are obtained based on a measurement signal from the encoder 11. In this example, in the control device 12, the position of the car 3 is obtained based on the measurement signal from the encoder 11, and the speed of the car 3 is obtained by differentiation of the position of the car 3. The control device 12 outputs an activation signal that is an electrical signal when the speed of the car 3 becomes abnormal.

[0013] The control portion 12 has a processing portion (computer) 13 for determining the presence/absence of an abnormality in the speed of the car 3, and an I/O port 14 as an input/output portion for the inputting of the measurement signal from the encoder 11 and for the outputting of the results of computation by the processing portion 13. In the control device 12, the activation signal as the electrical signal is outputted from the I/Oport 14 when the processing portion 13 determines that there is an abnormality in the speed of the car 3.

[0014] Provided in the vicinity of the governor sheave 8 is a rope catching device (rope restraining device) 15 as a braking portion for restraining the governor rope 9. Further, a condenser (not shown) is electrically connected to the rope catching device 15. Electric charge for supplying electric power for activating the rope catching device 15 is previously stored in the condenser.

[0015] The control device 12 selectively outputs an activation signal to a brake device of the hoisting machine 4 and to the rope catching device 15. The brake device of the hoisting machine 4 is activated when power supply is stopped upon input of the activation signal from the control device 12. Braking is applied to the drive sheave 4a upon the activation of the brake device. The rope catching device 15 is activated when supplied with an activating electric power from the condenser upon the input of the activation signal from the control device 12. The governor rope 9 is restrained upon the activation of the rope catching device 15.

[0016] Fig. 2 is a block diagram showing the control device 12 of Fig. 1. Referring to the drawing, a measurement signal from the encoder 11 is constantly inputted to the I/O port 14 as position information 71 and speed information 72 on the car 3. Further, an activation signal 73 and an activation signal 74 can be selectively outputted from the I/O port 14 to the brake device of the hoisting machine 4 and to the rope catching device 15, respectively. Further, a display 75 as a display portion for displaying specific computation results from the processing portion 13 is electrically connected to the I/O port 14.

[0017] The processing portion 13 has a storage portion (memory) 76 in which car speed abnormality determination references (set data) serving as the references in detecting the presence/absence of an abnormality in the speed of the car 3 are stored in advance, and a computing portion (CPU) 77 that detects the presence/absence of an abnormality in the speed of the car 3 based on information from each of the encoder 11 and the storage portion 76. The storage portion. 76 has a ROM 78 and a RAM 79. The car speed abnormality determination references are stored in the ROM 78.

[0018] Fig. 3 is a graph showing the car speed abnormality determination references stored in the storage portion 13 of Fig. 2. Referring to the drawing, in the hoistway 1, there is provided a hoisting zone in which the car 3 is raised and lowered between the highest floor (one terminal end portion) and the lowest floor (the other terminal end portion). Within the hoisting zone, there are provided acceleration/deceleration zones respectively adjoining the highest and lowest floors and in which the car 3 is accelerated/decelerated during normal operation, and a constant-speed zone located between the two acceleration/deceleration zones and in which the car 3 is moved at a constant speed (rated speed).

[0019] As the car speed abnormality determination references, three setting levels for determining the abnormality level of the speed of the car 3 are set in correspondence with the position of the car3. That is, as the car speed abnormality determination references, a normal speed setting level (normal speed pattern) 17 as the speed of the car 3 during normal operation, a first overspeed setting level (first overspeed pattern) 18 lager in value than the normal speed setting level 17, and a second overspeed setting level (second overspeed pattern) 19 larger in value than the first overspeed setting level 18, are each set in correspondence with the position of the car 3.

[0020] The normal speed setting level 17, the first overspeed setting level 18, and the second overspeed setting level 19 are each set such that its value is constant in the constant-speed zone and becomes progressively smaller toward the highest and lowest floors in the acceleration/deceleration zones. Further, the first overspeed setting level 18 and the second overspeed setting level 19 are set such that they become smaller in value than the rated speed of the car 3 on the sides closer to the terminal end portions of the acceleration/deceleration zones.

[0021] That is, in the storage portion 76, the normal speed setting level 17, the first overspeed setting level 18, and the second overspeed setting level 19 are stored as the car speed abnormality determination references in correspondence with the position of the car 3.

[0022] When the speed of the car 3 thus obtained exceeds the first overspeed setting level 18, the computing portion 77 outputs the activation signal 73 to the brake device of the hoisting machine 4; when the speed of the car 3 exceeds the second overspeed setting level 19, the computing portion 77 outputs the activation signal 74 to the rope catching device 15. The outputting of the activation signal 73 to the brake device of the hoisting machine 4 is maintained while the activation signal 74 is being outputted. It should be noted that when the rope catching device 15 is to be deactivated and returned to the normal state, the computing portion 77 outputs to the rope catching device 15 a return signal that is an electrical signal. When inputted with the return signal, the rope catching device 15 is returned upon supply of return electric power from the condenser.

[0023] The display 75 displays the detected position of the car 3 obtained based on information from the encoder 11, the value of the first overspeed setting level 18 at the detected position of the car 3, and the value of the second overspeed setting level 19 at the detected position of the car 3.

[0024] Fig. 4 is a front view showing the safety device 7 of Fig. 1. Further, Fig. 5 is a perspective view showing the connecting portions of the safety device 7 of Fig. 4. Referring to the figures, each safety device 7 has: a wedge 20 as a braking member that can be brought into and out of contact with the car guide rail 2; a pivot lever 21 as a link mechanism for displacing the wedge 20 relative to the car 3 through displacement of the car 3 relative to the governor rope 9; and a gripper metal 22 as a guide portion for guiding the wedge 20, which is displaced by the pivot lever 21, into contact with the car guide rail 2.

[0025] Each wedge 20 is arranged below the gripper metal 22. Each wedge 20 is affixed with a friction material 23 that contacts the car guide rail 2. Fixed to the lower end portion of each wedge 20 is a mounting portion 24 that extends downwards from the wedge 20.

[0026] A horizontally extending connecting shaft 25 is rotatably provided to the lower end portion of the car 3. One end of each pivot lever 21 is fixed to either end of the connecting shaft 25 (Fig. 5). Provided at the other end portion of each pivot lever 21 is an elongated hole 26 extending in the longitudinal direction of the pivot lever 21. Each pivot lever 21 is provided to the lower end portion of the car 3 such that the elongated hole 26 is arranged below the gripper metal 22. Each mounting portion 24 is slidably fitted in each elongate hole 26.

[0027] A lifting bar 27, to which the both ends of the governor rope 9 are connected, is pivotably connected to one of the pivot levers 21 (Figs. 4, 5). The lifting bar27 extends in the vertical direction. As the lifting bar 27 is displaced with respect to the car 3, each pivot lever 21 is pivoted about the axis of the connecting shaft 25. Each wedge 20 is displaced toward the gripper metal 22 as the other end portion of the pivot lever 21 is pivoted upwards.

[0028] The gripper metal 22 is arranged in a recess 29 provided at the lower end portion of the car 3. Further, the gripper metal 22 has a sliding member 30 and a pressing member 31 that are arranged so as to sandwich the car guide rail 2 therebetween. The sliding member 30 and the pressing member 31 are supported by a support member 32 fixed in the recess 29.

[0029] The sliding member 30 is provided with an inclined portion 33 that slidably holds the wedge 20. The inclined portion 33 is inclined with respect to the car guide rail 2 such that its distance to the car guide rail 2 becomes smaller toward its upper portion. It should be noted that the sliding member 30 is fixed to the support member 32.

[0030] The pressing member 31 is supported on the support member 32 through support springs 34 as elastic members. The pressing member 31 is affixed with a friction material 35 that contacts the car guide rail 2.

[0031] As it is slid upwards along the inclined portion 33, the wedge 20 is displaced into contact with the car guide rail 2 and pushed in between the car guide rail 2 and the sliding member 30. The car 3 is displaced to the left as seen in the figure as the wedge 20 is pushed in between the car guide rail 2 and the sliding member 30. As a result, the wedge 20 and the pressing member 31 are displaced toward each other so as to hold the car guide rail 2 therebetween. A braking force acting on the car 3 is generated as the wedge 20 and the pressing member 31 are pressed against the car guide rail 2.

[0032] It should be noted that at the lower end portion of the car 3, there is provided a torsion spring (not shown) urging the connecting shaft 25 so as to displace each wedge 20 downwards. The malfunction of each safety device 7 is thus prevented. Further, fixed to the lower end portion of the car 3 is a stopper 36 that regulates the downward pivotal movement of the pivot lever 21. This prevents inadvertent detachment of the wedge 20 from the inclined portion 33.

[0033] Fig. 6 is a structural view showing the rope catching device 15 of Fig. 1. Referring to the figure, the rope catching device 15 is supported on a frame member 41 to which the governor sheave 8 is provided. Further, the rope catching device 15 has: a pressing shoe 42 that is a restraining portion displaceable between a restraining position for restraining the governor rope 9 in place and a disengaged position for releasing the restraining of the governor rope 9; an electromagnetic actuator 43 that generates a drive force for displacing the pressing shoe 42 between the restraining position and the disengaged position; and a connecting mechanism portion 44 that connects between the electromagnetic actuator 43 and the pressing shoe 42 and transmits the drive force from the electromagnetic actuator 43 to the pressing shoe 42.

[0034] Fixed on top of the frame member 41 is a mounting member 45 to which the electromagnetic actuator 43 is mounted. The mounting member 45 has a horizontal portion 46 on which the electromagnetic actuator 43 is placed, and a vertical portion 47 extending upwards from an end portion of the horizontal portion 46.

[0035] The pressing shoe 42 is formed of a friction material having a contact surface opposed to the outer periphery of the governor sheave 8. Further, when in the restraining position, the pressing shoe 42 is pressed against the governor sheave 8 through the governor rope 9, and when in the disengaged position, the pressing shoe 42 is moved away from the governor rope 9.

[0036] The electromagnetic actuator 43 is activated upon input of the activation signal 74 from the control device 12 and displaces the pressing shoe 42 into the restraining position. Further, the electromagnetic actuator 43 is returned into position upon input of the return signal from the control device 12, whereby the pressing shoe 42 is displaced into the disengaged position.

[0037] The connecting mechanism portion 44 has a movable rod 48 that is caused to reciprocate through the drive of the electromagnetic actuator 43, and a displacement lever 49 provided with the pressing shoe 42 and causing the pressing shoe 42 to displace between the restraining position and the disengaged position due to the reciprocating motion of the movable rod 48.

[0038] One end portion (lower end portion) of the displacement lever 49 is pivotably attached to the frame member 41, and the other end portion (upper end portion) of the displacement lever 49 is slidably attached to the movable rod 48. Further, the pressing shoe 42 is pivotably attached to the intermediate portion of the displacement lever 49. As the movable rod 48 advances, the displacement lever 49 is pivoted so as to displace the pressing shoe 42 into the disengaged position, and as the movable rod 48 retracts, the displacement lever 49 is pivoted so as to displace the pressing shoe 42 into the restraining position.

[0039] The movable rod 48 extends horizontally from the electromagnetic actuator 43 and slidably penetrates the vertical portion 47. Further, a first spring connecting portion 51 is fixed to the distal end portion of the movable rod 48. Connected between the upper end portion of the displacement lever 49 and the first spring connecting portion 51 is a compression spring 52 serving as an elastic member for pressing the pressing shoe 42 onto the governor sheave 8 side when the pressing shoe 42 is in the restraining position.

[0040] A second spring connecting portion 53 is fixed between the electromagnetic actuator 43 of the movable rod 48 and the vertical portion 47. Connected between the vertical portion 47 and the second spring connecting portion 53 is an adjusting spring 54 serving as an elastic member for mitigating the load on the electromagnetic actuator 43. The adjusting spring 54 is adjusted to urge the movable rod 48 being reciprocated in the direction opposite to the direction of the urging by the compression spring 52. This prevents a large difference from developing between the magnitude of the load on the electromagnetic actuator 43 when the pressing shoe 42 is in the restraining position and the magnitude of the load on the electromagnetic actuator 43 when the pressing shoe 42 is in the disengaged position.

[0041] Fixed between the upper end portion of the displacement lever 49 of the movable rod 48 and the vertical portion 47 is a stopper 55 for regulating the range within which the upper end portion of the displacement lever 49 is allowed to slide. As the movable rod 48 advances, the stopper 55 causes the displacement lever 49 to pivot so as to displace the pressing shoe 42 into the disengaged position, while pressing on the other end portion of the displacement lever 49.

[0042] Fig. 7 is a sectional view showing the electromagnetic actuator 43 of Fig. 6. Referring to the figure, the electromagnetic actuator 43 has a movable iron core (movable portion) 56 fixed to the rear end portion of the movable rod 48, and a driver portion 57 for displacing the movable iron core 56.

[0043] The iron core 56 is displaceable between an activation position where the pressing shoe 42 restrains the governor rope 9 in the restraining position, and a release position where the pressing shoe 42 is displaced into the disengaged position to release the restraining of the governor rope 9.

[0044] The driver portion 57 has: a stationary iron core 61 including a pair of regulating portions 58, 59 regulating the displacement of the movable iron core 56, and a side wall portion 60 connecting the regulating portions 58, 59 to each other; a first coil 62 accommodated in the stationary iron core 61 and serving as a release coil which, when energized, displaces the movable iron core 56 into contact with one regulating portion, the regulating portion 58; a second coil 63 accommodated in the stationary iron core 61 and serving as an activation coil which, when energized, displaces the movable iron core 56 into contact with the other regulating portion, the regulating portion 59; and an annular permanent magnet 64 arranged between the first coil 62 and the second coil 63.

[0045] The one regulating portion 58 is provided with a through-hole 65 through which the movable rod 48 is passed. When in the release position, the movable iron core 56 is in abutment with the one regulating portion 58, and when in the release position, the movable iron core 56 is in abutment with the other regulating portion 59.

[0046] The first coil 62 and the second coil 63 are annular electromagnetic coils surrounding the movable iron core 56. Further, the first coil 62 is arranged between the permanent magnet 64 and the one regulating portion 58, and the second coil 63 is arranged between the permanent magnet 64 and the other regulating portion 59.

[0047] With the movable iron core 56 abutting the one regulating portion 58, a space acting as a magnetic resistance is present between the movable iron core 56 and the other regulating portion 59, so the amount of magnetic flux from the permanent magnet 64 becomes larger on the first coil 62 side than on the second coil 63 side, whereby the iron core 56 is retained in abutment with the one regulating portion 58.

[0048] Further, with the movable iron core 56 abutting the other regulating portion 59, a space acting as a magnetic resistance is present between the movable iron core 56 and the one regulating portion 58, so the amount of magnetic flux from the permanent magnet 64 becomes larger on the second coil 63 side than on the first coil 62 side, whereby the iron core 56 is retained in abutment with the other regulating portion 59.

[0049] Electric power stored in the condenser is supplied to the second coil 63 as the activation signal 74 from the I/O port 13 (Fig. 1) is inputted to the electromagnetic actuator 43. Further, when supplied with electric power from the condenser, the second coil 63 generates a magnetic flux acting against the force for retaining the abutment of the movable iron core 56 with the one regulating portion 58. Further, when the return signal from the processing portion 14 is inputted to the electromagnetic actuator 43, electric power stored in the condenser is supplied to the first coil 62. Further, when supplied with electric power from the condenser, the first coil 62 generates a magnetic flux acting against the force for retaining the abutment of the movable iron core 56 with the other regulating portion 59.

[0050] Next, operation will be described. During the normal operation, the pressing shoe 42 is displaced into the disengaged position as the movable rod 48 advances (Fig. 6). Further, the wedge 20 of each safety device 7 is moved away from the car guide rail 2 (Fig. 4).

[0051] When the speed of the car 3 abnormally increases and exceeds the first overspeed setting level 18 (Fig. 3), the activation signal 73 is outputted from the control device 12 to the brake device of the hoisting machine 4, thus activating the brake device. Braking is thus applied to the drive sheave 4a to brake the car 3.

[0052] When, even after the brake device of the hoisting machine 4 has been activated, the speed of the car 3 keeps rising due to, for example, a break in the main rope 5 and exceeds the second overspeed setting level 19 (Fig. 3), the activation signal 74 is outputted to the rope catching device 15 from the control device 12. Accordingly, electric power stored in the condenser is instantaneously supplied to the second coil 63. As a result, the movable rod 48 is retracted, whereby the displacement lever 49 is pivoted counterclockwise as seen in Fig. 5. Then, the pressing shoe 42 is pressed against the governor sheave 8 through the governor rope 9 and displaced into the restraining position. As a result, the governor rope is restrained by the rope catching device 15. In the state where the pressing shoe 42 has been displaced into the restraining position, the movable iron core 56 is retained in abutment with the other regulating portion 59.

[0053] Due to the restraining of the governor rope 9 by the rope catching device 15, the governor rope 9 is displaced upwards relative to the car 3 that is descending at an abnormal speed, whereby the wedge 20 is displaced toward the gripper metal 22, that is, in the upward direction. At this time, the wedge 20 is displaced into contact with the car guide rail 2 while sliding on the inclined portion 33. Then, the wedge 20 and the pressing member 31 are brought into contact with and pressed against the car guide rail 2. Upon contacting the car guide rail 2, the wedge 20 is displaced further upwards to be wedged between the car guide rail 2 and the sliding member 30. As a result, a large friction force is generated between each of the wedge 20 and pressing member 31 and the car guide rail 2, thereby braking the car 3.

[0054] When releasing the braking on the car 3, the car 3 is raised and then a return signal is outputted from the control device 12 to the rope catching device 15. As a result, electric power stored in the condenser is instantaneously supplied to the first coil 62. The movable rod 48 is thus advanced. Then, the displacement lever 49 is abutted against the stopper 55 to be rotated clockwise as seen in Fig. 5. The pressing shoe 42 is thus displaced into the disengaged position and the restraining of the governor rope 9 is released.

[0055] Next, description will be made on the procedure for performing an operation test on the emergency braking system for an elevator. First, the governor rope 9 is lifted up above the governor sheave 8, thus bringing the governor sheave 8 into a free state. Then, the governor sheave 8 is rotated by pressing a turning gear such as an electric drill against the governor sheave 8. Further, a tachometer is pressed against the governor sheave 8 to measure the rotational speed of the governor sheave 8.

[0056] When the governor sheave 8 is rotated by the turning gear, the detected position of the car 3 detected by the encoder 11, and the respective values of the first overspeed setting level 18 and second overspeed setting level 19 at the detected position are displayed on the display 75. Since it is measured while lifting up the governor rope 9 above the governor sheave 8, the detected position of the car 3 displayed on the display 75 differs from the actual position of the car 3 in most cases.

[0057] Thereafter, the rotational speed of the governor sheave 8 is increased while looking at the indication on the display 75 and the tachometer, and when the rotational speed of the governor sheave 8 corresponding to the detected position of the car 3 exceeds the value of the first overspeed setting level 18, the activation signal 73 is outputted from the control device 12 to the brake device of the hoisting machine 4. At this time, the presence/absence of an abnormality in the operation of the brake device of the hoisting device 4 can be checked through comparison between the value of the first overspeed setting level 18 displayed on the display 75 and the value of the rotational speed of the governor rope 8 as measured by the tachometer. That is, the braking device of the hoisting machine 4 is determined to be operating normally when the difference between the value of the first overspeed setting level 18 and the value of the rotational speed of the governor sheave 8 as measured by the tachometer falls within a permissible range, and the brake device of the hoisting machine 4 is determined to be operating abnormally when the above difference deviates from the permissible range.

[0058] Thereafter, the rotational speed of the governor sheave 8 is further increased, and when the rotational speed of the governor sheave 8 corresponding to the detected position of the car 3 exceeds the value of the second overspeed setting level 19, the activation signal 74 is outputted from the control device 12 to the rope catching device 15. At this time, the presence/absence of an abnormality in the operation of the rope catching device 15 is checked through comparison between the value of the second overspeed setting level 19 displayed on the display 75 and the value of the rotational speed of the governor rope 8 as measured by the tachometer. That is, the rope catching device 15 is determined to be operating normally when the difference between the value of the second overspeed setting level 19 and the value of the rotational speed of the governor sheave 8 as measured by the tachometer falls within a permissible range, and the rope catching device 15 is determined to be operating abnormally when the above difference deviates from the permissible range.

[0059] Thereafter, the governor rope 9 is wound around the governor sheave 8, and the detected position of the car 3 is made to coincide with the actual position of the car 3, thus completing the operation test on the emergency braking system.

[0060] In the emergency braking system for an elevator as described above, the detected position of the car 3 as detected by the encoder 11 and the respective values of the first overspeed setting level 18 and second overspeed setting level 19 at the detected position are displayed on the display 75. Accordingly, even in a case where the first overspeed setting level 18 and the second overspeed setting level 19 are set so as to change continuously according to the position of the car 3, the values of the respective setting levels when the brake device of the hoisting machine 4 and the rope catching device 15 operate during the operation test on the system can be easily and accurately ascertained. Therefore, the timings at which the brake device of the hoisting machine 4 and the rope catching device 15 operate can be easily and accurately ascertained, whereby the operation test can be easily and accurately performed on the brake device of the hoisting machine 4 and on the rope catching device 15.

Embodiment 2

[0061] Fig. 8 is a block diagram showing the control device 12 of an emergency braking system for an elevator according to Embodiment 2 of the present invention. Referring to the drawing, electrically connected to the I/O port 14 is a selector switch 82 capable of switching between a normal mode in which the position information 71 from the encoder 11 can be inputted to the I/O port 14 and a test mode in which desired setting information 81 can be inputted to the I/O port 14 as the position information on the car 3.

[0062] In the normal mode, the position information 71 from the encoder 11 is constantly inputted. Further, in the normal mode, the detected position of the car 3 obtained from the position information 71, and the respective values of the first overspeed setting level 18 and second overspeed setting level 19 at the detected position are displayed on the display 75. Accordingly, when the governor sheave 8 is rotated, the values displayed on the display 75 change in accordance with the rotation.

[0063] In the test mode, the set position of the car 3 obtained from the setting information 81 inputted to the I/O port 14, and the respective values of the first overspeed setting level 18 and second overspeed setting level 19 at the set position are displayed on the display 75. The values displayed on the display 75 thus do not change but remain fixed even when the governor sheave 8 is rotated. Otherwise, the construction and operation of Embodiment 2 are the same as those of Embodiment 1.

[0064] Next, description will be made on the procedure for performing an operation test on the emergency braking system for an elevator. First, the setting information 81 corresponding to the positions where the brake device of the hoisting machine 4 and the rope catching device 15 are to be activated is inputted to the I/O port 14, and the setting information 81 is stored in the storage portion 76.

[0065] Thereafter, the governor shave 8 is rotated by the turning gear in the same manner as in Embodiment 1, and the brake device of the hoisting machine 4 and the rope catching device 15 are activated in the stated order while increasing the rotation speed of the governor sheave 8. When the brake device of the hoistingmachine 4 is activated, it is checked whether or not the difference in value between the rotation speed of the governor sheave 8 as measured by the tachometer and the first overspeed setting level 18 falls within the permissible range. When the rope catching device 15 is activated, it is checked whether or not the difference in value between the rotation speed of the governor sheave 8 as measured by the tachometer and the second overspeed setting level 18 falls within the permissible range.

[0066] Thereafter, the test is performed again according to the above procedure while changing the value of the setting information 81. By repeating this test, the presence/absence of an abnormality in the operation of each of the brake device of the hoisting machine 4 and of the rope catching device 15 can be ascertained for each set position of the car 3.

[0067] Then, after winding the governor rope 9 around the governor sheave 8, the mode of the control device 12 is switched from the test mode to the normal mode by means of the selector switch 82.

[0068] In the emergency braking system for an elevator as described above, the control device 12 can be switched between the normal mode, in which the position of the car 3 can be found based on the position information 71 from the encoder 11, and the test mode, in which the position of the car 3 can be found based on the desired setting information 81 externally inputted. Accordingly, by switching the control device 12 to the test mode, the position of the car 3 can be freely set in the control device 12 irrespective of the rotation of the governor shave 8. This facilitates the setting of the position of the car 3, and the respective operations of the brake device of the hoisting machine 4 and of the rope catching device 15 can be easily tested.

Embodiment 3

[0069] Fig. 9 is an explanatory diagram showing a method of controlling the control device 12 of an emergency braking system for an elevator according to Embodiment 3 of the present invention. Referring to the drawing, the control device 12 can be switched between a normal mode, in which the car 3 is run so that the speed of the car 3 becomes the normal speed setting level 17, and a test mode, in which the car 3 is run at a sampling speed $V_{OS}(x)$ that is the same as the value of the first overspeed setting level 18 at a sampling position spaced apart by a predetermined distance x from the terminal end portion of the hoistway 1. Further, when, in the test mode, the car 3 passes an activation position (which in this example is an intermediate position M of the hoistway 1) spaced further apart from the terminal end portion of the hoistway 1 than the sampling position, the control device 12 causes the activation signal 73 to be forcibly outputted from the I/O port 14 to the brake device of the hoisting machine 4. As a result, the brake device is activated, so the car 3 is braked to stop. It should be noted that the sampling position is set within the acceleration/deceleration zone.

[0070] The display 75 displays a speed V_{BOS} of the car 3 at a simulated terminal end position spaced apart by the distance x from the intermediate position M of the hoistway 1. The construction and operation of Embodiment 3 are the same as those of Embodiment 1.

[0071] Next, description will be made on the procedure for performing an operation test on the emergency braking system for an elevator. First, the control of the control device 12 is switched from the normal mode to the test mode, thus causing the car 3 to run at the sampling speed $V_{OS}(x)$.

[0072] Thereafter, the brake device is activated when the car 3 reaches the intermediate position M of the hoistway 1. The drive sheave 4a is thus braked to stop the car 3. That is, the behaviors of the car 3 when the car 3 is braked by the brake device at the sampling position are simulated and reproduced at the intermediate portion of the hoistway 1. At this time, the speed V_{BOS} of the car 3 at the simulated terminal end position is displayed on the display 75.

[0073] Thereafter, it is checked whether or not the speed V_{BOS} of the car 3 displayed on the display 75 falls within the permissible range of the buffer capacity of a buffer disposed at the bottom portion of the hoistway 1.

[0074] In the emergency braking system for an elevator as described above, switching can be made between the normal mode, in which the car 3 is run at a speed at which the car 3 runs during the normal operation, and the test mode, in which the car 3 is run at the speed V_{OS} (x) that is the same as the value of the first overspeed setting level 18 at the sampling position spaced apart by the predetermined distance x from the terminal end portion of the hoistway 1. When, in the test mode, the car 3 passes the intermediate position M of the hoistway 1, the activation signal 73 is forcibly outputted from the control device 12 to the brake device of the hoisting machine 4. Accordingly, the behaviors of the car 3 in the vicinity of the terminal end portion of the hoistway 1 can be reproduced at the intermediate position of the hoistway 1, whereby the operation of the brake device of the hoisting machine 4 can be adjusted without directly colliding the car 3 against the buffer.

[0075] Further, the display 75 displays the speed V_{BOS} of the car 3 at the simulated terminal end position spaced apart by the distance x from the intermediate position M, so the speed of the car 3 when it collides against the buffer can be easily and accurately ascertained, whereby the operation test on the brake device of the hoisting machine 4 can be performed with greater ease and accuracy.

[0076] It should be noted that in the above-described example, the car 3 is run at the same speed as the value of the first overspeed setting level 18 at the sampling position, and the brake device of the hoisting machine 4 is activated at the intermediate position M of the hoistway 1. However, an arrangement is also possible in which the car 3 is run at a sampling speed $V_{TR}(x)$ that is the same as the value of the second overspeed setting level 19 at the sampling position, and when the car 3 passes the intermediate position M of the hoistway 1, the activation signal 74 is forcibly outputted from the control device 12 to the rope catching device 15 to thereby activate the rope catching device 15.

[0077] With the above arrangement, the behaviors of the car 3 in the vicinity of the terminal end portion of the hoistway 1 can be reproduced at the intermediate portion of the hoistway 1, and the state of braking on the car 3 through the operation of the rope catching device 15 can be ascertained at the intermediate portion of the hoistway 1. Accordingly, an operation test can be performed easily and accurately on the rope catching device 15 as well.

[0078] Further, when performing an operation test on the rope catching device 15 described above, the display 75 may display the speed of the car 3 at the simulated terminal end position spaced apart by the distance x from the intermediate position M. Accordingly, the speed of the car 3 when it collides against the buffer can be easily and accurately ascertained, whereby the operation test on the rope catching device 15 can be performed with greater ease and accuracy.

Embodiment 4

[0079] While in the above-described example the speed V_{BOS} of the car 3 at the simulated terminal end position spaced apart by the distance x from the intermediate position M is displayed on the display 75, a distance D_{SOS} that the car 3 travels from the intermediate position M until the car 3 stops through operation of the brake device may be displayed on the display 75.

[0080] As a result, whether or not the collision of the car 3 against the terminal end portion of the hoistway 1 can be prevented through the operation of the brake device of the hoisting machine 4 can be easily and accurately ascertained at the intermediate portion of the hoistway 1, whereby an operation test on the brake device of the hoisting machine 4 can be performed with greater ease and accuracy. Accordingly, adjustments can be easily and accurately made on the operation of the brake device and on the braking force.

[0081] Further, the display 75 may display the distance that the car 3 travels until it stops through the operation of the rope catching device 15. As a result, an operation test can be easily and accurately performed on the rope catching device 15 as well.

Embodiment 5

[0082] Fig. 10 is a structural view showing a rope catching device of an emergency braking system for an elevator according to Embodiment 5 of the present invention. Referring to the figure, an electromagnetic actuator 81 is mounted to the mounting member 45. The electromagnetic actuator 81 has: a movable portion 82 that is displaceable between an activation position for causing the pressing shoe 42 to restrain the governor rope 9 and a release position for releasing the restraining of the governor rope 9; a compression spring 83 as an urging portion for urging the movable portion 82 toward the activation position; and an electromagnet 84 for displacing the movable portion 82 toward the release position against the urging force of the compression spring 83. The electromagnet 84 is mounted on top of the horizontal portion 46.

[0083] The movable portion 82 has a movable plate 85 that is sucked onto the electromagnet 84 upon energizing the electromagnet 84, and a movable rod 86 fixed to the movable plate 85 and slidably penetrating the electromagnet 84 and the vertical portion 47.

[0084] The distal end portion of the movable rod 86 is connected to the upper end portion of the displacement lever 49 through a link 87. The link 87 is connected to each of the movable rod 86 and the displacement lever 49. A spring connecting portion 88 is fixed to the portion of the movable rod 86 between the electromagnet 84 and the vertical portion 47. The compression spring 83 is connected between the spring connecting portion 88 and the vertical portion 47.

[0085] Here, the displacement lever 49 is pivoted due to the reciprocating motion of the movable rod 86. Accordingly, the positional relation between the movable rod 86 and the displacement lever 49 varies due to a difference in displacement between the movable rod 86 and the displacement lever 49. The link 87 is connected between the movable rod 86 and the displacement lever 49 in order to permit this variation.

[0086] The electromagnetic actuator 81 is activated upon input of an activation signal from the control device 12. The electromagnetic actuator 81 is activated upon stopping the energization of the electromagnet 84. When the electromagnetic actuator 81 is activated, the movable portion 82 is retracted for displacement into the activationposition. This causes the pressing shoe 42 to be displaced into the restraining position.

[0087] Further, the activation of the electromagnetic actuator 81 is released upon input of a return signal from the control device 12. The electromagnetic actuator 81 is returned into position upon energization of the electromagnet 84. As the activation of the electromagnetic actuator 81 is released, the movable portion 82 is advanced for displacement into the release position. The pressing shoe 42 is thus displaced into the disengaged position. It should be noted that a connecting mechanism portion 89 has the link 87 and the displacement lever 49. Otherwise, Embodiment 5 is of the same construction as Embodiment 1.

[0088] Next, the operation of the rope catching device will be described. During the normal operation, the return signal from the control device 12 is continuously inputted to the electromagnetic actuator 81, thereby keeping the electromagnet 84 energized. The movable portion 82 is in the release position in this state, so the restraining of the governor rope 9 by the pressing shoe 42 is released.

[0089] When the activation signal from the control device 12 is inputted to the electromagnetic actuator 81, the energization of the electromagnet 84 is stopped. As a result, the adsorption of the movable plate 85 by the electromagnet 84 is released, and the movable portion 82 is retracted and displaced into the activation position while being urged by the compression spring 83. As a result, the pressing shoe 42 is displaced into the restraining position to restrain the governor rope 9. The subsequent operations are the same as those of Embodiment 1.

[0090] For a return operation, the return signal is outputted from the control device 12 to the electromagnetic actuator 81, thereby energizing the electromagnet 84. Accordingly, the movable portion 82 is advanced, so the pressing shoe 94 is displaced into the disengaged position. As a result, the restraining of the governor rope 9 is released.

[0091] As described above, also in the case of the emergency braking system for an elevator with which the rope catching device is activated by the electromagnetic activator 81, by applying the control device 12 according to each of Embodiments 1 through 4 to the system, the operation test can be easily and accurately performed on the brake device of the hoisting machine 4 and on the rope catching device.

Embodiment 6

[0092] Fig. 11 is a structural view showing a rope catching device of an emergency braking system for an elevator according to Embodiment 6 of the present invention. Referring to the figure, fixed to the lower end portion of the frame member 41 is a fixing member 91 extending downwards from the frame member 41. A receiving portion 92 formed of a high friction material is affixed to the fixing member 91. Further, the upper end portion of a substantially obtuse V-shaped displacement lever 93 is pivotably connected to the frame member 41.

[0093] Pivotably provided to the intermediate portion of the displacement lever 93 is a pressing shoe 94 as a pressing member displaceable into and out of contact with the receiving portion 92. The pressing shoe 94 is displaceable between a restraining position, where it is pressed against the receiving portion 92 through the governor rope 9 due to the pivotal movement of the displacement lever 93, and a disengaged position where it is moved away from the governor rope 9. The portion of the pressing shoe 94 which comes into contact with the governor rope 9 is formed of a high friction material.

[0094] An actuator supporting member 96 having a projection portion 95 is fixed below the frame member 41. The electromagnetic actuator 43 of the same construction as that of Embodiment 1 is supported on the actuator supporting member 96. A movable rod 97 fixed to the movable iron core 56 extends horizontally from the electromagnetic actuator 43. The movable rod 97 slidably penetrates the projection portion 95.

[0095] The lower end portion of the displacement lever 93 is slidably provided to the movable rod 97. Further, fixed to the distal end portion of the movable rod 97 is a stopper 98 for regulating the range within which the lower end portion of the displacement lever 93 is allowed to slide. A spring connecting portion 99 is fixed to the portion of the movable rod 97 between the lower end portion of the displacement lever 93 and the projection portion 95.

[0096] Connected between the lower end portion of the displacement lever 93 and the spring connecting portion 99 is a compression spring 100 that is an elastic member for pressing the pressing shoe 94 in the restraining position onto the receiving portion 92 side. Further, connected between the projection portion 95 and the spring connecting portion 99 is an adjusting spring 101 that is an elastic member for mitigating the load on the electromagnetic actuator 43.

[0097] The electromagnetic actuator 43 is activated upon input of an activation signal from the control device 12. The movable rod 97 is advanced through the activation of the electromagnetic actuator 43 to displace the pressing shoe 94 into the restraining position. Further, the movable rod 97 is retracted upon input of a return signal to the electormagnetic actuator 43. As the movable rod 97 is retracted, the pressing shoe 94 is displaced into the disengaged position.

[0098] It should be noted that a restraining portion 102 has the receiving position 92 and the pressing shoe 94. Further, a connecting mechanism portion 103 has the movable rod 97 and the displacement lever 93. Otherwise, Embodiment 6 is of the same construction as Embodiment 1.

[0099] Next, the operation of the rope catching device will be described. During the normal operation, the movable rod 97 is retracted and the pressing shoe 94 is thus placed in the disengaged position.

[0100] When the activation signal from the control device 12 is inputted to the electromagnetic actuator 43, the displacement lever 93 is pivoted as the movable rod 97 is advanced, so the pressing shoe 94 is displaced into the restraining position. As a result, the governor rope 9 is pinched between the receiving portion 92 and the pressing shoe 94 and restrained. The subsequent operations are the same as those of Embodiment 1.

[0101] For a return operation, the return signal is outputted from the control device 12, causing the movable rod 97 to retract. Accordingly, the pressing shoe 94 is displaced into the disengaged position, whereby the restraining of the governor rope 9 is released.

[0102] As described above, also in the case of the emergency braking system for an elevator of the type in which the restraining portion 102 of the rope catching device holds the governor rope 9 from both sides, by applying the control device 12 according to each of Embodiments 1 through 4 to the system, the operation test can be easily and accurately performed on the brake device of the hoisting machine 4 and on the rope catching device.

Embodiment 7

[0103] Fig. 12 is a structural view showing a rope catching device of an emergency braking system for an elevator according to Embodiment 7 of the present invention. Further, Fig. 13 is a structural view showing a state in which the rope catching device of Fig. 12 has been activated. Referring to the figures, a fixing member 111 is fixed in the vicinity of the governor rope 9. A receiving portion 112 formed of a high friction material is affixed to a side surface of the fixing member 111.

[0104] A horizontal shaft 113 is fixed in the hoistway 1. The horizontal shaft 113 is arranged at substantially the same height as the receiving portion 112. One end portion of an elastic expansion member 114 that is capable of expansion and contraction is pivotably provided to the horizontal shaft 113. Pivotably provided to the other end portion of the elastic expansion member 114 is a pressing shoe 115 that is displaceable into and out of contact with the receiving portion 112. As the elastic expansion member 114 pivots about the horizontal shaft 113, the pressing shoe 115 is displaced between a restraining position (Fig. 13) where the pressing shoe 115 is pressed against the receiving portion 112 through the governor rope 9, and a disengaged position (Fig. 12) where the pressing shoe 115 is moved away from the governor rope 9 to release the restraining of the governor rope 9. When the pressing shoe 115 is in the restraining position, the elastic expansion member 114 is contracted by the reaction force of the receiving portion 112.

[0105] The length of the elastic expansion member 114 is adjusted such that the pressing shoe 115 is pivoted without its lower end portion abutting the upper surface of the receiving portion 112 and that the elastic expansion member 114 undergoes contraction between the horizontal shaft 113 and the receiving portion 112 when the elastic expansion member 114 is substantially horizontal. Further, the elastic expansion member 114 has an expansion rod 116 to which the pressing shoe 115 is provided, and a compression spring 117 for urging the pressing shoe 115 that is in the restraining position onto the receiving portion 112 side.

[0106] The expansion rod 116 has a first connecting portion 118 pivotably provided to the horizontal shaft 113, a second connecting portion 119 pivotably connected to the pressing shoe 115, and an expansion portion 120 connecting between the first and second connecting portions 118, 119. The expansion portion 120 has a plurality of slide tubes 121 capable of sliding with respect to each other. Further, the expansion portion 120 can expand and contract as the slide tubes 121 are slid with respect to each other.

[0107] The compression spring 117 is connected between the first and second connecting portions 118, 119. Further, as the compressing spring 117 is displaced so as to bring the first connecting portion 118 and the second connecting portion 119 closer to each other, the compressing spring 117 generates an elastic restoration force acting in the direction in which the elastic expansion member 114 expands.

[0108] Further, the electromagnetic actuator 43 of the same construction as that of Embodiment 1 is disposed in the hoistway 1. Vertically extending from the electromagnetic actuator 43 is a movable rod 122 capable of reciprocating with respect to the electromagnetic actuator 43. A spring connecting portion 123 is fixed to the distal end portion of the movable rod 122. Further, a fastening member 124 is slidably provided to the portion of the movable rod 122 between the spring connecting portion 123 and the electromagnetic actuator 43. A connecting spring 125 is connected between the spring connecting portion 123 and the fastening member 124.

[0109] The fastening member 124 and the pressing shoe 115 are connected to each other through a connecting mechanism portion 126. The connecting mechanism portion 126 has a first link member 127 and a second link member 128 that are pivotably connected to each other.

[0110] The first link member 127 is supported on a support shaft 129 parallel to the horizontal shaft 113. The supported shaft 129 is fixed in position in the hoistway 1. The intermediate portion of the first link member 127 is pivotably provided to the support shaft 129. Further, one end portion of the first link member 127 is pivotably connected to the fastening member 124, and the other end portion of the first link member 127 is pivotably connected to one end portion of the second link member 128.

[0111] The length of the second link member 128 is smaller than the length of the first link member 127. The other end portion of the second link member 128 is pivotably connected to the pressing shoe 115.

[0112] As the movable rod 112 is displaced (advanced) upwards, the pressing shoe 115 is pivoted downwards about the horizontal shaft 113 to be displaced into the restraining position. Further, as the movable rod 112 is displaced (retracted) downwards, the pressing shoe 115 is pivoted upwards about the horizontal shaft 113 to be displaced into the disengaged position.

[0113] It should be noted that in the vicinity of the receiving portion 112, there is provided a stopper 130 for regulating the downward pivotal movement of the pressing shoe 115 to retain the pressing shoe 115 in the restraining position. Further, as the pressing shoe 115 contacts the governor rope 9 while the car 3 is lowered, the pressing shoe 115 is pivoted so as to be pressed onto the receiving portion 112 side. Otherwise, Embodiment 7 is of the same construction as Embodiment 1.

[0114] Next, the operation of the rope catching device will be described. During the normal operation, the movable rod 122 is retracted downwards and thus the pressing shoe 115 is placed in the disengaged position (Fig. 12).

[0115] When the activation signal from the control device 12 is inputted to the electromagnetic actuator 43, the movable rod 122 is advanced upwards, and the pressing shoe 115 is pivoted downwards about the horizontal shaft 113. At this time, the pressing shoe 115 presses the governor rope 9 rightwards in the figure while undergoing downward pivotal movement, thereby bringing the governor rope 9 into contact with the side surface of the receiving portion 112. Then, the pressing shoe 115 is pulled further downwards due to the movement of the governor rope 9 and the weight of the pressing shoe 115 itself. At this time, the pressing shoe 115 is displaced into the restraining position along the side surface of the receiving portion 112 while contracting the elastic expansion member 114, with the governor rope 9 being sandwiched between the pressing shoe 115 and the receiving portion 112. Accordingly, an elastic restoration force is generated in the compression spring 117, so the pressing shoe 115 presses the governor rope 9 against the receiving portion 112. As a result, the governor rope 9 is restrained (Fig. 13). The subsequent operations are the same as those of Embodiment 1.

[0116] For a return operation, the return signal is outputted from the control device 12 to cause the movable rod 122 to retract. As a result, the pressing shoe 115 is displaced into the disengaged position and thus the restraining of the governor rope 9 is released.

[0117] As described above, also in the case of the emergency braking system for an elevator which has the rope catching device whose restraining force on the governor rope 9 increases as the rope catching device is pulled by the governor rope 9, by applying the control device 12 according to each of Embodiments 1 through 4 to the system, the operation test can be easily and accurately performed on the brake device of the hoisting machine 4 and on the rope catching device.

Embodiment 8

[0118] Fig. 14 is a front view showing a rope catching device of an emergency braking system for an elevator according to Embodiment 8 of the present invention. Referring to the figure, support shafts 141, 142 are fixed to a frame member 41. A support portion 143 for the rotation shaft of the governor sheave 8 is provided to the portion of the frame member 41 between the support shaft 141 and the support shaft 142. One end portion (lower end portion) of the support link 144, and one end portion (lower end portion) of a displacement lever 145 are pivotably provided to the support shaft 141 and the support shaft 142, respectively.

[0119] Arranged above the frame member 41 is a movable base 146 displaceable with respect to the frame member 41. The movable base 146 is connected to the respective other end portions (upper end portions) of the support link 144 and displacement lever 145. The movable base 146 is thus supported on the frame member 41 through the support link 144 and the displacement lever 145.

[0120] The movable base 146 has a movable base main body 147, and a screw bar 148 extending outwards from the movable base main body 147 and slidably penetrated through the upper end portion of the displacement lever 145. The upper end portion of the support link 144 is pivotably provided to the movable base main body 147.

[0121] Mounted to the screw bar 148 is a spring fastening member 150 whose distance from the movable base main body 147 can be adjusted. A compression spring 151 as an elastic member fitted to the screw bar 148 is arranged between the upper end portion of the displacement lever 147 and the spring fasteningmember 150. The compression spring 151 is compressed between the upper end portion of the displacement lever 147 and the spring fastening member 150. As a result, the upper end portion of the displacement lever 147 and the spring fastening member 150 are urged so as to move away from each other.

[0122] A pressing shoe 152 as a pressing member is pivotably provided to the intermediate portion of the displacement lever 147. The pressing shoe 152 is displaceable between a restraining position where it is pressed against the governor sheave 8 through the governor rope 9, and a disengaged position where it is moved away from the governor rope 9. The pressing shoe 152 is displaced between the restraining position and the disengaged position due to the pivotal movement of the displacement lever 147 about the support shaft 141.

[0123] Fixed to the governor sheave 8 is a ratchet gear 153 rotated integrally with the governor sheave 8. The ratchet gear 153 has a plurality of tooth portions 154 in its outer peripheral portion.

[0124] A latch supporting shaft 155 is fixed to the movable base main body 147. A latch 157 having a claw portion 156 is pivotably provided to the latch supporting shaft 155. The latch 157 is displaceable between an engaged position where the claw portion 156 is engaged with the tooth portion 154 of the ratchet gear 153, and a release position where the claw portion 156 is released from engagement with the ratchet gear 153. The latch 157 is displaced between the engaged position and the release position as it pivots about the latch supporting shaft 155.

[0125] The latch supporting shaft 155 is arranged at a position lower than the height of the distal end portion of the claw portion 156 when the latch 157 is in the engaged position. Further, the cutting angle of the tooth portions 154 with respect to the rotation direction of the ratchet gear 153 is set such that the trajectory of the claw portion 156 when the latch 157 is pivoted about the latch supporting shaft 155 does not overlap the tooth portions 154. Accordingly, it is possible to reduce the magnitude of the drive force required for the operation of displacing the latch 157 from the engaged position to the release position, that is, the return operation.

[0126] Mounted on top of the movable base main body 147 is the electromagnetic actuator 43 of the same construction as that of Embodiment 1. Amovable rod 158 capable of reciprocating with respect to the electromagnetic actuator 43 extends horizontally from the electromagnetic actuator 43. The movable rod 158 is horizontally reciprocated through the drive of the electromagnetic actuator 43. An elongated hole 163 is provided at the distal end portion of the movable rod 158. Fixed to the latch 157 is a latch mounting member 159 slidably fitted in the elongated hole 163. The latch 157 is displaced into the engaged position as the movable rod 158 advances, and is displaced into the release position as the movable rod 158 retracts.

[0127] When the latch 157 is in the release position, the movable base main body 147 is supported in a balanced manner by the support link 144 and the displacement lever 145, and the pressing shoe 152 is displaced into the disengaged position. Further, in the state in which the ratchet gear 153 is being rotated in the direction in which the car 3 is being lowered (in the state in which the ratchet gear 153 is being rotated in the direction C in the figure), when the latch 157 is displaced into the engaged position, due to the rotation force of the ratchet gear 153, the movable base main body 147 is displaced in the direction (leftwards in the figure with respect to the frame member 41) for causing the pressing shoe 152 to be displaced into the restraining position.

[0128] It should be noted that the frame member 41 is provided with a first stopper 160 and a second stopper 161 which regulate the pivotal movement of the support link 144. With the first stopper 160 regulating the pivotal movement of the support link 144, it is possible to prevent the pressing shoe 152 from being moved away from the governor sheave 8 more than necessary. Further, with the second stopper 161 regulating the pivotal movement of the support link 144, the force with which the pressing shoe 152 is pressed onto the governor sheave 8 side can be prevented from increasing more than necessary, thereby reducing damage to the governor rope 9.

[0129] Next, the operation of the rope catching device will be described. During the normal operation, the movable rod 158 is retracted and thus the latch 157 is displaced into the release position. Further, the pressing shoe 152 is placed in the disengaged position. At this time, the support link 144 is in abutment with the first stopper 160.

[0130] When the rotation speeds of the governor sheave 8 and ratchet gear 153 become abnormal, and the activation signal from the control device 12 is inputted to the electromagnetic actuator 43, the movable rod 158 is advanced, so the latch 157 is displaced into the engaged position. As a result, the tooth portion 154 of the ratchet gear 153 is engaged with the latch 157.

[0131] Thereafter, due to the rotation force of the ratchet gear 153, the movable base main body 147 is displaced leftwards in the figure with respect to the frame member 41, so the pressing shoe 152 is displaced into the restraining position. At this time, as it is urged by the compression spring 151, the pressing shoe 152 is pressed against the governor sheave 8 through the governor rope 9. The governor rope 9 is thus restrained. The pressing force of the pressing shoe 152 is rendered appropriate through the abutment of the support link 144 against the second stopper 161. The subsequent operations are the same as those of Embodiment 1.

[0132] As described above, also in the case of the emergency braking system for an elevator which has the rope catching device that utilizes the rotation force of the governor sheave 8 for the restraining force on the governor rope 9, by applying the control device 12 according to each of Embodiments 1 through 4 to the system, the operation test can be easily and accurately performed on the brake device of the hoisting machine 4 and on the rope catching device.

[0133] While in the above-described embodiments the safety device applies braking with respect to the overspeed in the downward direction of the car, braking may be applied to an overspeed in the upward direction by vertically inverting the safety device and fitting it onto the car.

Claims

1. An emergency braking system for an elevator, **characterized by** comprising:

    a detection portion that detects a position and a speed of a car;
    a control portion having a storage portion storing an overspeed setting level which, within a predetermined section of a hoistway adjoining a terminal end portion of the hoistway, is set to become smaller toward the terminal end portion, the control portion outputting an activation signal when a detected speed of the car exceeds the overspeed setting level at a detected position of the car obtained based on information from the detection portion;
    a braking portion for braking the car, the braking portion being activated upon input of the activation signal; and
    a display portion that displays the detected position and the overspeed setting level at the detected position based on information from the control portion.

2. An emergency braking system for an elevator, **characterized by** comprising:

    a detection portion that detects a position and a speed of a car;
    a control portion having a storage portion storing an overspeed setting level which, within a predetermined section of a hoistway adjoining a terminal end portion of the hoistway, is set to become smaller toward the terminal end portion,

the control portion being switchable between a normal mode, in which a position of the car can be found based on information from the detection portion, and a test mode, in which the position of the car can be found based on information externally inputted, and outputting an activation signal when a detected speed of the car exceeds the overspeed setting level at the position of the car;

a braking portion for braking the car, the braking portion being activated upon input of the activation signal; and

a display portion that displays, when in the test mode, the position of the car and the overspeed setting level at the position of the car based on information from the control portion.

3. An emergency braking system for an elevator according to Claim 1, **characterized in that**: the control portion is switchable between a normal mode, in which the car is run under normal operation control, and a test mode, in which the car is run at the same speed as a value of the overspeed setting level at a sampling position spaced apart by a predetermined distance from the terminal end portion of the hoistway; and when in the test mode, the control portion forcibly outputs the activation signal when the car reaches an activation position at an intermediate portion of the hoistway.

4. An emergency braking system for an elevator according to Claim 3, **characterized in that** the display portion further displays a detected speed of the car at a position spaced apart by the predetermined distance from the activation position.

5. An emergency braking system for an elevator according to Claim 3 or 4, **characterized in that** the display portion further displays a distance that the car travels from the activation position until the car stops.

FIG. 1

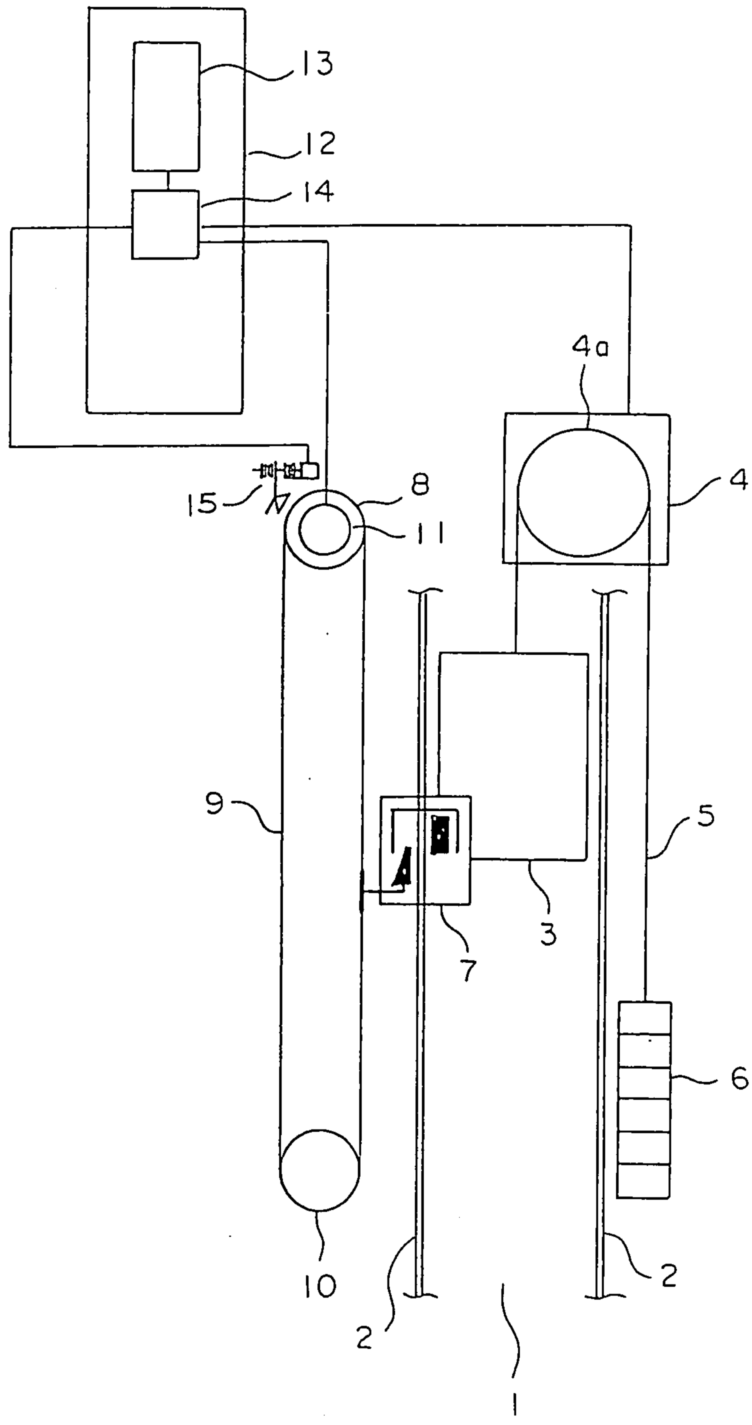


FIG. 2

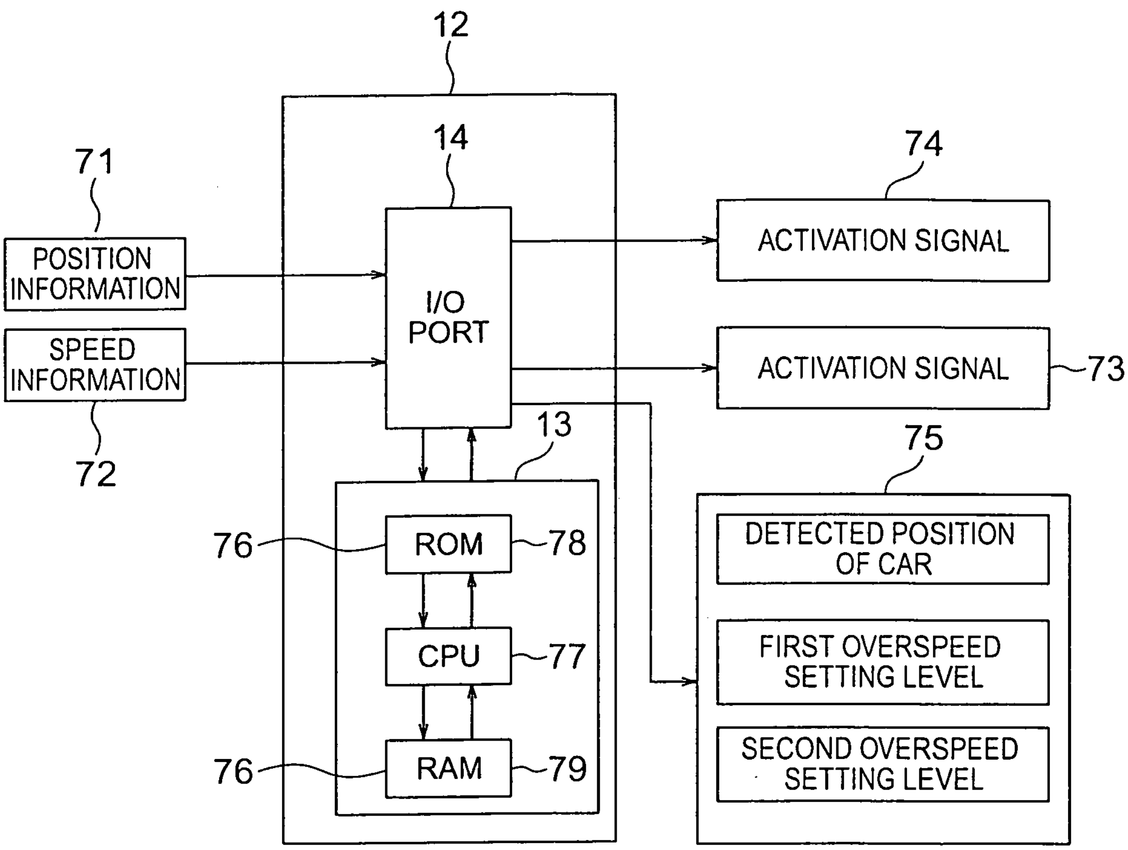

12
14
71
POSITION INFORMATION
SPEED INFORMATION
72
I/O PORT
13
ROM
CPU
RAM
76
78
77
76
79
74
ACTIVATION SIGNAL
ACTIVATION SIGNAL
73
75
DETECTED POSITION OF CAR
FIRST OVERSPEED SETTING LEVEL
SECOND OVERSPEED SETTING LEVEL

FIG. 3

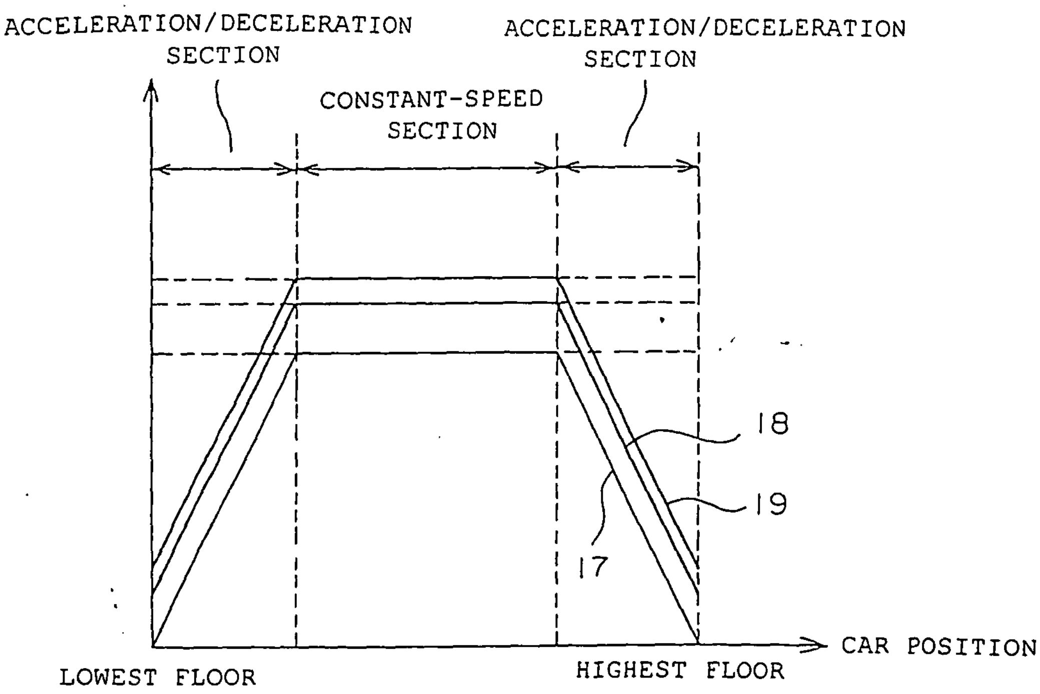

ACCELERATION/DECELERATION SECTION
CONSTANT-SPEED SECTION
ACCELERATION/DECELERATION SECTION
18
19
17
CAR POSITION
LOWEST FLOOR
HIGHEST FLOOR

FIG. 4

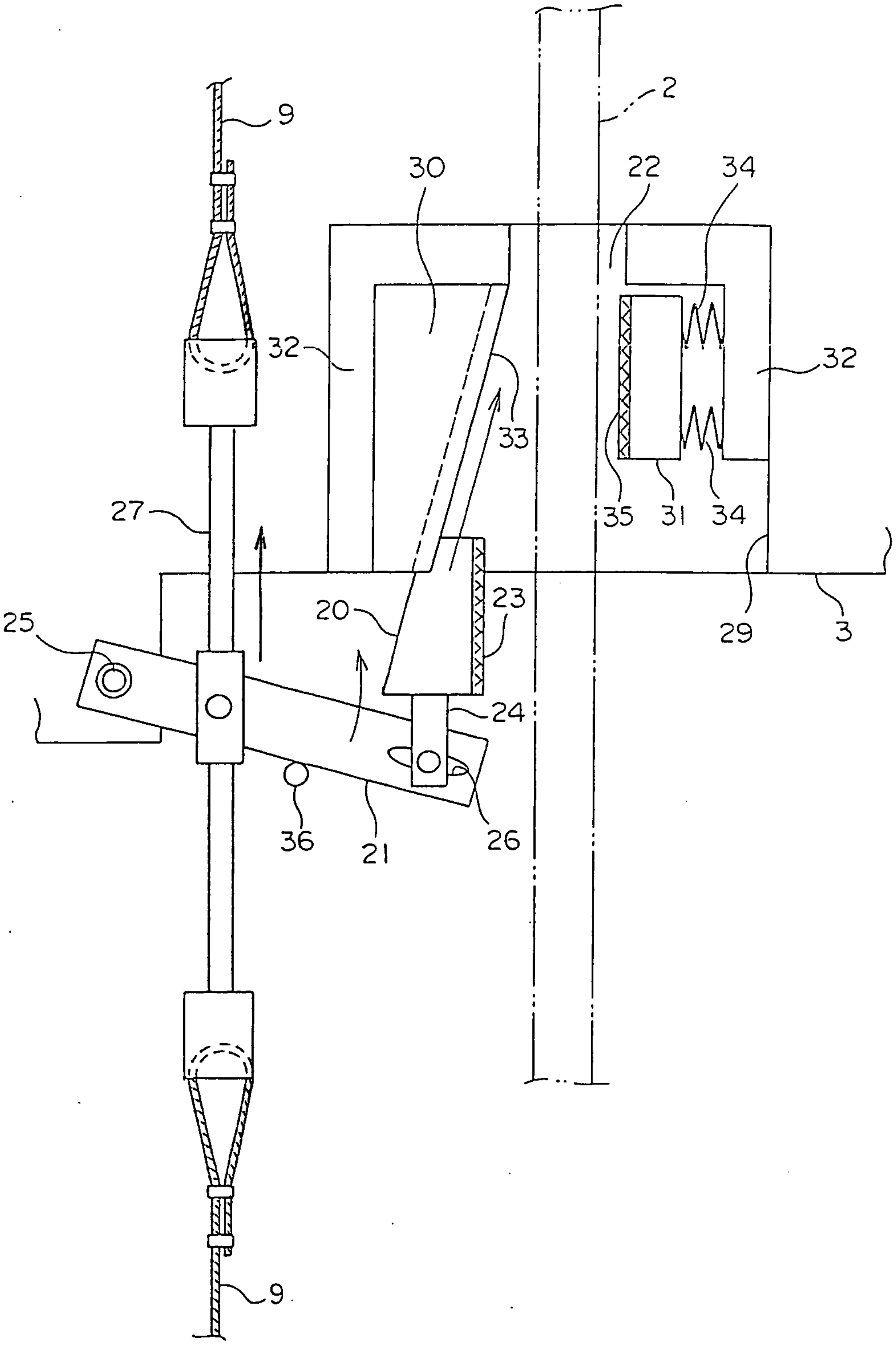


FIG. 5

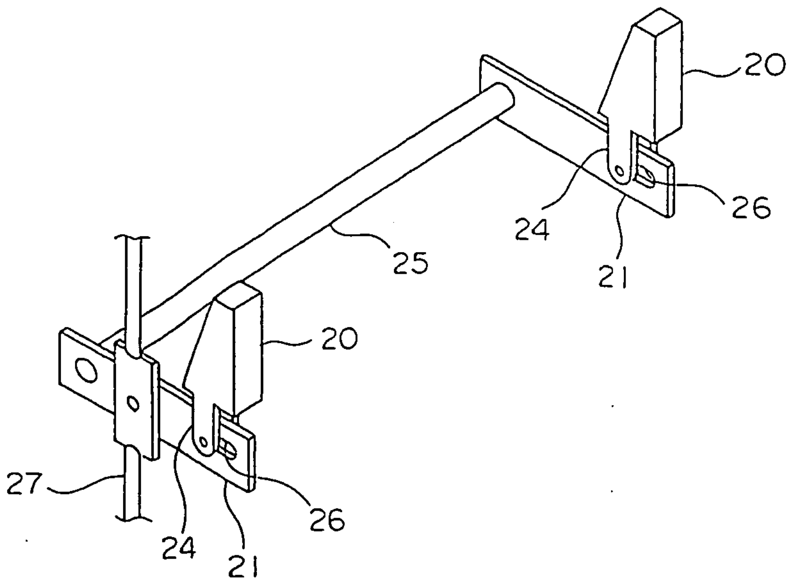


FIG. 6

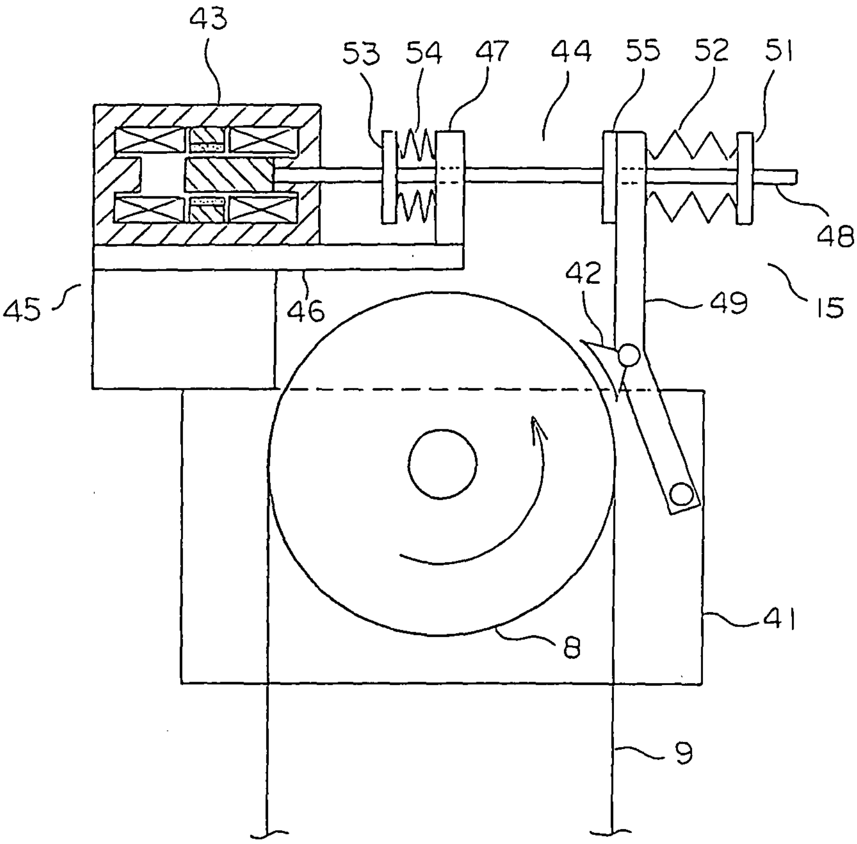


FIG. 7

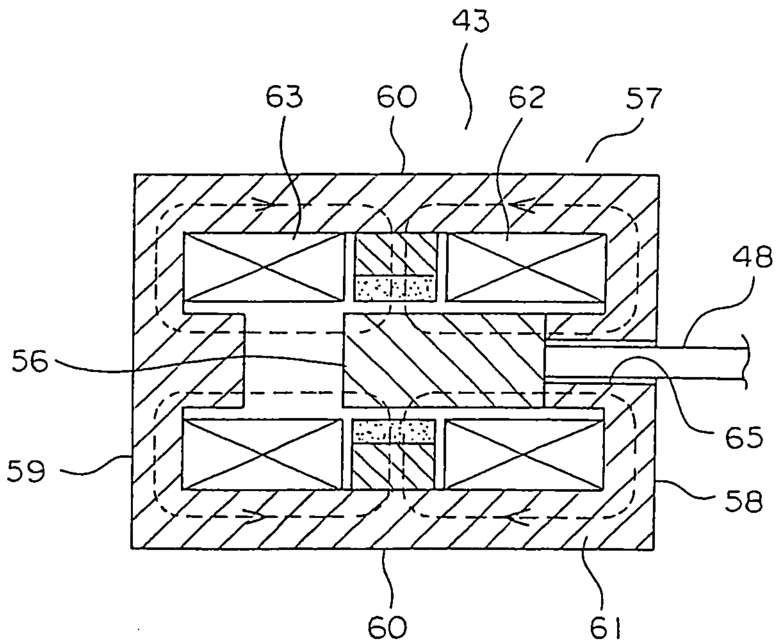


FIG. 8

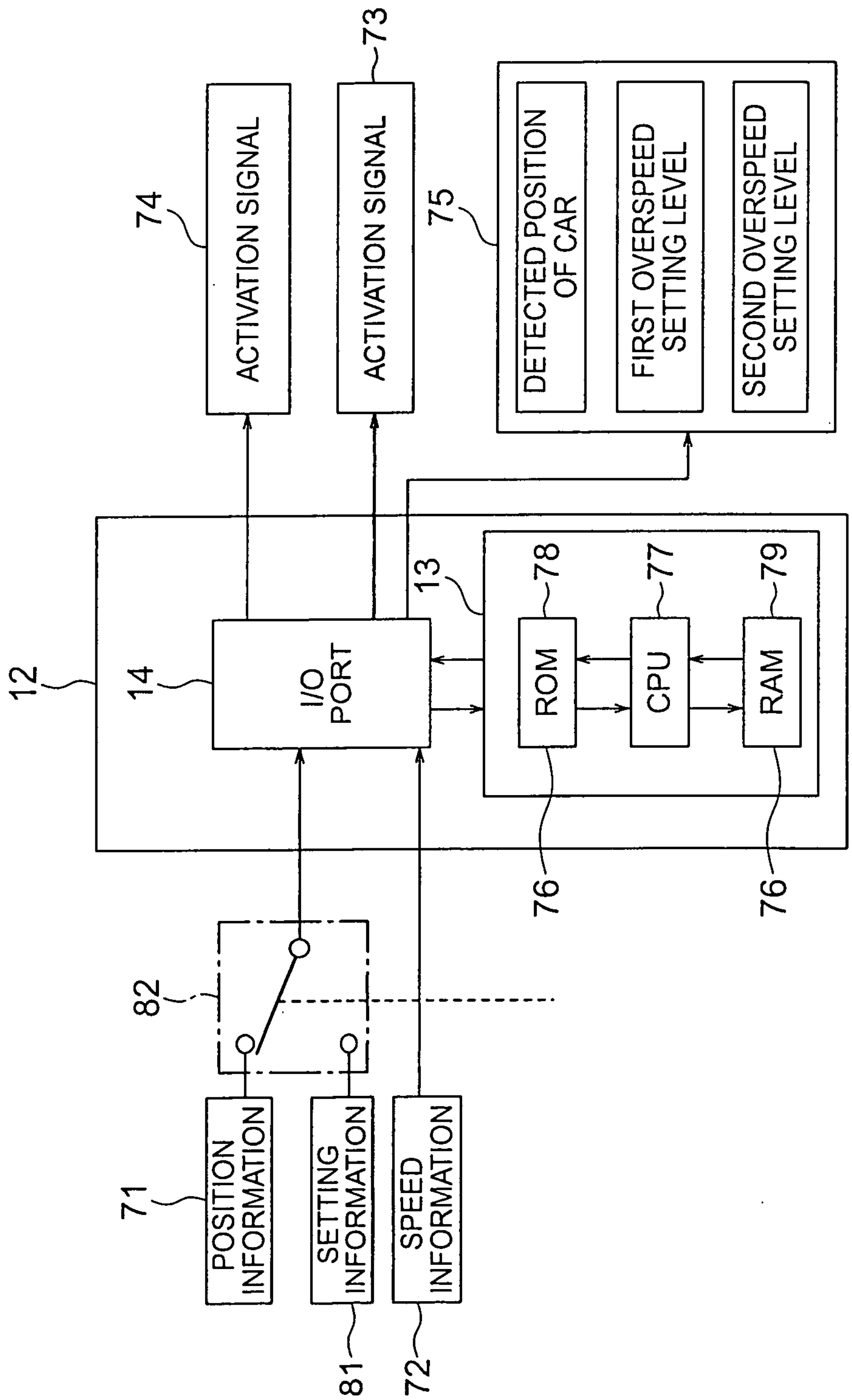

74
ACTIVATION SIGNAL
73
ACTIVATION SIGNAL
75
DETECTED POSITION OF CAR
FIRST OVERSPEED SETTING LEVEL
SECOND OVERSPEED SETTING LEVEL
12
14
I/O PORT
13
78
ROM
77
CPU
79
RAM
76
76
82
71
POSITION INFORMATION
81
SETTING INFORMATION
72
SPEED INFORMATION

FIG. 9

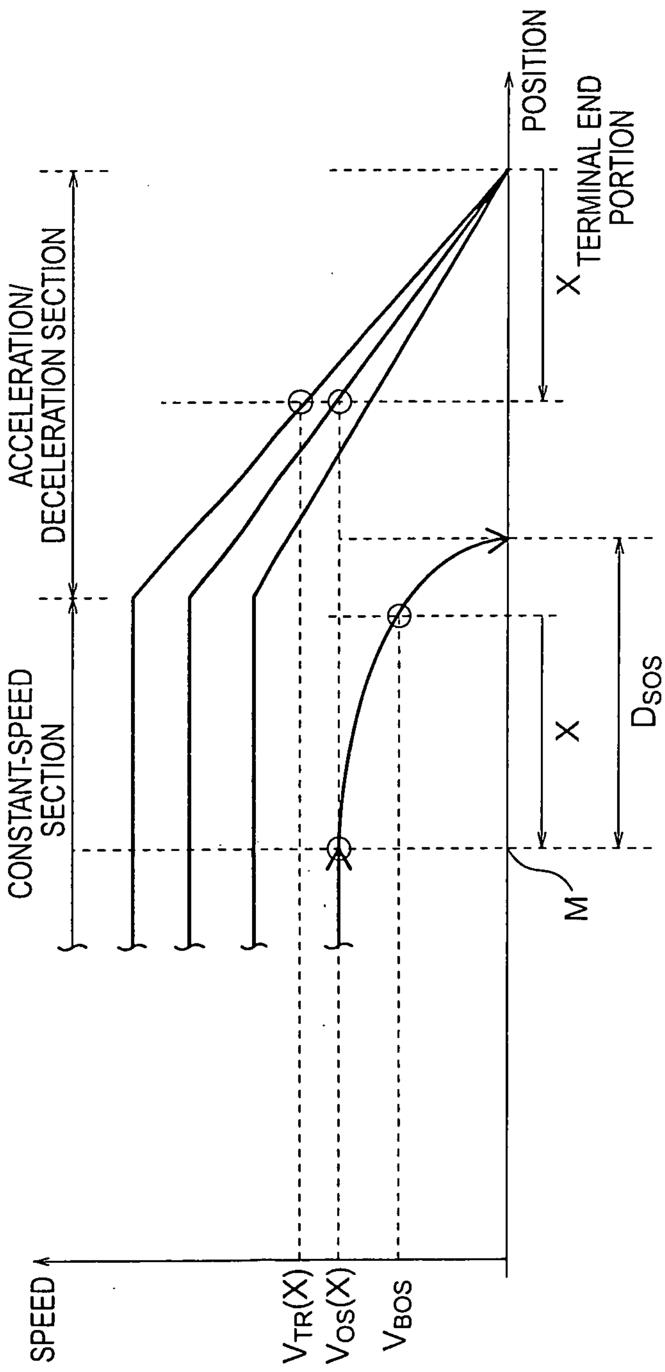
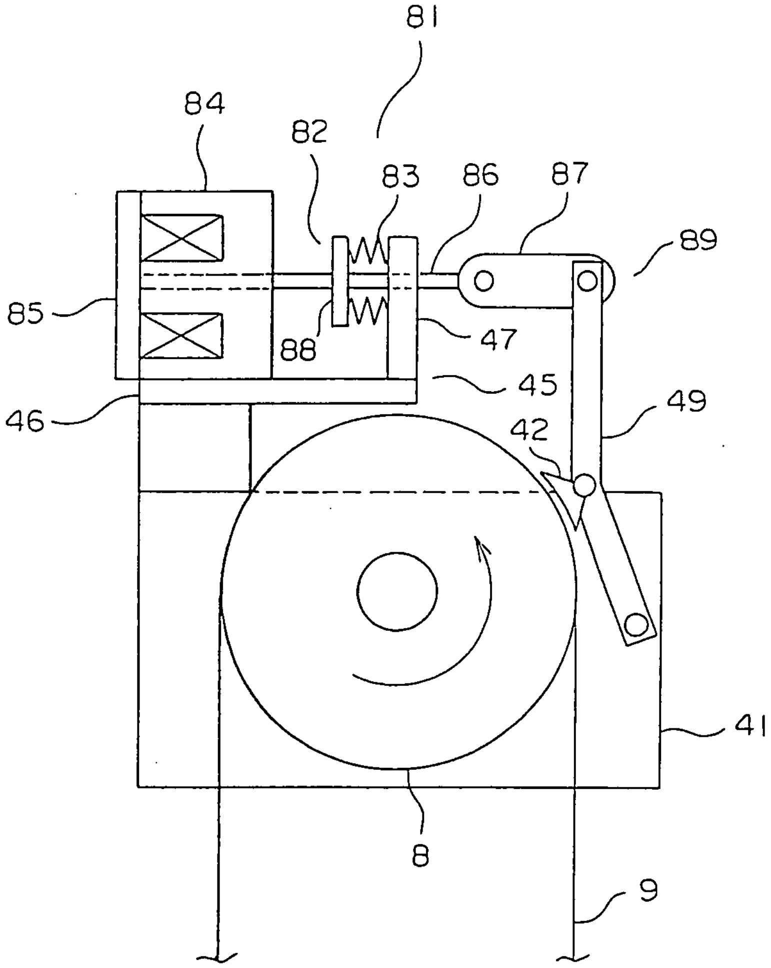

SPEED
POSITION
CONSTANT-SPEED SECTION
ACCELERATION/ DECELERATION SECTION
$X_{TERMINAL END PORTION}$
X
D_{SOS}
M
$V_{TR}(X)$
$V_{OS}(X)$
V_{BOS}

FIG. 10



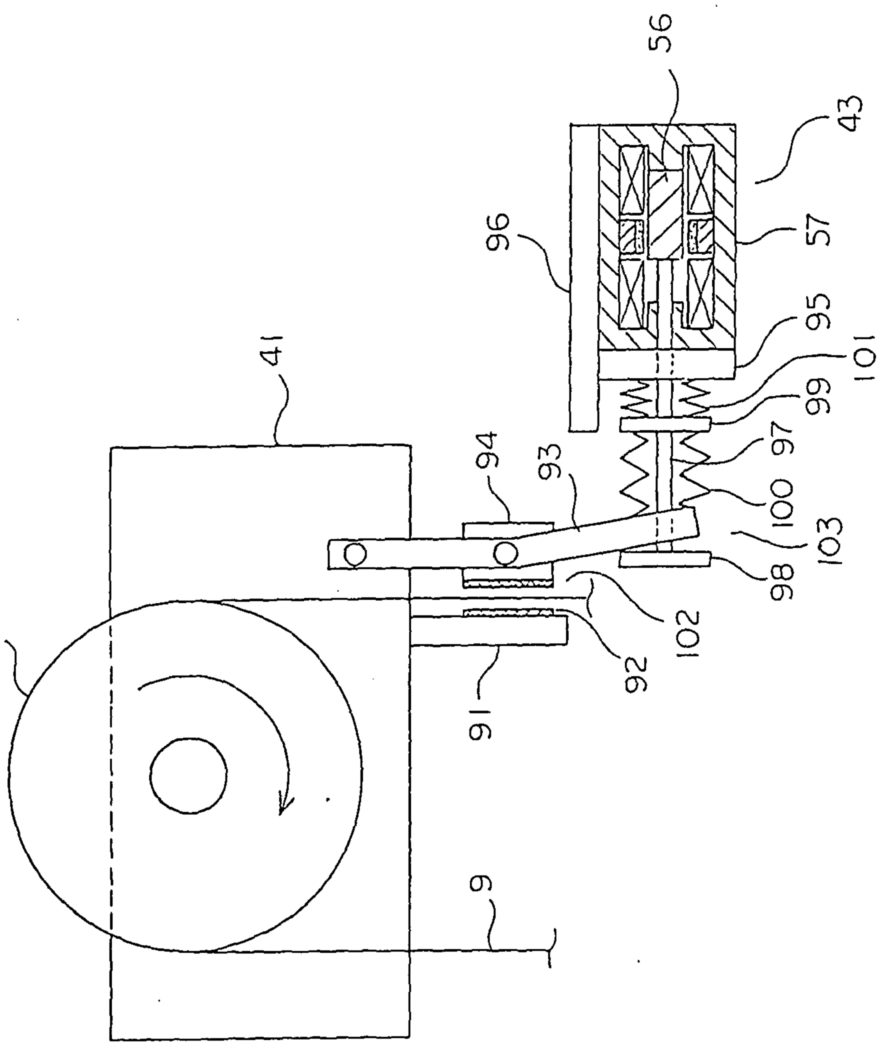


FIG. 11

FIG. 12

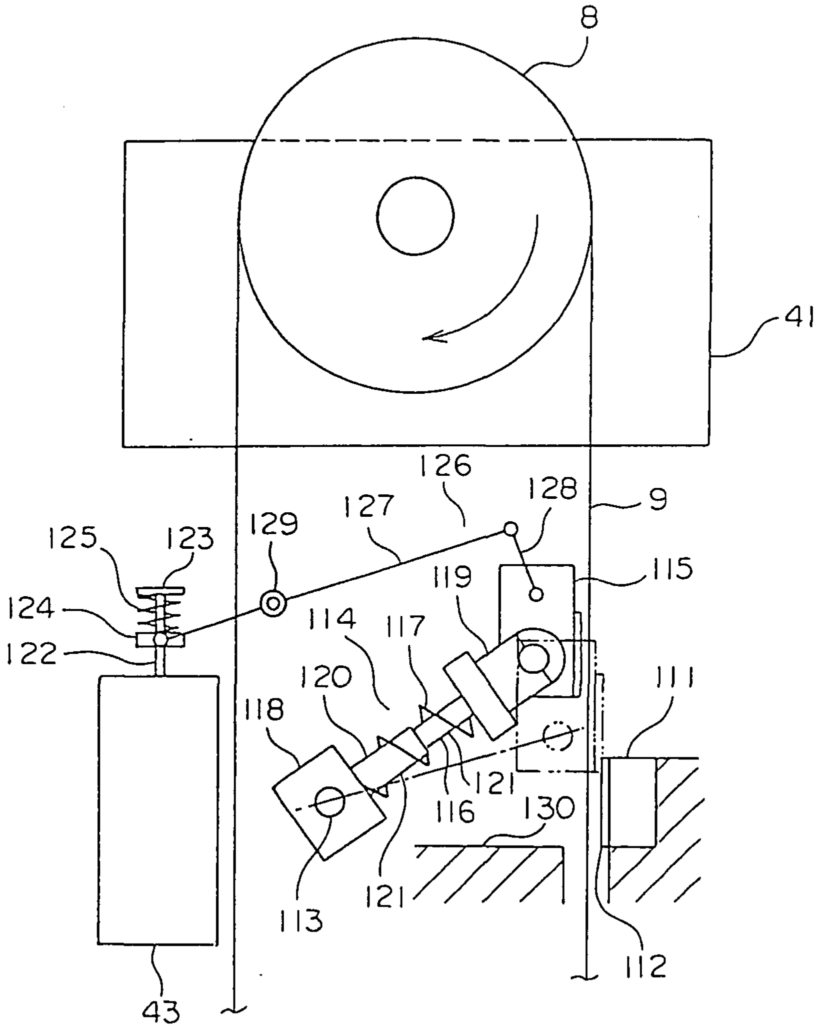

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FIG. 13

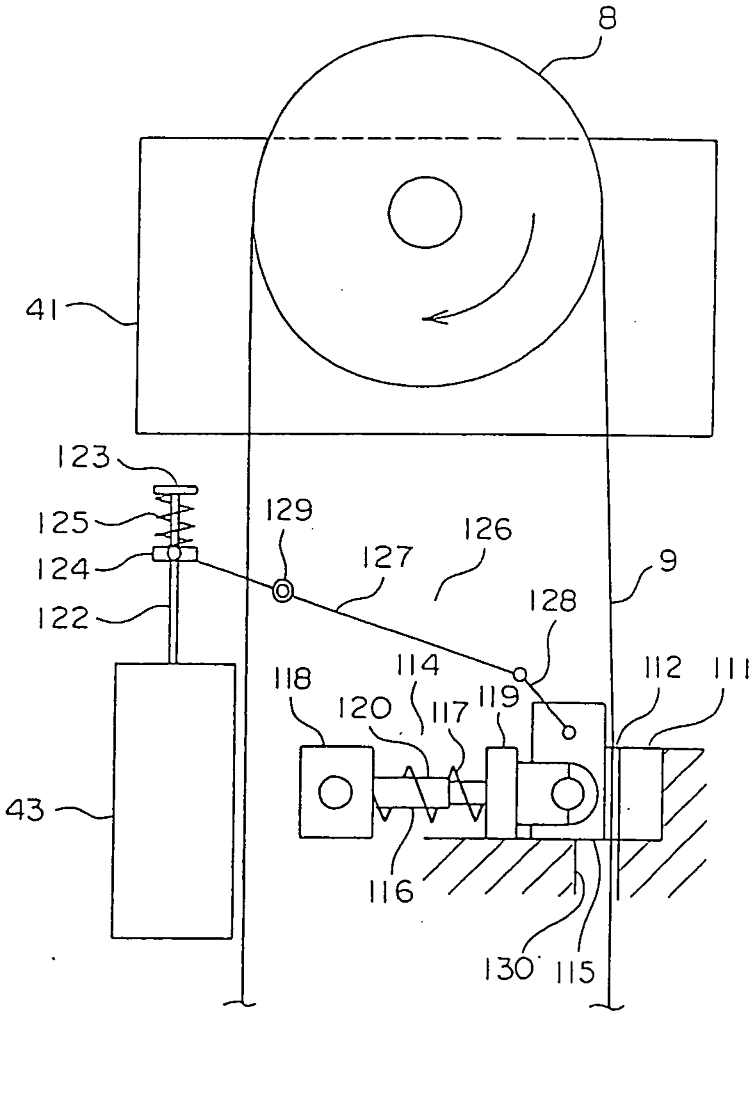
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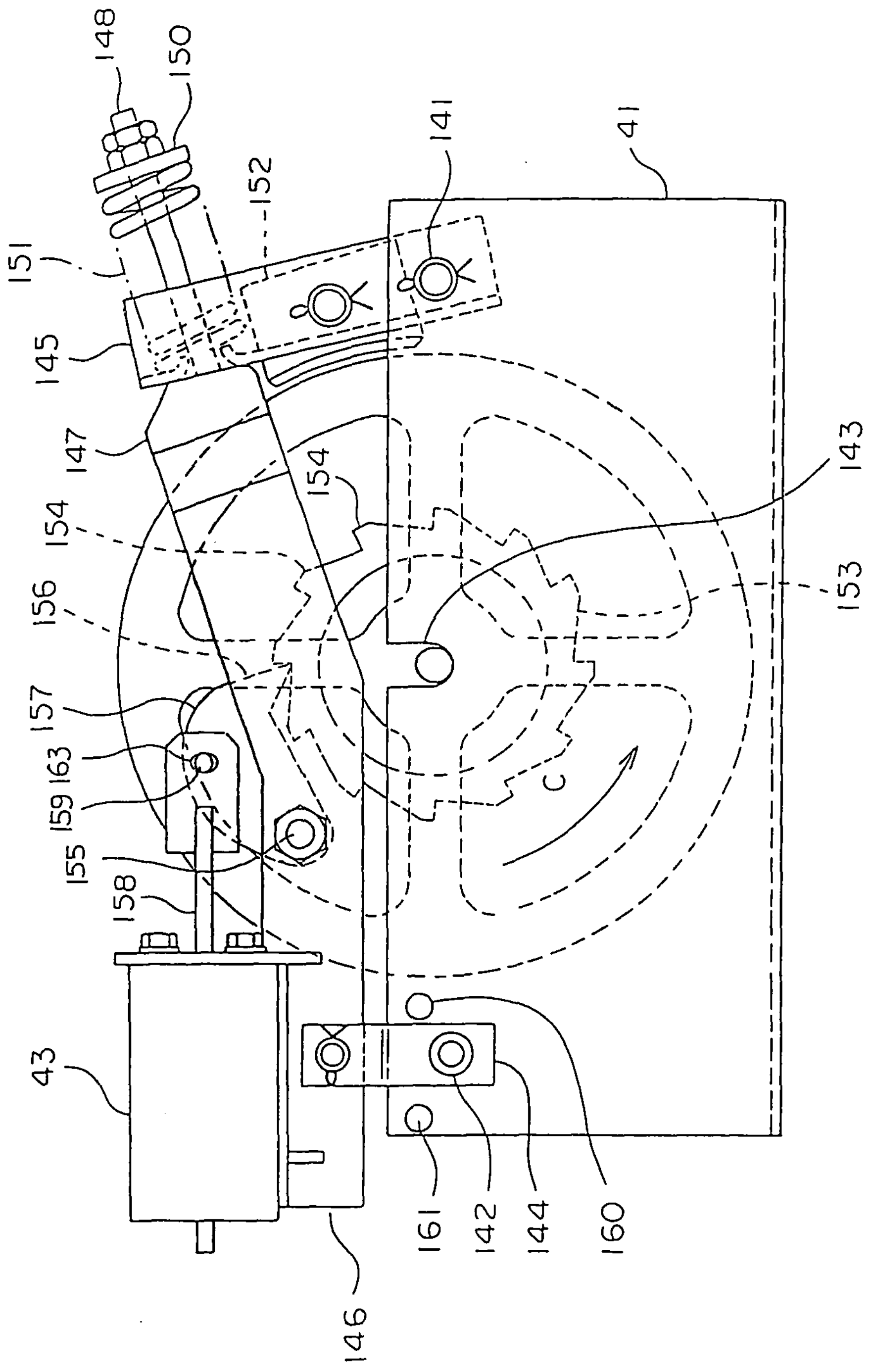
FIG. 14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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/006325

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl^{7} B66B5/06, 3/00

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} B66B3/00-5/28

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2005
Kokai Jitsuyo Shinan Koho	1971-2005	Toroku Jitsuyo Shinan Koho	1994-2005

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2001-354372 A (Mitsubishi Electric Corp.), 25 December, 2001 (25.12.01), Claims; Par. Nos. [0040] to [0041], [0047] to [0049]; Figs. 1 to 6 (Family: none)	1-5
A	JP 2003-104648 A (Mitsubishi Electric Corp.), 09 April, 2003 (09.04.03), Par. Nos. [0014] to [0016]; Figs. 1, 4 to 5 & WO 03/029123 A1 & EP 1431229 A1 & US 2004/0200671 A1	1-5

[X] Further documents are listed in the continuation of Box C.   [ ] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 January, 2005 (25.01.05)	08 February, 2005 (08.02.05)

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

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/006325

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 7-91002 B2 (Hitachi Building System Eng. & Service Co., Ltd.), 04 October, 1995 (04.10.95), Page 3, left column, line 30 to page 4, right column, line 21 & JP 2-33077 A	1-5
A	JP 10-324474 A (Mitsubishi Electric Corp.), 08 December, 1998 (08.12.98), Par. Nos. [0038] to [0042], [0049] to [0053]; Figs. 1 to 7, 11 to 13 (Family: none)	1-5
A	JP 11-130353 A (Toshiba Elevator and Building Systems Corp.), 18 May, 1999 (18.05.99), Abstract (Family: none)	1-5
A	JP 2003-54852 A (Toshiba Elevator and Building Systems Corp.), 26 February, 2003 (26.02.03), Abstract (Family: none)	1-5

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- JP 8324907 A **[0002]**
- JP 2001354372 A **[0003]**