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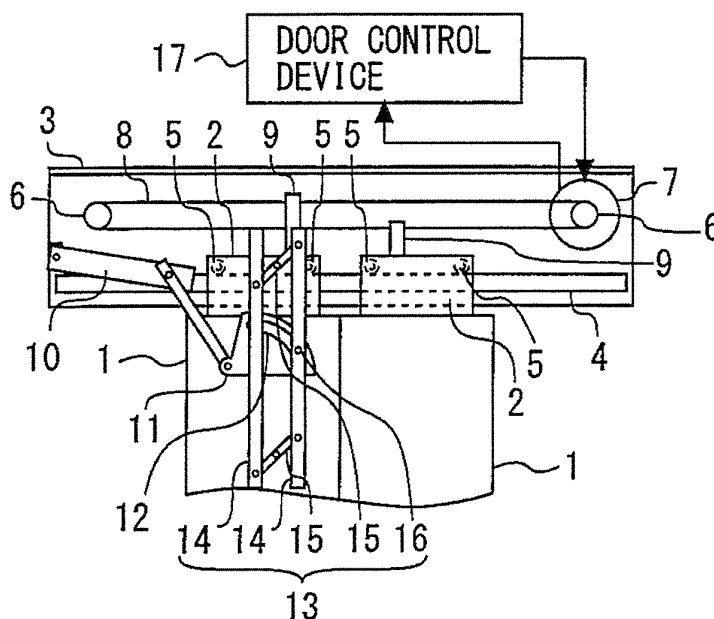
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(54) **ELEVATOR DOOR CONTROL DEVICE**

(57) There is provided an elevator door control device in which even in the case where the speeds of a car door and a hall door are different from each other, the followability of actual speed of the elevator door to the speed instruction value of the elevator door can be enhanced. For this purpose, the elevator door control device includes a generating part that generates a speed instruction value of the elevator door in which the car door and the hall door are coupled by engagement, a

speed controlling part that determines a motor instruction value given to a motor for driving the elevator door by using the mass of the elevator door so that the speed of the elevator door coincides with the speed instruction value, and an identifying part that identifies the mass of the elevator door at the time when the motor instruction value is determined for each opening/closing position of the elevator door based on the speeds of the car door and the hall door.

FIG. 1



Description

Technical Field

5 **[0001]** The present invention relates to an elevator door control device.

Background Art

10 **[0002]** An elevator door consists of a car door and a hall door. The car door and the hall door each are provided with an engagement device. The car door is mounted with a motor. When this motor is driven, the car door begins to open. Thereafter, the engagement device of car door moves relatively with respect to the car door. By this movement, the engagement devices of the car door and the hall door are engaged with each other. By this engagement, the car door and the hall door are coupled with each other. In this state, the car door and the hall door open.

15 **[0003]** As the above-described elevator door control device that controls the motion of elevator door, there has been proposed a door control device that is premised on an assumption that the speeds of the car door and the hall door coincide with each other (for example, refer to Patent Literatures 1 and 2).

Citation List

20 Patent Literature

[0004]

Patent Literature 1: Japanese Patent No. 3540509

25 Patent Literature 2: Japanese Patent Laid-Open No. 2009-155086

Summary of Invention

Technical Problem

30 **[0005]** For the elevator door, after the engagement devices of the car door and the hall door have been engaged with each other, in some cases, the engagement device of the car door moves relatively with respect to the car door. In this case, a difference in speed occurs between the car door and the hall door. If the motion of elevator door is controlled by using the door control device described in Patent Literature 1 or 2 in this state, the turbulence increases with increasing mass of hall door. As a result, the followability of actual speed of the elevator door to the speed instruction value of the elevator door decreases.

35 **[0006]** The present invention has been made to solve the above problem, and accordingly an object thereof is to provide an elevator door control device in which even in the case where the speeds of a car door and a hall door are different from each other, the followability of actual speed of the elevator door to the speed instruction value of the elevator door can be enhanced.

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Means for Solving the Problems

45 **[0007]** An elevator door control device of the present invention includes a generating part which generates a speed instruction value of an elevator door in which a car door and a hall door are coupled by engagement; a speed controlling part which determines a motor instruction value given to a motor for driving the elevator door by using the mass of the elevator door so that the speed of the elevator door coincides with the speed instruction value; and an identifying part which identifies the mass of the elevator door at the time when the motor instruction value is determined for each opening/closing position of the elevator door based on the speeds of the car door and the hall door.

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Advantageous Effect of Invention

55 **[0008]** According to the present invention, even in the case where the speeds of a car door and a hall door are different from each other, the followability of actual speed of the elevator door to the speed instruction value of the elevator door can be enhanced.

Brief Description of the Drawings

[0009]

Figure 1 is a front view of an elevator door to which the elevator door control device in accordance with a first embodiment of the present invention is applied.

Figure 2 is a block diagram of the elevator door control device in accordance with the first embodiment of the present invention.

Figure 3 is a diagram showing the followability of the actual speed of elevator door to the speed instruction value in the case where the mass of elevator door is not identified for each opening/closing position of elevator door.

Figure 4 is a diagram showing the followability of the actual speed of elevator door to the speed instruction value in the case where the mass of elevator door is identified for each opening/closing position of elevator door.

Figure 5 is a block diagram of an elevator door control device in accordance with the second embodiment of the present invention.

Description of Embodiments

[0010] Embodiments of the present invention will now be described with reference to the accompanying drawings. In the drawings, the same signs are applied to the same or equivalent elements, and duplicated explanation thereof is simplified or omitted as appropriate.

First embodiment

[0011] Figure 1 is a front view of an elevator door to which the elevator door control device in accordance with a first embodiment of the present invention is applied.

[0012] The elevator door shown in Figure 1 is the same as the elevator door described in Japanese Patent Laid-Open No. 2006-103882. In Figure 1, at an entrance (not shown) of an elevator car (not shown), door panels 1 are disposed as a car door. In Figure 1, the door panels 1 are positioned at the fully-closed position. At the upper end of each of the door panels 1, a hanging member 2 is provided.

[0013] In an upper edge portion of the entrance of car, a beam 3 is provided. The beam 3 is disposed so as to be horizontal in the lengthwise direction thereof. The beam 3 is provided with a guide rail 4. The guide rail 4 is disposed so as to be horizontal in the lengthwise direction thereof. On the guide rail 4, hanger rollers 5 are provided so as to be movable in the horizontal direction. The hanger rollers 5 are mounted on the hanging member 2.

[0014] At both sides of the beam 3, a pulley 6 is pivotally mounted. To one of the pulleys 6, a motor 7 is connected. Around the pulleys 6, a driving wire rope 8 is wound in an endless form in a state of being tensioned. To the lower side of the driving wire rope 8, the upper end of one of connecting members 9 is connected. The lower end of the one of the connecting members 9 is connected to one of the hanging members 2. To the upper side of the driving wire rope 8, the upper end of the other of connecting members 9 is connected. The lower end of the other of the connecting members 9 is connected to the other of the hanging members 2.

[0015] On one side of the beam 3, a link 10 is provided. One end of the link 10 is connected to one side end portion of the beam 3. The other end of the link 10 is arranged on the center side of the entrance of car. At the other end of the link 10, a cam 11 is provided. The cam 11 is provided with a cam groove 12.

[0016] On the door panel 1, an engagement device 13 is provided. The engagement device 13 is provided with a pair of vanes 14, a pair of parallel links 15, and a cam follower 16. The paired vanes 14 are disposed so as to be vertical in the lengthwise direction thereof. One of the parallel links 15 is connected to between the upper portions of the paired vanes 14. The other of the parallel links 15 is connected to between the lower portions of the paired vanes 14. The cam follower 16 is provided in the center of the vane 14 on the doorstep side. The cam follower 16 is guided by the cam groove 12.

[0017] At an entrance (not shown) of an elevator hall (not shown), door panels are disposed as a hall door. On the door panel of the hall door, an engagement device (not shown) is provided. The engagement device of the hall door consists of, for example, a hall-side roller.

[0018] Reference sign 17 denotes a door control device. The door control device 17 is provided above the car. The door control device 17 is connected to the motor 7. The door control device 17 has a function of controlling the electric current for driving the motor 7 so as to correspond to the speed instruction value of elevator.

[0019] When the elevator door is fully closed, the engagement device 13 of the car door and the engagement device of the hall door keep a predetermined space therebetween so as not to come into contact with each other. Thereby, when the car moves up and down in a shaft, the contact of the engagement device 13 of the car door with the engagement device of the hall door is avoided.

[0020] When the elevator door is opened in the state in which the car faces to the hall, the motor 7 is energized by the door control device 17. By this energization, one of the pulleys 6 is rotated. Following this rotation, the driving wire rope 8 moves. Following this movement, the connecting members 9 move to the door pocket direction.

Following this movement, the hanger rollers 5 move to the door pocket direction. Following this movement, the door panels 1 move toward the door pocket side so as to separate from each other.

[0021] Following the movement of the door panels 1, the link 10 operates. As the result of this operation, the cam 11 rotates. On account of this rotation, the cam follower 16 also moves. On account of this movement, the vanes 14 move in the direction such as to come close to each other. On account of this movement, the paired vanes 14 hold the engagement device of the hall door therebetween. As the result, the car door and the hall door are coupled with each other.

[0022] The car door and the hall door are accelerated immediately after the start of door opening. At this time, the engagement device of the hall door receives a load applied from the doorstop-side vane 14 toward the door pocket direction. As the result, the state in which the car door and the hall door are coupled is maintained. The car door and the hall door are decelerated immediately before full opening. At this time, the engagement device of the hall door receives a load applied from the door pocket-side vane 14 toward the door open direction. As the result, the state in which the car door and the hall door are coupled is maintained. Thereafter, the car door and the hall door are fully opened.

[0023] When the elevator door is closed, the motor 7 is energized by the door control device 17. By this energization, one of the pulleys 6 is rotated. Following this rotation, the driving wire rope 8 moves. Following this movement, the connecting members 9 move to the doorstop direction. Following this movement, the hanger rollers 5 move to the doorstop direction. Following this movement, the door panels 1 move toward the doorstop side so as to come close to each other.

[0024] The car door and the hall door are accelerated immediately after the start of door closing. At this time, the engagement device of the hall door receives a load applied from the door pocket-side vane 14 toward the doorstop direction. As the result, the state in which the car door and the hall door are coupled is maintained. The car door and the hall door are decelerated immediately before full closing. At this time, the engagement device of the hall door receives a load applied from the doorstop-side vane 14 toward the door pocket direction. As the result, the state in which the car door and the hall door are coupled is maintained. Thereafter, the car door and the hall door are fully closed.

[0025] The relative position of the vanes 14 with respect to the car door depends on the shape of the cam 11 and the shape of the cam groove 12. In Figure 1, the cam 11 and the cam groove 12 are formed so that the operation of the vanes 14 finishes before either of the vanes 14 comes into contact with the engagement device of the hall door when the car door is fully opened from the fully closed state.

[0026] In this case, before the engagement device 13 of the car door and the engagement device of the hall door engage with each other, the door control device 17 controls the electric current of the motor 7 based on the masses of the vanes 14, which are considerably smaller than the mass of the hall door and the mass of the car door. Thereafter, when the car door and the hall door are coupled with each other, the door control device 17 controls the electric current of the motor 7 on the assumption that the car door and the hall door are opened/closed at the same speed. Therefore, the mass parameter at the time when the electric current of the motor 7 is controlled need not be changed complicatedly.

[0027] However, for the elevator, the force for manually opening the door from the hall is restricted for the purpose of the rescue of passengers in the car. For example, according to EN rule (8.11 of EN81-1), in the case where the elevator door is unlocked in the state in which the motor 7 is not driven, it is necessary to configure the elevator so that the car door can be opened fully or partially by a manually door opening force of 300(N) or smaller from the hall door.

[0028] In this case, it is necessary to satisfy the condition of manual door opening from the hall considering the influence of a loss and the like caused by the friction between the cam follower 16 and the cam groove 12. Therefore, the shape of the cam 11 and the shape of the cam groove 12 cannot always be designed so that the movement of the vanes 14 finishes before the engagement device 13 of the car door and the engagement device of the hall door are engaged with each other.

[0029] That is, depending on the shape of the cam 11 and the shape of the cam groove 12, the vanes 14 sometimes move relatively with respect to the car door after the engagement device 13 of the car door and the engagement device of the hall door have been engaged with each other. In this case, a difference in speed occurs between the car door and the hall door. At this time, a delay in actual speed of the elevator occurs with respect to the speed instruction value of the door control device 17. As the result, the opening/closing time of elevator becomes long.

[0030] Accordingly, in this embodiment, the configuration is made such that at each elevator opening/closing position, the mass of elevator door is identified based on the speeds of the car door and the hall door. Thereby, even in the case where the speeds of the car door and the hall door are different from each other, the followability of actual speed of the elevator door to the speed instruction value is made high.

[0031] Next, the outline of a method for identifying the mass of elevator door is explained. In the case where the speeds of the car door and the hall door are different from each other, the driving force F_m of the driving wire rope 8 generated by the rotational driving of the motor 7 is expressed by Formula (1).

$$\begin{aligned}
 F_m &= M_1 v_1' + M_2 v_2' = M_1 v_1' + M_2 (p v_1)' \\
 &= M_1 v_1' + M_2 (p' v_1 + p v_1') \\
 &= [M_1 + M_2 (p' v_1 / v_1' + p)] v_1' \quad (1)
 \end{aligned}$$

[0032] Incidentally, M_1 is the total mass of the door panel 1 including the hanger rollers 5 and the hanging member 2 on the car side. M_2 is the total mass of the door panel including the hanger rollers and the hanging member on the hall side. v_1 is the speed of the car door. v_2 is the speed of the hall door. p is the relative speed ratio (v_2/v_1) of the hall door with respect to the car door. $'$ is the operator of time differentiation.

[0033] Therefore, by Formula (1), the equivalent mass of elevator door is identified as $M (= M_1 + M_2 (p' v_1 / v_1' + p))$.

[0034] At this time, the relative speed ratio p is calculated based on the displacement of the vanes 14 with respect to the position of the car door. That is, the relative speed ratio p is preset based on the shape of the cam 11 and the shape of the cam groove 12. Therefore, the relative speed ratio p is determined as a function depending on the opening/closing position of elevator door. That is, the relative speed ratio p may be a common parameter not relating to the floor.

[0035] The relationship among the rotation angle acceleration $a (= v_1' \times r, r: \text{pulley diameter of the pulley 6})$ of motor 7, the motor shaft converted inertia J of total mass of elevator door, the running resistance loss b of elevator door, and the generated torque τ ($iO \times Kt$, Kt : torque constant) of the motor 7 is expressed by Formula (2).

$$J a + b = \tau \quad (2)$$

[0036] Incidentally, Formula (2) holds in the case where the speeds of the car door and the hall door are equal to each other. In the case where a difference in speed occurs between the car door and the hall door, the following Formulas (3) to (5) hold.

[0037]

$$J_1 a_\alpha + J_2 p_\alpha a_\alpha + b = \tau_\alpha \quad (3)$$

$$J_1 a_\beta + J_2 p_\beta a_\beta + b = \tau_\beta \quad (4)$$

$$J_2 = (\tau_\alpha - \tau_\beta - J_1 a_\alpha + J_1 a_\beta) / (p_\alpha a_\alpha - p_\beta a_\beta) \quad (5)$$

[0038] Incidentally, J_i is the motor shaft converted inertia ($= Mr^2$). $i = 1$ corresponds to the car door, and $i = 2$ corresponds to the hall door. a_j is the angular acceleration of a motor shaft. τ_j is the generated torque of the motor 7. p_j is the relative speed ratio of the hall door with respect to the car door. $j = \alpha$ corresponds to a first position selected from the opening/closing positions of elevator, and $j = \beta$ corresponds to a second position selected from the opening/closing positions of elevator. For the sake of simplification, in Formula (1), it is assumed that $(p' v_1 / v_1') \ll p$ holds.

[0039] When the elevator doors move to the same direction, the running resistance loss b does not change greatly. Therefore, by taking the finite difference of data at a plurality of points in series of door opening operations or door closing operations as in Formulas (3) and (4), the term of the running resistance loss b has only to be deleted. At this time, if the position of elevator door in the vicinity of a position at which the angular acceleration or the torque of the motor 7 becomes at the peak in the positive-and-negative direction is selected, the influence of noise decreases relatively. Therefore, the identification accuracy of total mass of the elevator door is enhanced.

[0040] To identify the total mass of elevator door with high accuracy, the mass M_1 of the car door and the mass M_2 of the hall door has only to be separated. To identify the mass M_1 of the car door, only the car door has only to be opened/closed in the state in which the landing time of elevator is excluded. In the case where the performing at the normal operation time is difficult to do, the mass of the car door has only to be estimated based on the information on the size and material quality of car door. If the mass M_1 of the car door and the relative speed ratio p have been calculated,

the mass M_2 of the hall door is identified by using Formula (5).

[0041] Next, referring to Figure 2, explanation is given of the door control device 17 that uses the above-described method when the total mass of elevator door is identified.

[0042] Figure 2 is a block diagram of the elevator door control device in accordance with the first embodiment of the present invention.

[0043] In Figure 2, reference sign 18 denotes a current detector. The current detector 18 has a function of detecting the electric current supplied to the motor 7. Reference sign 19 denotes a sensor. The sensor 19 has a function of outputting the rotational position of the motor 7. Reference sign 20 denotes a speed instruction value generating part. The speed instruction value generating part 20 has a function of outputting a speed instruction value V^* , which serves as a target of opening/closing operation of the door panel 1, so that the elevator door is opened/closed within predetermined opening/closing time. Reference sign 21 denotes a speed calculating part. The speed calculating part 21 has a function of calculating the rotational speed of the motor 7 based on the output result of the sensor 19. The speed calculating part 21 also estimates, in some cases, the rotational speed of the motor 7 based on the detection result of the current detector 18.

[0044] Reference sign 22 denotes a speed controlling part. The speed controlling part 22 has a function of outputting a motor current instruction value I_q^* at fixed time intervals T so that the errors of the actual speed V of elevator door and the speed instruction value V^* are corrected. Thereby, the influence of turbulence such as running resistance caused by the clogging of dust, friction loss caused by the deformation of the door panel 1, or contact of the driven elevator door with a substance is excluded.

[0045] Specifically, the speed controlling part 22 is provided with a first feedforward controller (not shown), a second feedforward controller (not shown), and a feedback controller (not shown). The feedforward controllers each have a function of designating the followability of the actual speed V to the speed instruction value V^* . The feedback controller has a function of correcting the rotational error. Therefore, the speed controlling part 22 sets the following performance of the actual speed V to the speed instruction value V^* and the correcting performance of the rotational error independently.

[0046] The first feedforward controller uses the speed instruction value V^* as an input. The first feedforward controller is indicated by transfer function $C_f(s) = \omega_f / (s + \omega_f)$, in which, ω_f is a frequency designating the response characteristic of the output to the target value. This output is used as an input to the feedback controller.

[0047] The second feedforward controller uses the speed instruction value V^* as an input. The second feedforward controller is indicated by transfer function $P_m(s)^{-1} \times C_f(s)$, in which, $P_m(s)$ is a model for controlling the door equipment. Specifically, $P_m(s)$ is indicated by $P_m(s) = 1/Js$, in which, J is the motor shaft converted inertia of the total mass of elevator door. That is, the output of the second feedforward controller is a motor current instruction value $J \times V^* \times C_f(s)$ in the case where a turbulence-less and ideal state is assumed.

[0048] The feedback controller is identified by, for example, transfer function $C_b(s) = K_{sp} + K_{si}/s$. The proportional gain K_{sp} is $K_{sp} = J \times \omega_c / K_T$. K_T is the torque characteristic of the motor 7. ω_c is a control crossover frequency that designates the performance of error correction of the output to the target value. By selecting the motor shaft converted inertia J and a proper control crossover frequency ω_c that are set so that the integral gain K_{si} is $K_{si} \leq K_{sp} \times \omega_c / 5$, the correcting performance of rotational error is set so as to suppress the vibrations of the door panel 1.

[0049] The speed controlling part 22 thus configured outputs the sum of the output of the second feedforward controller and the output of the feedback controller as the motor current instruction value I_q^* .

[0050] Reference sign 23 denotes a current controlling part. The current controlling part 23 has a function of feeding back the current value detected by the current detector 18 and thereby controlling the value of current supplied to the motor 7 based on the motor current instruction value I_q^* . The output of the current controlling part 23 is inputted to the motor 7 via a PWM inverter. Based on this input, the motor 7 is driven. By this driving, the elevator door is opened or closed.

[0051] Reference sign 24 denotes a data storing part. The data storing part 24 stores the relative speed ratio p for each opening/closing position of elevator door. The data storing part 24 stores a parameter obtained by converting the total mass that is based on the size of equipment exerting an influence on the load of the motor 7 into the inertia J_0 by motor shaft conversion as an initial value for each floor. The equipment exerting an influence on the load of the motor 7 is the door equipment including the car door, the hall door, various sensors of the door panel 1, rotational systems of a speed reducer and the pulley 6, and the like.

[0052] Reference sign 25 denotes an identifying part. The identifying part 25 uses the speed or position information of elevator door, which is sent from the sensor 19, as one input, and uses the motor current instruction value I_q^* , which is the output of the speed controlling part 22, as the other input. In place of the motor current instruction value I_q^* , the current detection value of the current detector 18 is sometimes used. The identifying part 25 has a function of identifying the total mass of elevator door for each opening/closing position of elevator by using the above-described method based on the speed or position information of elevator door and the motor current instruction value I_q .

[0053] In the door control device 17 thus configured, the data storing part 24 stores an equivalent mass corresponding to the total mass of elevator door identified by the identifying part 25. For example, the data storing part 24 stores the total mass itself of elevator door that reflects the relative speed ratio p as the equivalent mass, or stores the equivalent

mass at the time when the relative speed ratio p is made equal to 1 as the reference. Based on this equivalent mass, the speed controlling part 22 outputs the motor current instruction value I_q^* for each opening/closing position of elevator door.

[0054] For example, concerning the feedback controller, the motor shaft converted inertia J is selected for each floor by using the total mass data of elevator door stored in the data storing part 24. Also, the proportional gain K_{sp} is sometimes set by using the relative speed ratio p .

[0055] However, the gain change of the feedback controller may be a cause for unstabilization caused by modeling error or the like. Therefore, it is desirable that the gain change of the feedback controller be kept within a fixed range.

[0056] In the case where the difference in total mass of elevator door or the change in the relative speed ratio p for each floor is small, even if a fixed value is used for the proportional gain K_{sp} , a fixed performance can be ensured.

[0057] The gain change of the feedforward controller does not exert an influence on the stability. Therefore, concerning the feedforward controller, the motor shaft converted inertia J may be selected for each floor by using the total mass data of elevator door stored in the data storing part 24.

[0058] In the case where the difference in total mass of elevator door or the change in the relative speed ratio p for each floor is small, even if a fixed value is used for the gain, a fixed performance can be ensured.

[0059] In particular, if the gain change of the feedback controller is not made, and only the gain change of the feedforward controller is made, the followability of the actual speed of elevator door to the speed instruction value V^* is enhanced while the stability is ensured.

[0060] Next, referring to Figures 3 and 4, explanation is given of the followability of the actual speed of elevator door to the speed instruction value V^* .

[0061] Figure 3 is a diagram showing the followability of the actual speed of elevator door to the speed instruction value in the case where the mass of elevator door is not identified for each opening/closing position of elevator door. Figure 4 is a diagram showing the followability of the actual speed of elevator door to the speed instruction value in the case where the mass of elevator door is identified for each opening/closing position of elevator door. In Figures 3 and 4, the abscissas represent time, and the ordinates represent the speed of elevator door.

[0062] As shown in Figure 3, in the case where the mass of elevator door is not identified for each opening/closing position of elevator door, immediately after the door opening start, an engagement low-speed section is formed. The speed instruction value V^* in the engagement low-speed section keeps a relatively small value. At the halfway point in the engagement low-speed section, the engagement device 13 of the car door and the engagement device of the hall door are engaged with each other.

[0063] After the engagement low-speed section, the speed instruction value V^* increases gradually. By the driving force of the motor 7, the car door and the hall door are moved in a coupled form. At this time, the speed of the car door does not follow the speed instruction value V^* . Thereafter, approximately when the speed instruction value V^* becomes at the maximum, the speed of the car door coincides with the speed instruction value V^* . Thereafter, the speed of the car door keeps in a state of coinciding with the speed instruction value V^* .

[0064] As shown in Figure 4, in the case where the mass of elevator door is identified for each opening/closing position of elevator door, immediately after the door opening start, an engagement low-speed section is formed. The speed instruction value V^* in the engagement low-speed section keeps a relatively small value. At the halfway point in the engagement low-speed section, the engagement device 13 of the car door and the engagement device of the hall door are engaged with each other.

[0065] After the engagement low-speed section, the speed instruction value V^* increases gradually. By the driving force of the motor 7, the car door and the hall door are moved in a coupled form. At this time, the speed of the car door follows the speed instruction value V^* . Thereafter, the speed of the car door keeps in a state of coinciding with the speed instruction value V^* .

[0066] If the mass of elevator door is identified for each opening/closing position of elevator door as described above, the timing at which the speed of the car door coincides with the speed instruction value V^* is moved forward. Therefore, the operation time of elevator is shortened.

[0067] According to the first embodiment explained above, the mass of elevator door at the time when the motor current instruction value I_q^* is determined is identified for each opening/closing position of elevator door. Specifically, the mass of elevator door is identified based on the relative speed ratio p for each opening/closing position of elevator door. Therefore, even if the speeds of the car door and the hall door are different from each other, the followability of the actual speed of elevator to the speed instruction value V^* of elevator door can be enhanced. This followability is maintained even in the case where the mass of the hall door is different at different floor.

[0068] The shapes of the engagement device 13 of the car door and the engagement device of the hall door need not be restricted to those in the first embodiment. For example, the configuration may be such that by moving the vanes 14 to the direction such as to increase the distance therebetween, the vanes 14 are brought into contact with the engagement device of the hall door, and the engagement device of the hall door is fixed.

Second embodiment

[0069] Figure 5 is a block diagram of an elevator door control device in accordance with the first embodiment of the present invention. The same signs are applied to elements that are the same as or equivalent to those in the first embodiment, and the explanation thereof is omitted.

[0070] The opening and closing of elevator door repeat acceleration and deceleration. When the acceleration and deceleration values are equal to each other, the driving force of the motor 7 increases with increasing total mass M of elevator door. The amount of the driving force of the motor 7 exerts an influence on the size and cost of the motor 7. Therefore, the performance of the motor 7 has a limitation.

[0071] In the case where the speeds of the car door and the hall door are different from each other, the relative speed ratio p exerts an influence on the equivalent total mass M of elevator door. Therefore, when the acceleration in the speed instruction value V^* becomes at the maximum in a region in which the relative speed ratio p is high, the motor 7 is required to have a torque higher than usual.

[0072] Accordingly, in the second embodiment, the speed instruction value V^* is inputted from the data storing part 24 to the speed instruction value generating part 20 so that the acceleration of the car door does not take the maximum value in the region in which the relative speed ratio p is high. The speed instruction value generating part 20 adjusts the speed instruction value V^* according to the relative speed ratio p so that the motor current instruction value I_q^* does not exceed the allowable value of the motor 7. As a result, the increase in necessary torque of the motor 7 is restrained.

[0073] When the elevator door is being closed, the energy and force are restricted to prevent a passenger from being held between the doors. In contrast, when the elevator door is being opened, the speed of the elevator door becomes relatively high. Thereby, the opening/closing time of elevator door is shortened. Therefore, when the elevator door is being opened, the acceleration and deceleration of elevator door tend to increase relatively. For this reason, it is important to estimate the necessary torque of the motor 7 at the time when the elevator door is being opened.

[0074] According to the second embodiment explained above, the speed instruction value V^* is adjusted according to the relative speed ratio p so that the motor current instruction value I_q^* does not exceed the allowable value of the motor 7. By this adjustment, the opening/closing positions of the elevator door at which the acceleration and deceleration of elevator door become at the maximum are adjusted. Therefore, the motor 7 having a low output torque can be used.

Industrial Applicability

[0075] As described above, the elevator door control device in accordance with the present invention can be used for an elevator in which even in the case where the speeds of a car door and a hall door are different from each other, the followability of actual speed of the elevator door to the speed instruction value of the elevator door is enhanced.

Description of symbols

[0076]

- 1 door panel
- 2 hanging member
- 3 beam
- 4 guide rail
- 5 hanger roller
- 6 pulley
- 7 motor
- 8 wire rope
- 9 member
- 10 link

- 11 cam
- 12 cam groove
- 5 13 engagement device
- 14 vane
- 15 parallel link
- 10 16 cam follower
- 17 door control device
- 15 18 current detector
- 19 sensor
- 20 speed instruction value generating part
- 20 21 speed calculating part
- 22 speed controlling part
- 25 23 current controlling part
- 24 data storing part
- 25 25 identifying part
- 30

Claims

- 35 1. An elevator door control device comprising:
 - a generating part which generates a speed instruction value of an elevator door in which a car door and a hall door are coupled by engagement;
 - a speed controlling part which determines a motor instruction value given to a motor for driving the elevator door by using the mass of the elevator door so that the speed of the elevator door coincides with the speed instruction value; and
 - 40 an identifying part which identifies the mass of the elevator door at the time when the motor instruction value is determined for each opening/closing position of the elevator door based on the speeds of the car door and the hall door.
- 45 2. The elevator door control device according to claim 1, wherein that
 - the elevator door control device further comprises a storing part which stores the speed ratio of the car door and the hall door for each opening/closing position of the elevator door, and
 - the identifying part identifies the mass of the elevator door for each opening/closing position of the elevator door by using the speed ratio.
- 50 3. The elevator door control device according to claim 1 or 2, wherein that
 - the generating part adjusts the speed instruction value according to the speed ratio so that the motor instruction value does not exceed the allowable value of the motor, and thereby the opening/closing positions of the elevator door at which the acceleration and deceleration of the elevator door become at the maximum are adjusted.
- 55 4. The elevator door control device according to any one of claims 1 to 3, wherein that
 - the speed controlling part is provided so that a feedforward function in which the performance in that the actual speed of elevator door follows the speed instruction value is set based on the mass of the elevator door and a

feedback function in which the performance for suppressing vibrations of the elevator door is set based on the mass of the elevator door are set independently of each other; and
 for the feedback function, the identifying part does not identify the mass of the elevator door based on the speeds of the car door and the hall door, and, for the feedforward function, the identifying part identifies the mass of the elevator door based on the speeds of the car door and the hall door.

Amended claims under Art. 19.1 PCT

1. An elevator door control device comprising:

a generating part which generates a speed instruction value of an elevator door in which a car door and a hall door are coupled by engagement;
 a speed controlling part which determines a motor instruction value given to a motor for driving the elevator door by using the mass of the elevator door so that the speed of the elevator door coincides with the speed instruction value; and
 an identifying part which identifies the mass of the elevator door at the time when the motor instruction value is determined for each opening/closing position of the elevator door based on the speeds of the car door and the hall door.

2. The elevator door control device according to claim 1, wherein that the elevator door control device further comprises a storing part which stores the speed ratio of the car door and the hall door for each opening/closing position of the elevator door, and the identifying part identifies the mass of the elevator door for each opening/closing position of the elevator door by using the speed ratio.

3. The elevator door control device according to claim 2, wherein that the generating part adjusts the speed instruction value according to the speed ratio so that the motor instruction value does not exceed the allowable value of the motor, and thereby the opening/closing positions of the elevator door at which the acceleration and deceleration of the elevator door become at the maximum are adjusted.

4. The elevator door control device according to any one of claims 1 to 3, wherein that the speed controlling part is provided so that a feedforward function in which the performance in that the actual speed of elevator door follows the speed instruction value is set based on the mass of the elevator door and a feedback function in which the performance for suppressing vibrations of the elevator door is set based on the mass of the elevator door are set independently of each other; and for the feedback function, the identifying part does not identify the mass of the elevator door based on the speeds of the car door and the hall door, and, for the feedforward function, the identifying part identifies the mass of the elevator door based on the speeds of the car door and the hall door.

FIG. 1

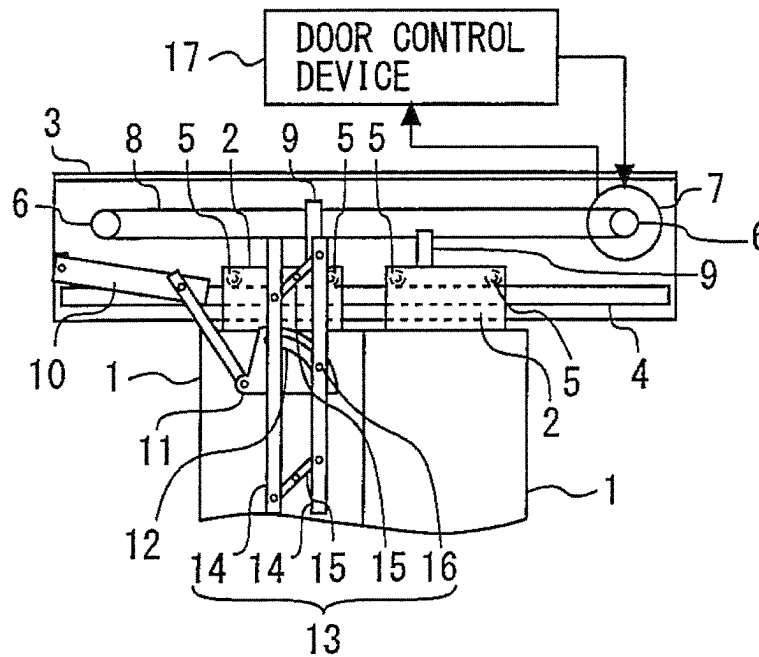


FIG. 2

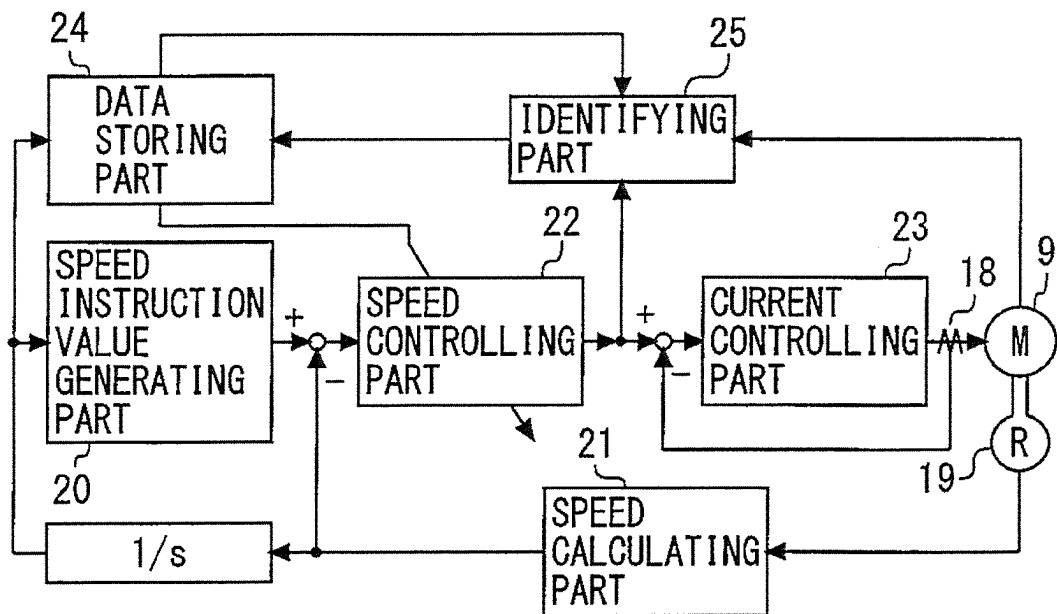


FIG. 3

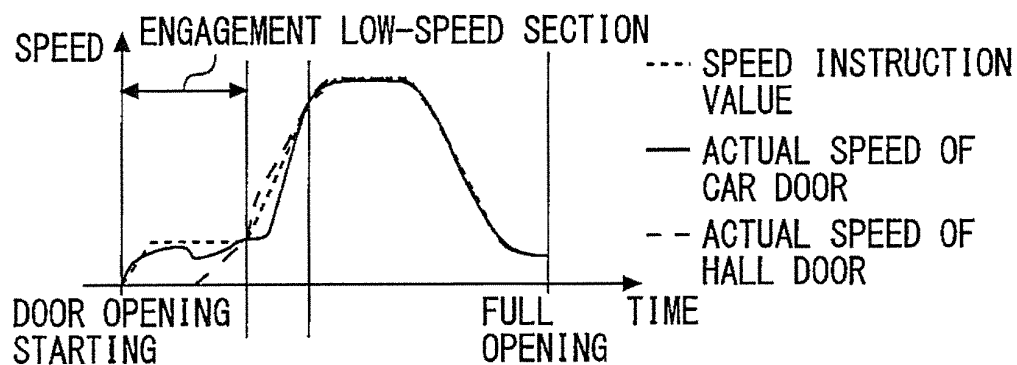


FIG. 4

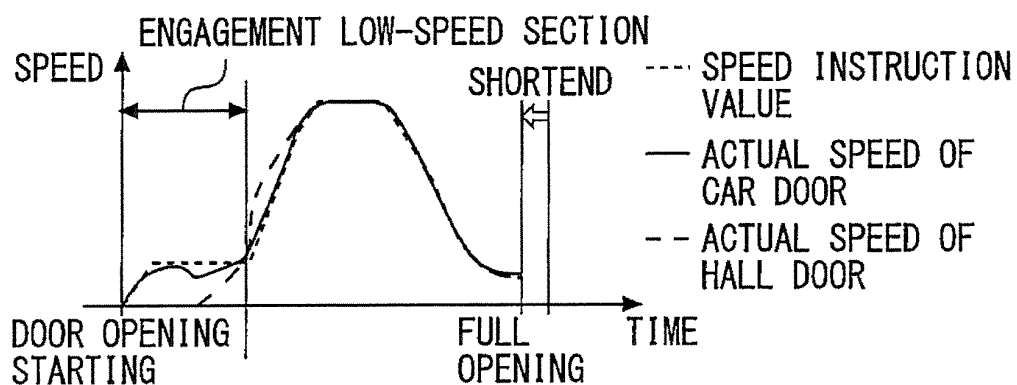
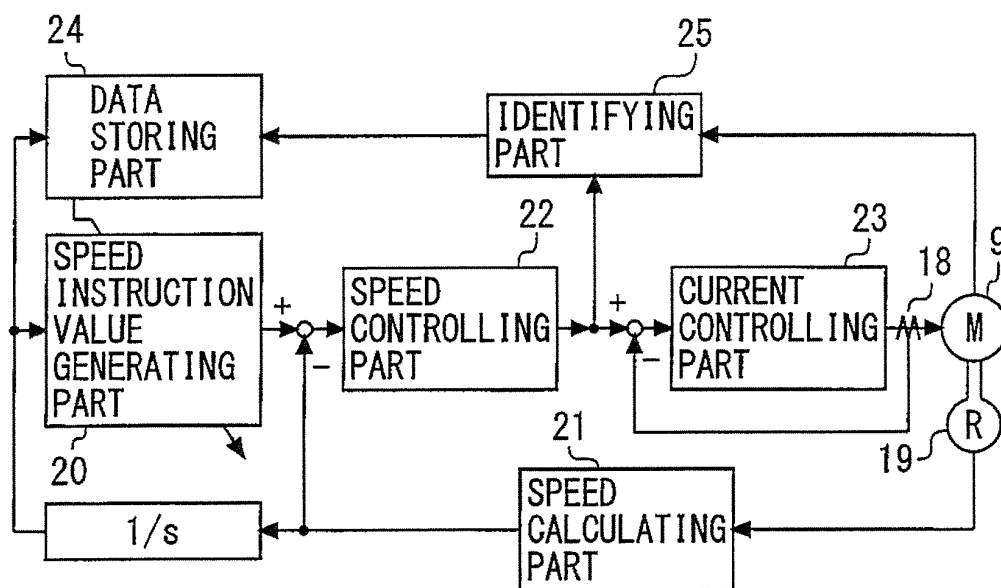


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/056788

A. CLASSIFICATION OF SUBJECT MATTER

B66B13/14 (2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B66B13/14

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2011
Kokai Jitsuyo Shinan Koho	1971-2011	Toroku Jitsuyo Shinan Koho	1994-2011

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	WO 2011/027450 A1 (Mitsubishi Electric Corp.), 10 March 2011 (10.03.2011), paragraphs [0016] to [0047] (Family: none)	1 2-4
Y A	JP 9-272681 A (Hitachi, Ltd.), 21 October 1997 (21.10.1997), paragraphs [0020] to [0022]; fig. 12 (Family: none)	1 2-4
A	WO 2009/060519 A1 (Mitsubishi Electric Corp.), 14 May 2009 (14.05.2009), paragraphs [0011] to [0019] & CN 101687614 A	1-4

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

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Date of the actual completion of the international search
25 April, 2011 (25.04.11)Date of mailing of the international search report
10 May, 2011 (10.05.11)Name and mailing address of the ISA/
Japanese Patent Office

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/056788

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 2002-302369 A (Mitsubishi Electric Corp.), 18 October 2002 (18.10.2002), paragraph [0029] (Family: none)	1-4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3540509 B [0004]
- JP 2009155086 A [0004]
- JP 2006103882 A [0012]