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(54) **CONTROL DEVICE OF ELEVATOR**

(57) Provided is an elevator control system in which an elevator which has a speed controller, which generates a torque command value from a speed command value and a speed signal, and causes a car and a counter weight to be ascend and descend by controlling an electric motor by use of a power converter on the basis of the torque command value. In this elevator control system, after a prescribed time during which the elevator releases a brake, a torque command on startup is held, and speed patterns which determine the jerk, accelerated and decelerated speeds, and rated speed of the car are changed according to the torque command. In an elevator which is provided with a load weighing device which detects an in-car load and outputs a load weighing signal, and in which unbalanced loads on the car side and on the counter weight side are calculated on the basis of the load weighing signal and the torque command value is corrected on the basis of the unbalanced loads, speed patterns which determine the jerk, accelerated and decelerated speeds, and rated speed of the car are changed according to the torque command.

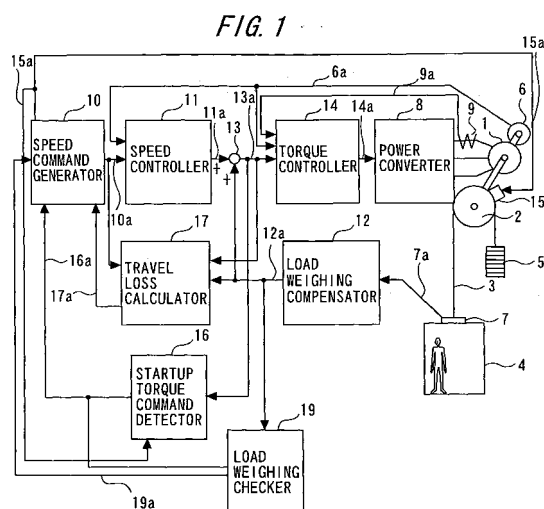
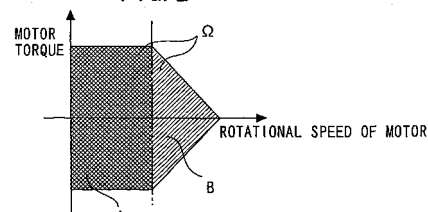


FIG. 2



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Description

Technical Field

5 **[0001]** The present invention relates to an elevator control system which adjusts acceleration and maximum speed by changing speed patterns given to motors of an elevator and the like according to loads, and the like.

Background Art

10 **[0002]** A technique related to a conventional elevator control system will be described by referring to Figure 10. Figure 10 is a diagram which shows the relationship between the output frequency (speed: hereinafter "frequency" has the same meaning as "speed") and torque of a conventional elevator control system. In Figure 10, f_0 represents a basic frequency (rated speed), T_{max} a maximum output torque value, T_x a torque value necessary under a first load, T_y a torque value necessary under a second load (second load < first load), f_x a maximum output frequency capable of being
15 outputted under a first load, and f_y a maximum output frequency capable of being outputted under a second load.

[0003] In a frequency range of not less than a basic frequency f_0 , a torque obtained in a frequency zone higher than a frequency f_x is smaller than a torque value T_x necessary for, for example, a first load and, therefore, a maximum output frequency for the first load (necessary torque value T_x) becomes not more than the frequency f_x . Also, because a torque obtained in a frequency zone higher than the a frequency f_y is smaller than a torque value T_y necessary for a second
20 load, a maximum output frequency for the second load (necessary torque value T_y) becomes not more than the frequency f_y .

[0004] In view of the foregoing, in order to obtain a sufficient torque for various loads large and small, it has hitherto been a general practice to rotate a motor by setting the operating frequency of the motor to a frequency of not more than an output frequency which enables a torque for a supposed maximum load to be obtained.

25 **[0005]** In an elevator control system as described above, a maximum frequency can be set at a high value in the case of a small load, whereas in the case of a large load, a sufficient torque cannot be obtained unless a maximum output frequency is set at a low value, and hence an ascent becomes impossible in an elevator and the like, thereby posing a problem. Therefore, it was necessary to perform operation by setting a maximum output frequency at a frequency at which a sufficient torque can be obtained in the case of a maximum load.

30 **[0006]** That is, in the example shown in Figure 10, a maximum output frequency is set at f_x and even in the case of a small load, the maximum output frequency remained to be f_x . For this reason, because of a low maximum output frequency in the case of a small load, acceleration requires time and operating time cannot be shortened, thereby posing the problem that efficiency is low.

[0007] To solve this problem, for example, in the Japanese Patent Laid-Open No. 3-56308, for a frequency which is not less than a rated frequency, a power value is found from voltage and current and this power value is compared with a power value at a rated frequency, whereby a speed setting is outputted in a variable speed device. In a control system disclosed in the Japanese Patent Laid-Open No. 8-107699, a variable speed device which has an inverter section which converts a DC current into an AC current of variable frequency and variable voltage is provided with a voltage detection circuit which detects a DC bus bar voltage on the entry side of the inverter section, a current detection circuit which
35 detects the current of each phase on the output side of the inverter section, and a control circuit which automatically judges the magnitude of a load connected to the inverter section by using the detected DC bus bar voltage and the detected current of each phase and determines and outputs a maximum output frequency.

[0008] In conventional elevator control systems, maximum speeds were changed according to loads in order to shorten operating time. However, operating time is not always shortened by raising maximum speeds alone, and it might be
40 thought that in the case of a short moving distance, operating time becomes short when an acceleration, rather than maximum speeds, is raised. Therefore, operating time becomes long depending on moving distance only by changing maximum speeds according to loads, thereby posing a problem.

[0009] Also, in the case of an elevator, the detection of loads is performed by use of a load weighing device provided in a car. However, because detection errors are included in loads detected by the load weighing device, a torque becomes
45 insufficient if a maximum speed is raised on the basis of the loads detected by the load weighing device, thereby posing a problem.

[0010] The present invention has been made to solve these problems as described above and has as its object the provision of an elevator control system which can shorten operating time by changing maximum speeds and acceleration according to loads and moving distances. Also, the invention has as its another object the provision of an elevator control
50 system which can detect loads with high accuracy.

Disclosure of the Invention

[0011] An elevator control system related to the present invention is characterized in that in an elevator which has a speed controller, which generates a torque command value from a speed command value and a speed signal, and causes a car and a counter weight to be ascend and descend by controlling an electric motor by use of a power converter on the basis of the torque command value, after a prescribed time during which the elevator releases a brake, a torque command on startup is held, and speed patterns which determine the jerk, accelerated and decelerated speeds, and rated speed of the car are changed according to the torque command.

[0012] In an elevator which has a speed controller, which generates a torque command value from a speed command value and a speed signal, and causes a car and a counter weight to be ascend and descend by controlling an electric motor by use of a power converter on the basis of the torque command value, and which elevator is provided with a load weighing device which detects an in-car load and outputs a load weighing signal, unbalanced loads on the car side and on the counter weight side being calculated on the basis of the load weighing signal, and the torque command value being corrected on the basis of the unbalanced loads, after a prescribed time during which the elevator releases a brake, a torque command on startup is held, and speed patterns which determine the jerk, accelerated and decelerated speeds, and rated speed of the car are changed according to the torque command.

[0013] The speed patterns have predetermined standard values, and the accelerated and decelerated speeds and rated speed are increased from the standard values at prescribed increase rates to values limited by a maximum output of the power converter and a maximum output of the electric motor.

[0014] The speed patterns which determine the jerk, accelerated and decelerated speeds, and rated speed of the car are changed by correcting the torque command on startup of the elevator in terms of travel loss on the basis of a torque command during traveling in the last travel.

[0015] To detect a load, the number of passengers in the car is judged from an image photographed by a camera within the car of the elevator, and speed patterns which determine the jerk, accelerated and decelerated speeds, and rated speed of the car are changed on the basis of a camera signal which outputs results of the judgment.

[0016] In an elevator which has a speed controller, which generates a torque command value from a speed command value and a speed signal, and causes a car and a counter weight to be ascend and descend by controlling an electric motor on the basis of the torque command value, and which elevator is provided with a load weighing device which detects an in-car load and outputs a load weighing signal, unbalanced loads on the car side and on the counter weight side being calculated on the basis of the load weighing signal, and the torque command value being corrected on the basis of the unbalanced loads, there is provided a speed pattern determining device which judges the number of passengers in the car from the load weighing signal, or the torque signal on startup of the elevator, or an image photographed by a camera within the car of the elevator, and which device selects, from tables of acceleration and speed, speed patterns which determine the jerk, accelerated and decelerated speeds, and rated speed of the car according to a camera signal which outputs results of the judgment, or according to combinations of these data, and increase rates of the acceleration and speed are changed according to a moving distance to a target floor. The longer a moving distance to a target floor, the more dominant an increase of a maximum speed will be made.

[0017] In an elevator provided with a load weighing device which detects an in-car load and outputs a load weighing signal, speed patterns which determine the jerk, accelerated and decelerated speeds and rated speed of the car being changed according to the load weighing signal, there is provided a load weighing check device which stops the changing of speed patterns, when a difference in the load weighing signal and the torque signal on startup exceeds a prescribed value, and which returns the speed patterns to predetermined standard values.

Brief Description of the Drawings

[0018] Figure 1 is a system configuration diagram which shows an elevator control system in the first embodiment of the present invention; Figure 2 is a characteristic diagram which shows the relationship between the torque generated in a motor and the rotational speed of the motor in the first embodiment of the present invention; Figure 3 is a schematic diagram for deriving a mechanical system model of an elevator in the first embodiment of the present invention; Figure 4 is a characteristic diagram which shows the relationship between car speed patterns and motor torque patterns in the first embodiment of the present invention; Figure 5 is a flowchart which shows the procedure for calculating car speed patterns in the first embodiment of the present invention; Figure 6 is a diagram which shows speed and accelerated and decelerated speed tables in the first embodiment of the present invention; Figure 7 is a diagram which shows other different speed and accelerated and decelerated speed tables; Figure 8 is a system configuration diagram which shows an elevator control system in the second embodiment of the present invention; Figure 9 is a characteristic diagram which shows the relationship between torques capable of being outputted by a motor and speed ranges in the fourth embodiment of the present invention; and Figure 10 is a characteristic diagram which shows the relationship between output frequency and torque in a conventional elevator control system.

Best Mode for Carrying Out the Invention

[0019] The first embodiment of the present invention will be described below on the basis of the drawings.

[0020] Figure 1 is a system configuration diagram which shows an elevator control system in the first embodiment of the present invention. In Figure 1, a main rope 3 is wound on a driving sheave 2 of a traction machine which is driven by a hoisting motor 1, and a car 4 and a counter weight 5 are each connected to both ends of the main rope 3. A speed detector 6, which is connected to the hoisting motor 1, outputs a speed signal 6a corresponding to the rotational speed of the motor 1. A load weighing device 7, which is provided in the car 4, detects an in-car load and outputs a load weighing signal 7a. A power converter 8 supplies a power source which drives the motor 1. A current detector 9 detects a current of the motor 1 and outputs a current signal 9a. A speed command generator 10 generates a speed command value 10a of the elevator. A speed controller 11, which is connected to the speed command generator 10 and the speed detector 6, outputs a first torque command value 11a using the speed command value 10a and the speed signal 6a as inputs. A load weighing compensator 12, which is connected to the load weighing device 7, outputs a torque compensation signal 12a using the load weighing signal 7a as an input. An adder 13, which is connected to the speed controller 11 and the load weighing compensator 12, outputs a second torque command value 13a. A torque controller 14 is connected to the adder 13, the speed detector 6 and the current detector 9, and the torque controller 14 outputs its output 14a. A brake 15, which holds still the driving sheave 2 of the traction machine, is released on the basis of a startup command 15a from the speed command generator 10. On the basis of the startup command 15a from the speed command generator 10, a startup torque command detector 16 holds a torque command on startup after a prescribed time during which the elevator releases the brake 15. On the basis of the speed command value 10a, a travel loss calculator 17 calculates a travel loss 17a during elevator traveling by deducting the torque compensation signal 12a from the load weighing compensator 12 from the second torque command value 13a during traveling at a rated speed or a constant speed. A load weighing checker 19 makes a comparison between the torque command 16a on startup detected by the startup torque command detector 16 and the torque compensation signal 12a from the load weighing compensator 12 and, in case this value exceeds a prescribed value, the weighing checker judges that a detection error of the load weighing device 7 is large, and outputs an abnormal signal 19a in the speed command generator 10.

[0021] Next, the operation of the elevator control system constructed as given above will be described.

[0022] When a passenger gets into the car 4, an in-car load is detected by the load weighing device 7 and a load weighing signal 7a is outputted. The load weighing compensator 12 calculates a difference between the weight on the car 4 side and the weight on the counter weight 5 side, i.e., an unbalanced weight and calculates a torque compensation signal 12a on the basis of this unbalanced weight. This torque compensation signal 12a corresponds to a motor torque for balancing with the unbalanced load.

[0023] After the startup of the car 4, the speed controller 11 outputs a first torque command value 11a on the basis of a speed command value 10a and a speed signal 6a. Usually, PI calculation by a difference between the speed command value 10a and the signal speed signal 6a is used as speed control calculation. A first torque command value 11a is added to a torque compensation signal 12a in the adder 13 and becomes a second torque command value 13a. The torque controller 14 calculates an output 14a from the second torque command value 13a, the speed signal 6a and current signal 9a, and controls the torque of the hoisting motor 1 via the power converter 8. As a result of this, the car 4 and the counter weight 5 ascend and descend.

[0024] On startup of the car 4, the brake 15 of the driving sheave 2 of the traction machine is released on the basis of a startup command 15a from the speed command generator 10. The startup torque command detector 16 holds a torque command on startup after a prescribed time during which the elevator releases the brake 15. Furthermore, by correcting a travel loss 17a during elevator traveling calculated by the travel loss calculator 17, a balance torque during traveling at a constant speed is calculated. Although an unbalanced torque generated by a mass difference between the car 4 and the counter weight 5 in a balanced torque may be replaced with the torque compensation signal 12a outputted from the load weighing compensator 12, detection errors are included in loads detected by the load weighing device 7. Therefore, results of high accuracy are obtained by calculating a balanced torque by use of a torque command after the speed controller 11 performs control for holding still after startup.

[0025] Next, the procedure until the generation of speed patterns will be described with reference to Figures 2 to 5. Figure 2 is a characteristic diagram which shows the relationship between the torque generated in a motor and the rotational speed of the motor. Figure 3 is a schematic diagram for deriving a mechanical system model of an elevator, which shows the relationship among the hoisting motor 1, the driving sheave 2 of the traction machine, the car 4 and the counter weight 5. The lower part of Figure 4 shows a motor torque pattern, and the upper part of the figure shows a car speed pattern at this time. Figure 5 is a flowchart which shows the calculation procedure for generating car speed patterns.

[0026] In Figure 2, the hoisting motor 1 can operate in a region of shaded portion enclosed on the lines of maximum output value, which changes depending on the motor torque axis and the rotational speed of the motor, and a region containing the boundary. It is necessary only that the regions be a convex set. However, even when they are not a

convex set, it is enough to perform approximation in order to ensure that the operating regions become a convex set. The regions of positive torque shows a power running state and the regions of negative torque shows a regenerative state. These regions are represented by Ω . The region A is a rated travel region in which traveling is possible at a rated speed and a standard accelerated and decelerated speeds in cases ranging from a case where there is no passenger in the car 4 to a maximum load. The region B is a region in which a rated speed, a standard acceleration, variable accelerated and decelerated speeds, and a variable speed are possible in a case where there is a passenger in the car 4 and in a small unbalanced state of the counter weight 5, i.e., when the motor torque is a light load.

[0027] In Figure 3, T_m represents a motor torque, T_1 a travel loss torque, J the moment of inertia, r the radius of the traction machine, m_1 the mass of the counter weight, m_2 the mass of the car, α a car acceleration, and ω the rotational speed of the traction machine. Furthermore, g represents a gravity acceleration. By deriving a motion equation for the construction of Figure 3, a relational expression of a motor torque and a car acceleration, an unbalanced torque and a travel loss torque is obtained as follows:

$$T_m = \{2J/r + r(m_1 + m_2)/2\}\alpha - \frac{r}{2}(m_1 - m_2)g + T_1 \quad \cdots (1)$$

[0028] Incidentally, in the construction of Figure 3, a relational expression of car acceleration and motor torque is given by Eq. (1). However, other constructions may be adopted so long as they ensure that the relationship between the two can be described by a linear function. Next, on the assumption that the rotational speed of the motor is equal to the rotational speed of the traction machine and if v represents the car speed, the car speed can be calculated from the rotational speed of the motor as follows:

$$v = r \omega \quad \cdots (2)$$

[0029] Hence, Figure 2 can be transformed to a figure which shows the relationship between motor torque and car speed. Incidentally, it was assumed that the rotational speed of the motor is equal to the rotational speed of the traction machine. However, if a transformation ensures that the relationship between the two can be described by a linear function, it is not always necessary to use Eq. (2) above. For example, the present invention can be applied also to a case where a speed reducer or the like is used.

[0030] In Figure 4, the car speed pattern in the upper part of the figure is calculated with respect to the torque pattern in the lower part by Eq. (1) above and an integral value of the equation. Also, in Figure 4, t_0 to t_7 each represent a time, Δt_1 to Δt_7 an interval of time, v_0 to v_7 a car speed for each time, and t_{m0} to t_{m7} a motor torque for each time. In this figure, $T_{m0} = T_{m3} = T_{m4} = T_{m7} = T_{M0}$; $T_{m1} = T_{m2} = T_{M1}$; and $T_{m5} = T_{m6} = T_{M2}$. Also, $v_0 = 0$, $t_0 = 0$.

[0031] In Figure 4, traveling with a constant jerk value (with a constant value of accelerated speed, i.e., rate of change of car acceleration) is performed in the intervals of time Δt_1 , Δt_3 , Δt_5 , Δt_7 , traveling with a constant acceleration is performed in the intervals of time Δt_2 and Δt_6 , and traveling with a constant speed is performed in the interval of time Δt_4 . By substituting $\alpha = 0$ in Eq. (1) above, a balanced torque T_{M0} can be calculated as in Eq. (3) below:

$$T_{M0} = -r(m_1 - m_2)g/2 + T_1 \quad \cdots (3)$$

[0032] How to select a speed pattern in the speed command generator 10 in the first embodiment will be described by using Figure 5.

[0033] In Figure 5, in the processing for setting a destination floor in Step S21, for a destination floor set by a passenger in the car, in the hall or the like, the travel distance L of the car or the number of floors to be traveled is set on the basis of the floor at which the car stops next. Next, in the processing for detecting a balanced torque in Step S22, a balanced torque is calculated by adding the torque command 16a on startup detected by the startup torque command detector 16 and the travel loss 17a during elevator travel calculated by the travel loss calculator 17. Next, in the processing for setting speed and accelerated and decelerated speeds in Step S23, tables of speeds, accelerated and decelerated speeds are selected according to the travel distance L of the car or the number of floors to be traveled set in Step S21 and the balanced torque calculated in Step S22. Next, in the processing for generating speed patterns in Step S24, the

speed pattern shown in Figure 4 is generated on the basis of the tables of speeds, accelerated and decelerated speeds selected in Step S23.

[0034] For torque limiting conditions, it is necessary that the speed pattern and torque pattern of Figure 4 be limited within the operating range of the motor. Therefore, on the basis of Eq. (1), it is necessary to prepare beforehand tables of speeds, accelerated and decelerated speeds as shown in Figure 6 in order to ensure that the motor torque is limited within the operating range of the motor when traveling is performed in a set speed pattern and accelerated and decelerated speed patterns according to a motor torque on startup.

[0035] In this first embodiment, there are available, as travel patterns, multiple tables of speeds, accelerated and decelerated speeds corresponding to a balanced torque or an in-car loaded weight (expressed in the ratio to a rating), operating direction, etc. as shown in Figure 6. The elevator control system selects a speed, accelerated and decelerated speeds corresponding to a motor torque on startup and the operating direction from selected tables, and performs the operation of the elevator according to the selected speed, accelerated and decelerated speeds. The above-described multiple tables of speeds, accelerated and decelerated speeds can be set as follows, for example.

[0036] The table E of speeds, accelerated and decelerated speeds of Figure 6 is set in consideration of the moving distance L of the car for a tradeoff between car speeds and accelerated and decelerated speed of the car. In this case, a table to be used is selected by considering how many meters the floor to floor distance is until the target floor is reached. Incidentally, a table may be divided by the number of floors passed by the car in place of the floor to floor distance. Multiple tables are available according to the moving distance L. In the case of a short moving distance L, the operating time is shortened by increasing accelerated and decelerated speeds rather than speeds and the operation efficiency is high. Therefore, accelerated and decelerated speeds are set at high values. Inversely, when the moving distance L is large, the operating efficiency is raised by increasing speeds rather than accelerated and decelerated speeds. Therefore, speeds are set at high values. In this case, on startup, the moving distance L is first calculated on the basis of information on the floor at which the car is at a stop and the floor at which the car is to stop next, and a table is selected according to the moving distance L. For example, when the moving distance L is 12 meters, the bottommost table is selected. Next, a speed and accelerated and decelerated speeds suited to a balanced torque on the abscissa and the operation of the elevator is started.

[0037] Although the table E above is a table based on the moving distance L, a balanced torque and an operating direction, it is also possible to use a table based on the moving distance L alone and a table based on a balanced torque alone. And a table based on any combination of the above items, for example, a table based on the moving distance L and an operating direction may be used.

[0038] Also, the table F of speed and accelerated and decelerated speeds as shown in Figure 7, which is based on the ratio of car load to rated load in place of a balanced torque, may be used.

[0039] Next, the second embodiment of the present invention will be described on the basis of the drawings.

[0040] Figure 8 is a system configuration diagram which shows an elevator control system in the second embodiment of the present invention. In Figure 8, a main rope 3 is wound on a driving sheave 2 of a traction machine which is driven by a hoisting motor 1, and a car 4 and a counter weight 5 are each connected to both ends of the main rope 3. A speed detector 6, which is connected to the hoisting motor 1, outputs a speed signal 6a corresponding to the rotational speed of the motor 1. A load weighing device 7, which is provided in the car 4, detects an in-car load and outputs a load weighing signal 7a. A power converter 8 supplies a power source which drives the motor 1. A current detector 9 detects a current of the motor 1 and outputs a current signal 9a. A speed command generator 10 generates a speed command value 10a of the elevator. A speed controller 11, which is connected to the speed command generator 10 and the speed detector 6, outputs a first torque command value 11a using the speed command value 10a and the speed signal 6a as inputs. A load weighing compensator 12, which is connected to the load weighing device 7, outputs a torque compensation signal 12a using the load weighing signal 7a as an input. An adder 13, which is connected to the speed controller 11 and the load weighing compensator 12, outputs a second torque command value 13a. A torque controller 14 is connected to the adder 13, the speed detector 6 and the current detector 9, and the torque controller 14 outputs its output 14a. A brake 15, which holds still the driving sheave 2 of the traction machine, is released on the basis of a startup command 15a from the speed command generator 10. A camera 18 is provided within the car 4 of the elevator. The number of passengers in the car is judged from an image photographed by use of this camera 18 and a camera signal 18a which outputs the result of the judgment is regarded as a balanced torque. On the basis of the startup command 15a from the speed command generator 10, an in-car passenger detector 20 which replaces the startup torque command detector 16 in the first embodiment holds a torque command on startup after a prescribed time during which the elevator releases the brake 15. On the basis of the speed command value 10a, a travel loss calculator 17 calculates a travel loss 17a during elevator traveling by deducting the torque compensation signal 12a from the load weighing compensator 12 from the second torque command value 13a during traveling at a rated speed or a constant speed.

[0041] In this second embodiment, the camera signal 18a is regarded as a balanced torque and accelerated and decelerated speeds and rated speed are determined by the method of selecting a speed pattern shown in Figure 5.

[0042] As the third embodiment of the present invention, there is also available a method by which the tables of speeds

and accelerated and decelerated speeds of the above described method of selecting a speed pattern are not used, and as shown in Eq. (4) and Eq. (5) below, for a standard speed V_0 and a standard accelerated or decelerated speed α_0 , which are predetermined, an accelerated or decelerated speed α and a rated speed V which are appropriate to a balanced torque T (expressed in the ratio to a rating) are increased at prescribed increase rates k_1 , k_2 to values limited by a maximum output of the power converter 8 and a maximum output of the motor 1.

$$V = k_2 / T \times V_0 \quad \dots (4)$$

$$\alpha = k_1 / T \times \alpha_0 \quad \dots (5)$$

[0043] When the load weighing checker 19 of Figure 1 judges that detection errors of the load weighing device 7 are large and outputs an abnormal signal, the speed pattern is returned to the standard speed V_0 and the standard accelerated or decelerated speed α_0 , which are predetermined standard values.

[0044] As the fourth embodiment of the present invention, control means which performs field-weakening control is provided in the control of the motor which drives the traction machine. Field-weakening control is a motor control method applied to a permanent magnet motor, and is a control method which enables the motor to be driven at higher revolutions by suppressing the terminal voltage of the motor owing to the demagnetization effect, which is obtained by causing a negative current to flow in the field magnetic flux direction (d-axis direction). Figure 9 shows torques capable of being outputted by the motor and speed ranges. In Figure 9, (a) shows a region in which motor output is possible when field-weakening control is not performed, and (b) shows a region in which motor output is possible when field-weakening control is performed. The driving region of the motor can be widened to the high speed side by performing field-weakening control. At this time, it is unnecessary to change the capacity of electrical equipment, such as an inverter. Therefore, by using field-weakening control, it is possible to set an upper limit to a constant speed to the higher speed side without changing electrical equipment. The smaller the difference between the weight of the car side and the weight of the counter weight, the greater the effect of field-weakening control. The reason is as follows. When the difference between weight of the car side and the weight of the counter weight is small, a required motor torque is small and, therefore, the power consumption and regenerative power of the elevator also become small. As a result, the elevator control system becomes less affected by restrictions by the capacity of power supply equipment and limiting conditions of the regenerative capacity, and from the nature of field-weakening control, the smaller a generated torque, the higher the rotational speed at which the motor can be driven.

[0045] A motor can be driven at higher rotational speeds by adopting a method by which a tertiary harmonic wave is superposed on the inverter voltage and a two-phase modulation method as a method of raising the voltage utilization rate of an inverter in order to drive a motor at high rotational speeds.

[0046] When the rotational speed of a motor increases and the output voltage of an inverter rises, it is necessary to raise the voltage value of a DC link and the electromagnetic noise of the motor increases. However, the electromagnetic noise can be considerably suppressed by performing a dead time (T_d) correction of a voltage type inverter.

[0047] As described above, according to the present invention, after a prescribed time during which the elevator releases the brake, a torque command on startup is held and speed patterns which determine the jerk (acceleration), accelerated and decelerated speeds and rated speed of the car are changed according to the torque command. Also, on the basis of a torque command during traveling of the last travel, speed patterns which determine the jerk, accelerated and decelerated speeds and rated speed of the car are changed by correcting the torque command on startup of the elevator by a travel loss. Therefore, because the change of speed patterns is performed on the basis of the torque command in which a travel loss is added to the torque command after the control for holding still by the speed controller, detection errors of the load weighing device etc. are not contained and the effect of a travel loss etc. is taken into consideration. Therefore, results of high accuracy are obtained.

[0048] Furthermore, speed patterns have predetermined standard values, and for these predetermined standard values, an accelerated or decelerated speed and a rated speed are increased at prescribed increase rates to values limited by a maximum output of the power converter and a maximum output of the motor. Therefore, the construction can be made simple and high-accuracy speed patterns limited by a maximum output of the power converter and a maximum output of the motor can be generated.

[0049] As a method of detecting loads, the number of passengers in the car is judged from an image photographed by use of a camera provided in the elevator car, and speed patterns which determine the jerk, accelerated and decelerated speeds, rated speed of the car are changed on the basis of a camera signal which outputs the result. Therefore, even when large detection errors are generated in the load weighing device and the like, speed patterns can be accurately

changed within the motor torque range.

[0050] The number of passengers in the car is judged from a load weighing signal, a torque command on startup of the elevator or an image photographed by use of a camera provided in the car, there is provided a speed pattern determining device which selects speed patterns which determine the jerk, accelerated and decelerated speeds, and rated speed of the car from a camera signal which outputs the result of the judgment or combinations of these data, and increase rates of the acceleration and speed are made variable in order to ensure that the longer the moving distance to a destination floor, the more dominant an increase in a maximum speed. Therefore, this provides the advantage that with a simple construction, the moving time of passengers is shortened, resulting in an increase in the operation efficiency of the car.

[0051] Even in the case of an elevator which is provided with a load weighing device which detects an in-car load and outputs a load weighing signal and speed patterns which determine the jerk, accelerated and decelerated speeds, and rated speed of the car are changed according to the load weighing signal, a load weighing checker is provided and in case a difference between the load weighing signal and a torque command on startup exceeds a prescribed value, the change of speed patterns is stopped and set values are returned to standard values. Therefore, even when large detection errors are produced in the load weighing device and the like, the errors are detected and the change of speed patterns is stopped. Therefore, it is possible to increase reliability.

Industrial Applicability

[0052] As described above, an elevator control system of the present invention changes maximum speed and acceleration according to load and moving distance and can shorten operating time. Furthermore, the detection of loads can be performed with high accuracy.

Claims

1. An elevator control system, **characterized in that** in an elevator which has a speed controller, which generates a torque command value from a speed command value and a speed signal, and causes a car and a counter weight to be ascend and descend by controlling an electric motor by use of a power converter on the basis of the torque command value, after a prescribed time during which the elevator releases a brake, a torque command on startup is held, and speed patterns which determine the jerk, accelerated and decelerated speeds, and rated speed of the car are changed according to the torque command.
2. An elevator control system, **characterized in that** in an elevator which has a speed controller, which generates a torque command value from a speed command value and a speed signal, and causes a car and a counter weight to be ascend and descend by controlling an electric motor by use of a power converter on the basis of the torque command value, and which elevator is provided with a load weighing device which detects an in-car load and outputs a load weighing signal, unbalanced loads on the car side and on the counter weight side being calculated on the basis of the load weighing signal, and the torque command value being corrected on the basis of the unbalanced loads, after a prescribed time during which the elevator releases a brake, a torque command on startup is held, and speed patterns which determine the jerk, accelerated and decelerated speeds, and rated speed of the car are changed according to the torque command.
3. The elevator control system according to claim 1 or 2, **characterized in that** the speed patterns have predetermined standard values, and **in that** the accelerated and decelerated speeds and rated speed are increased from the standard values at prescribed increase rates to values limited by a maximum output of the power converter and a maximum output of the electric motor.
4. The elevator control system according to any of claims 1 to 3, **characterized in that** the speed patterns which determine the jerk, accelerated and decelerated speeds, and rated speed of the car are changed by correcting the torque command on startup of the elevator in terms of travel loss on the basis of a torque command during traveling in the last travel.
5. An elevator control system, **characterized in that** in an elevator which has a speed controller, which generates a torque command value from a speed command value and a speed signal, and causes a car and a counter weight to be ascend and descend by controlling an electric motor on the basis of the torque command value, and in which the number of passengers in the car is judged from an image photographed by a camera within the car of the elevator, and speed patterns which determine the jerk, accelerated and decelerated speeds, and rated speed of

the car are changed on the basis of a camera signal which outputs results of the judgment.

- 5 6. An elevator control system, **characterized in that** in an elevator which has a speed controller, which generates a torque command value from a speed command value and a speed signal, and causes a car and a counter weight to be ascend and descend by controlling an electric motor on the basis of the torque command value, and which elevator is provided with a load weighing device which detects an in-car load and outputs a load weighing signal, unbalanced loads on the car side and on the counter weight side being calculated on the basis of the load weighing signal, and the torque command value being corrected on the basis of the unbalanced loads, there is provided a speed pattern determining device which judges the number of passengers in the car from the load weighing signal, 10 or the torque signal on startup of the elevator, or an image photographed by a camera within the car of the elevator, and selects, from tables of acceleration and speed, speed patterns which determine the jerk, accelerated and decelerated speeds, and rated speed of the car according to a camera signal which outputs results of the judgment, or according to combinations of these data, and increase rates of the acceleration and speed are changed according to a moving distance to a target floor. 15
7. The elevator control system according to claim 6, **characterized in that** the longer a moving distance to a target floor, the more dominant an increase of a maximum speed will be made.
- 20 8. An elevator control system, **characterized in that** in an elevator which has a speed controller, which generates a torque command value from a speed command value and a speed signal, and causes a car and a counter weight to be ascend and descend by controlling an electric motor by on the basis of the torque command value, there is provided a load weighing device which detects an in-car load and outputs a load weighing signal, speed patterns which determine the jerk, accelerated and decelerated speeds and rated speed of the car being changed according to the load weighing signal, and there is provided a load weighing check device which stops the changing of speed 25 patterns, when a difference in the load weighing signal and the torque signal on startup exceeds a prescribed value, and which returns the speed patterns to predetermined standard values.

FIG. 1

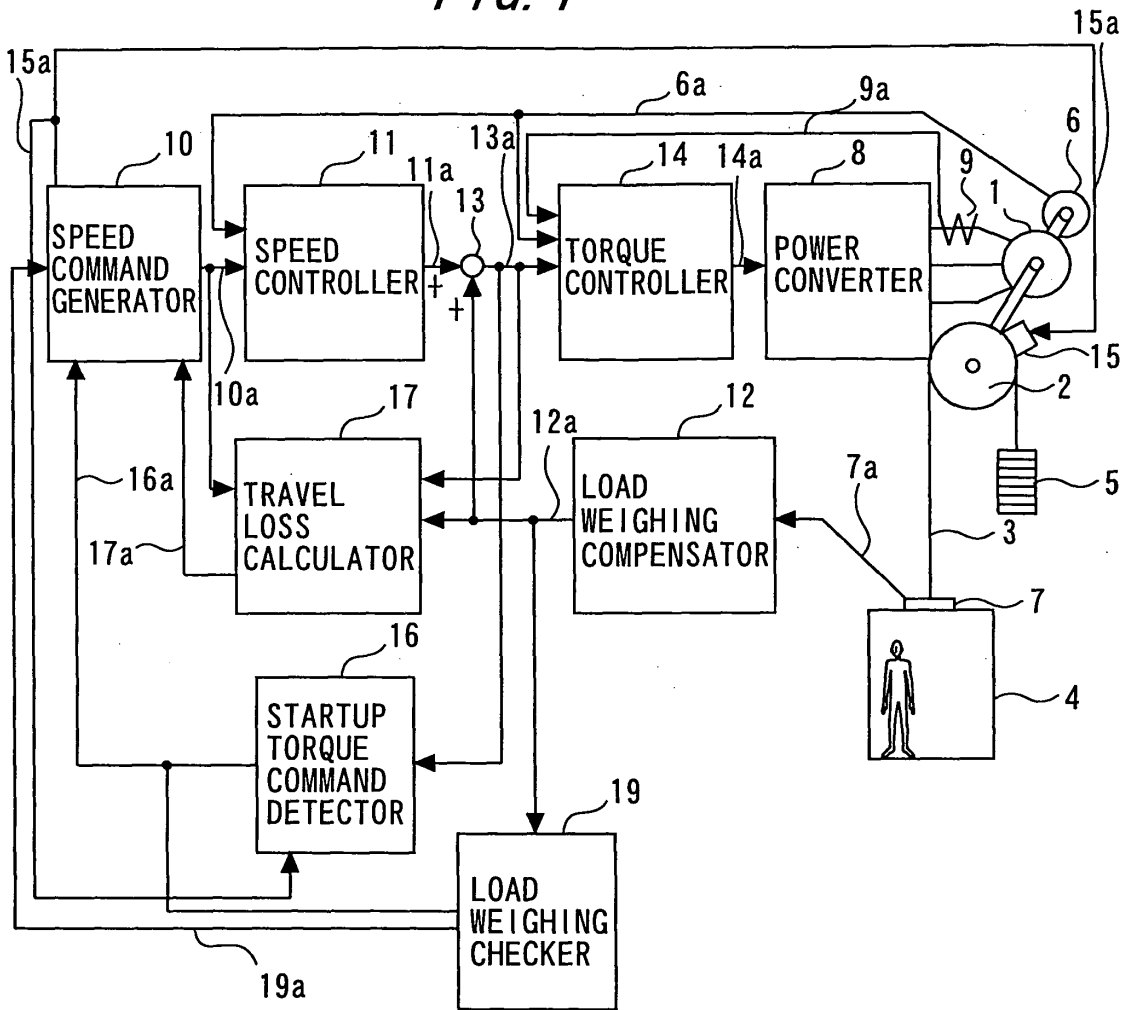


FIG. 2

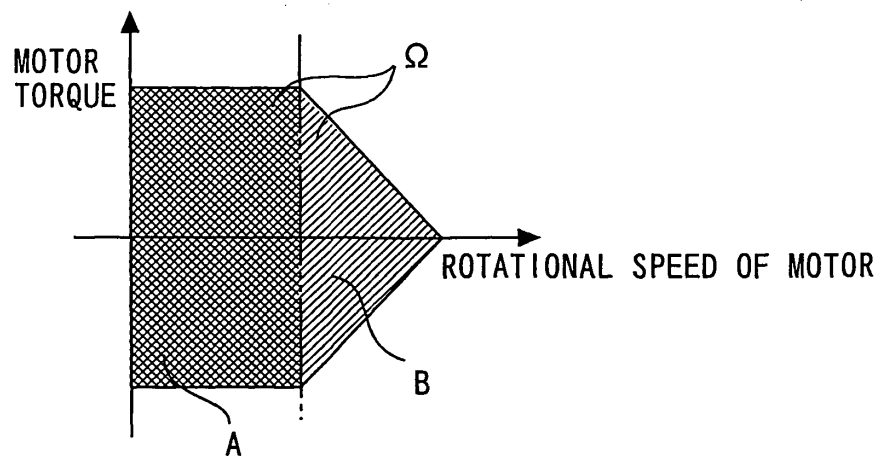


FIG. 3

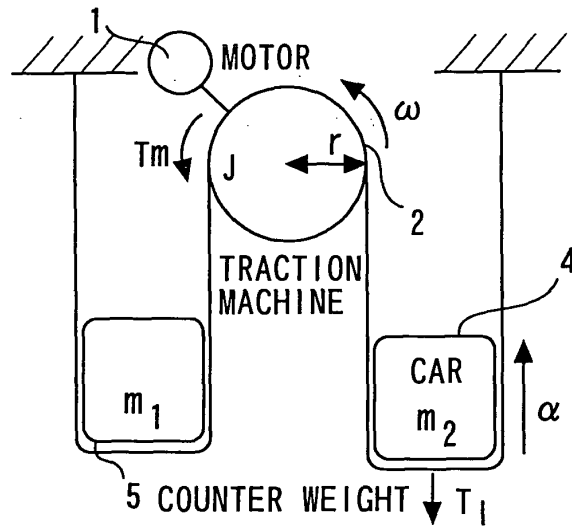


FIG. 4

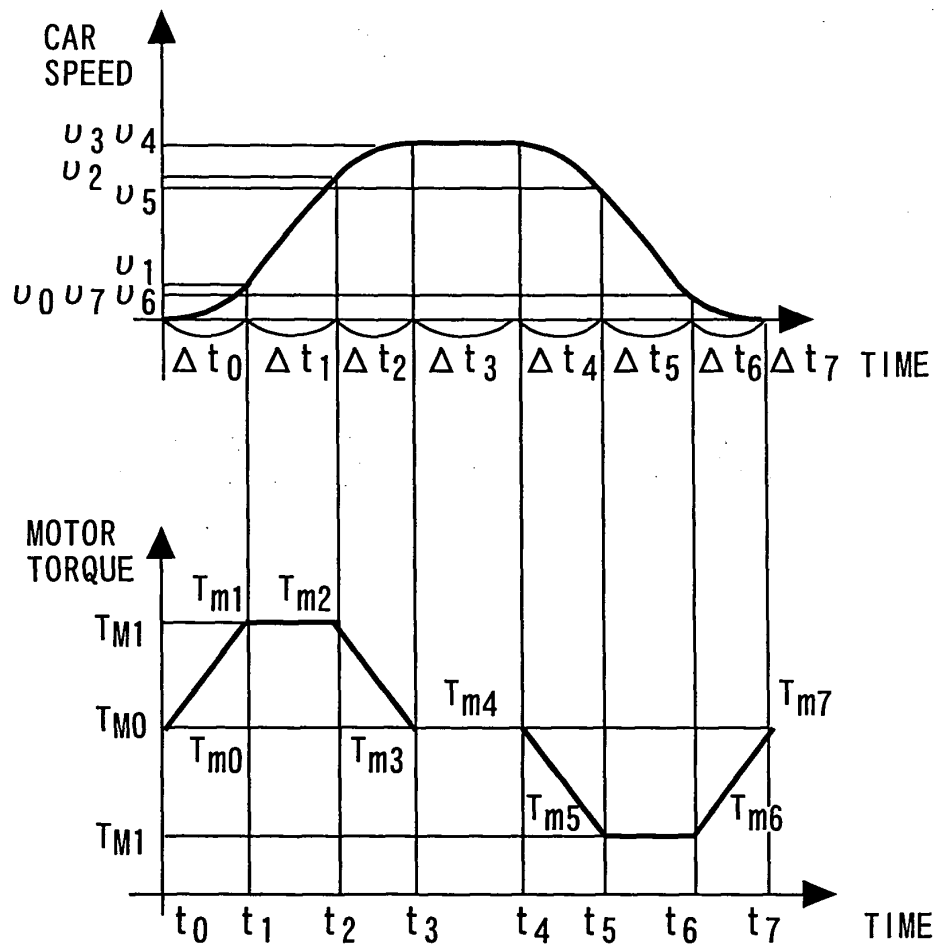


FIG. 5

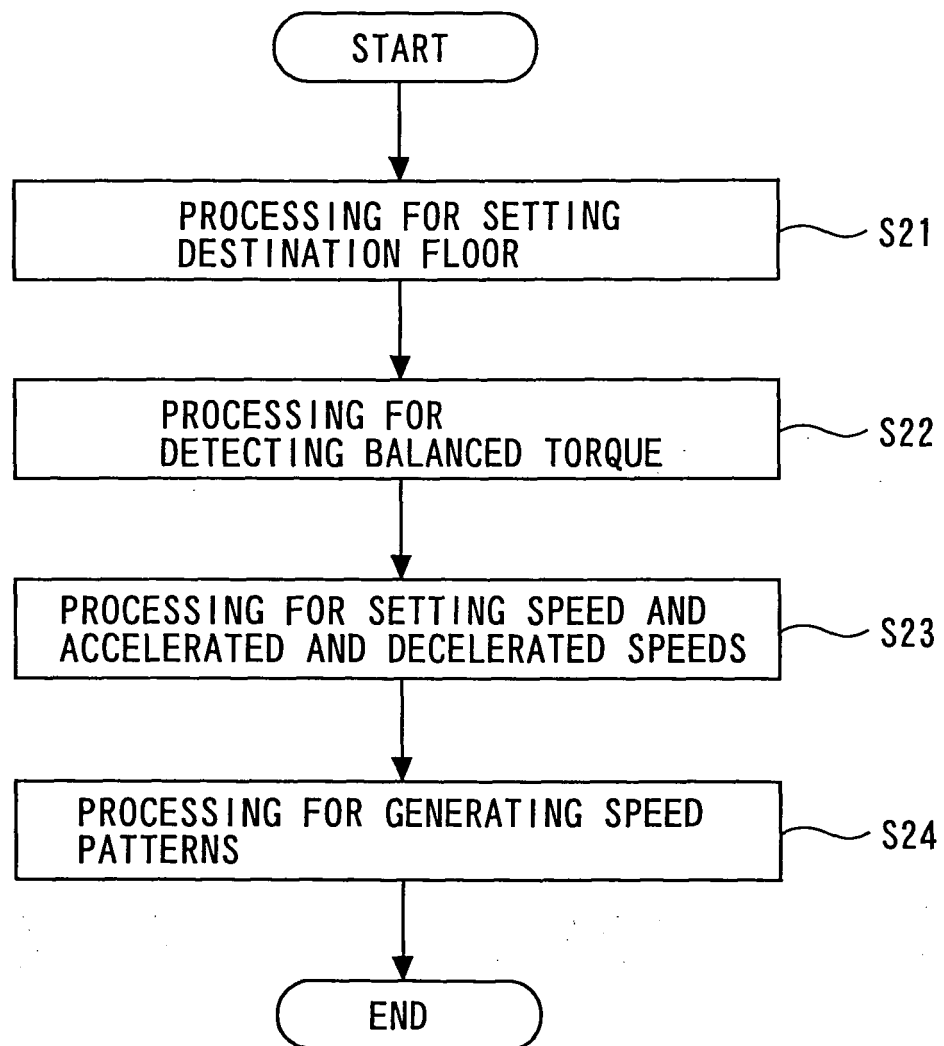


FIG. 6

TABLE E

 $L < 5$

BALANCED TORQUE [%]		0~29	30~69	70~100
SPEED [m/min]	UP	80	70	60
	DOWN	80	70	60
ACCELERATED SPEED [m/s ²]	UP	1.0	0.9	0.8
	DOWN	1.0	0.9	0.8
DECELERATED SPEED [m/s ²]	UP	1.0	0.9	0.8
	DOWN	1.0	0.9	0.8

 $5 \leq L < 10$

BALANCED TORQUE [%]		0~29	30~69	70~100
SPEED [m/min]	UP	90	80	70
	DOWN	90	80	70
ACCELERATED SPEED [m/s ²]	UP	0.9	0.8	0.7
	DOWN	0.9	0.8	0.7
DECELERATED SPEED [m/s ²]	UP	0.9	0.8	0.7
	DOWN	0.9	0.8	0.7

 $L \geq 10$

BALANCED TORQUE [%]		0~29	30~69	70~100
SPEED [m/min]	UP	100	90	80
	DOWN	100	90	80
ACCELERATED SPEED [m/s ²]	UP	0.8	0.7	0.6
	DOWN	0.8	0.7	0.6
DECELERATED SPEED [m/s ²]	UP	0.8	0.7	0.6
	DOWN	0.8	0.7	0.6

FIG. 7

TABLE F

 $L < 5$

CAR LOAD [%]		0~29	30~69	70~100
SPEED [m/min]	UP	60	70	60
	DOWN	60	70	60
ACCELERATED SPEED [m/s ²]	UP	0.8	0.9	0.8
	DOWN	0.8	0.9	0.8
DECELERATED SPEED [m/s ²]	UP	0.8	0.9	0.8
	DOWN	0.8	0.9	0.8

 $5 \leq L < 10$

CAR LOAD [%]		0~29	30~69	70~100
SPEED [m/min]	UP	70	80	70
	DOWN	70	80	70
ACCELERATED SPEED [m/s ²]	UP	0.7	0.8	0.7
	DOWN	0.7	0.8	0.7
DECELERATED SPEED [m/s ²]	UP	0.7	0.8	0.7
	DOWN	0.7	0.8	0.7

 $L \geq 10$

CAR LOAD [%]		0~29	30~69	70~100
SPEED [m/min]	UP	80	90	80
	DOWN	80	90	80
ACCELERATED SPEED [m/s ²]	UP	0.6	0.7	0.6
	DOWN	0.6	0.7	0.6
DECELERATED SPEED [m/s ²]	UP	0.6	0.7	0.6
	DOWN	0.6	0.7	0.6

FIG. 8

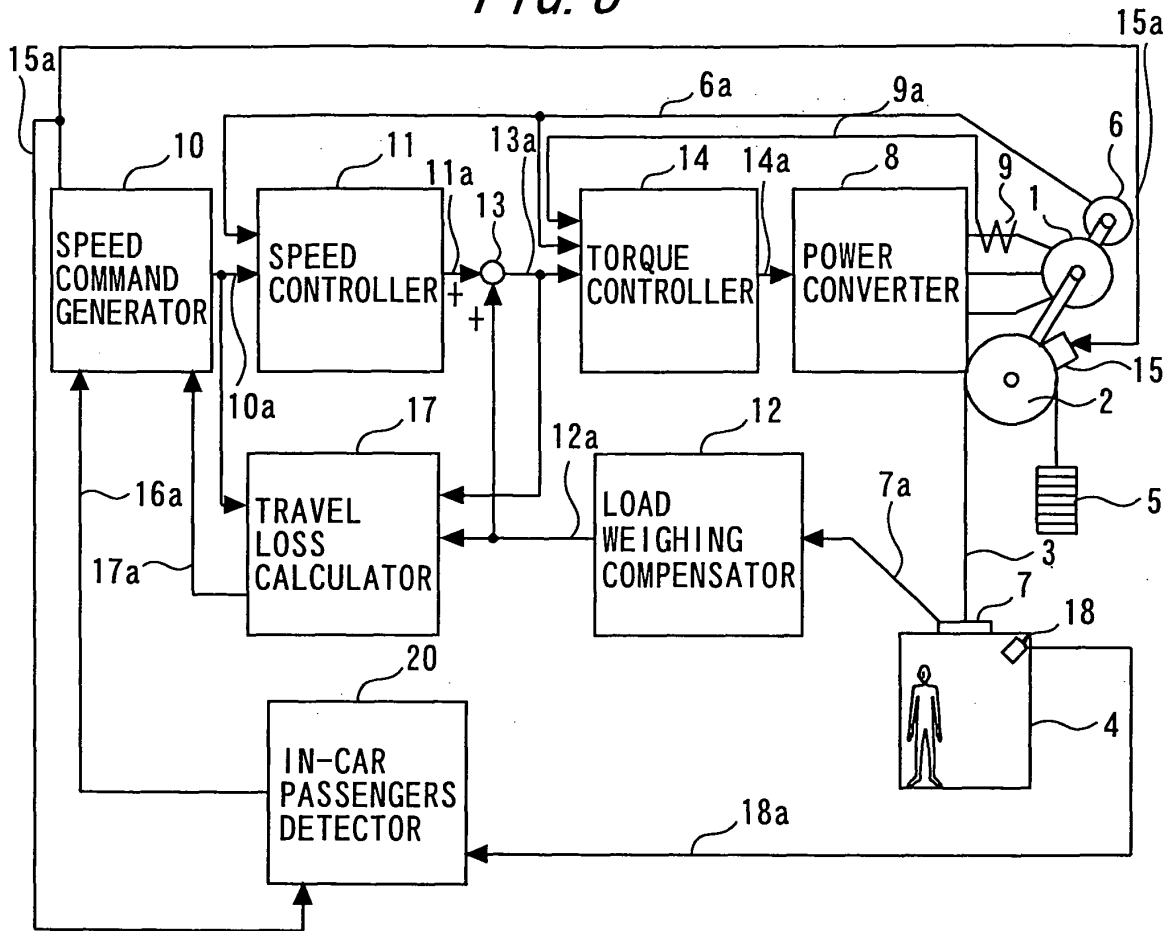


FIG. 9

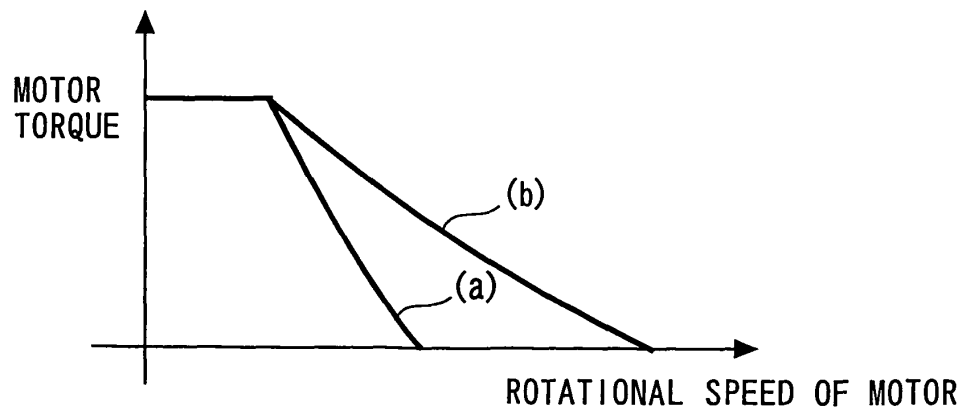
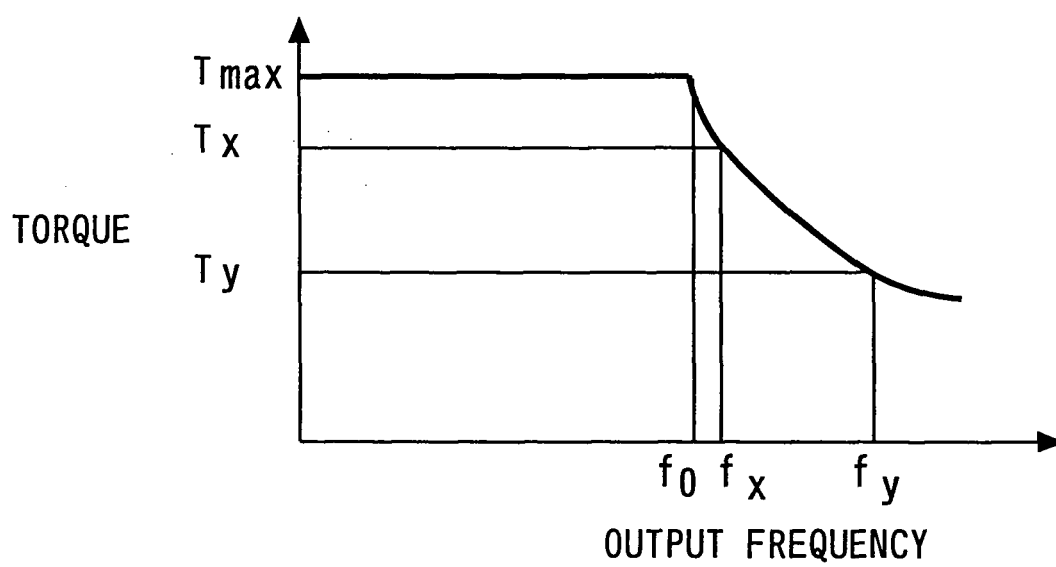


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2004/004492

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ B66B1/30		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) Int.Cl ⁷ B66B1/00-5/28		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926-1996 Jitsuyo Shinan Toroku Koho 1996-2004 Kokai Jitsuyo Shinan Koho 1971-2004 Toroku Jitsuyo Shinan Koho 1994-2004		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2003-192246 A (Toshiba Elevator and Building Systems Corp.), 09 July, 2003 (09.07.03), Pay attention to Claims (Family: none)	1-7 8
Y A	JP 2003-238037 A (Mitsubishi Electric Corp.), 27 August, 2003 (27.08.03), Pay attention to Claims & WO 03/050028 A1	1-7 8
Y	JP 7-165372 A (Hitachi, Ltd.), 27 June, 1995 (27.06.95), Pay attention to Claims (Family: none)	3
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 24 December, 2004 (24.12.04)		Date of mailing of the international search report 25 January, 2005 (25.01.05)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2004/004492

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	JP 2001-278553 A (Mitsubishi Electric Corp.), 10 October, 2001 (10.10.01), Pay attention to Claims, Par. No. [0017] & CN 1315284 A & US 6328134 B1	5-7
Y	JP 57-184078 A (Tokyo Shibaura Electric Co., Ltd.), 12 November, 1982 (12.11.82), Pay attention to Claims, page 3, upper right column, line 2 to page 3, lower left column, line 17 (Family: none)	5-7
Y	JP 7-215611 A (Toshiba Corp.), 15 August, 1995 (15.08.95), Pay attention to Par. Nos. [0002] to [0007] (Family: none)	5-7
A	JP 7-330231 A (Hitachi, Ltd.), 19 December, 1995 (19.12.95), Pay attention to abstract (Family: none)	8
A	JP 7-228444 A (Hitachi, Ltd.), 29 August, 1995 (29.08.95), Pay attention to Claims (Family: none)	8

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REFERENCES CITED IN THE DESCRIPTION

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- JP 8107699 A [0007]