United States Patent

Shima

[15] **3,670,851**

[45] **June 20, 1972**

[54] SPEED PATTERN GENERATOR FOR ELEVATOR CONTROL SYSTEM

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[73] Assignee: **Hitachi, Ltd.**, Tokyo, Japan

[22] Filed: **Sept. 24, 1970**

[21] Appl. No.: **75,171**

[30] **Foreign Application Priority Data**

Sept. 29, 1969 Japan 44/76938

[52] **U.S. Cl.** ..... **187/29 R**

[51] **Int. Cl.** **B66b 1/28**

[58] **Field of Search** 187/29; 318/143, 448, 449, 318/611

[56] **References Cited**

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Assistant Examiner—W. E. Duncanson, Jr.
Attorney—Craig, Antonelli & Hill

[57] **ABSTRACT**

A speed pattern generator for an elevator control system generating an accelerating speed pattern with is a function of time and increases monotonously, a decelerating speed pattern which is a function of the distance between the elevator and the desired floor level and decreases monotonously, and a compensating speed pattern which is a function of the difference between the accelerating speed pattern and the decelerating speed pattern and decreases monotonously so that the compensating speed pattern ensures a smooth transition from the accelerating speed pattern to the decelerating speed pattern.

5 Claims, 12 Drawing Figures

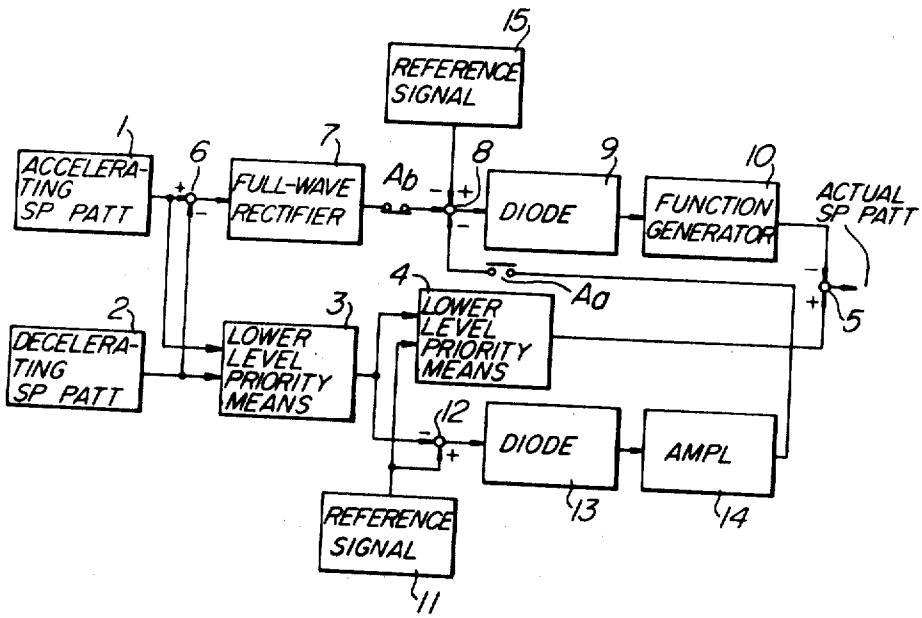


FIG. 1a

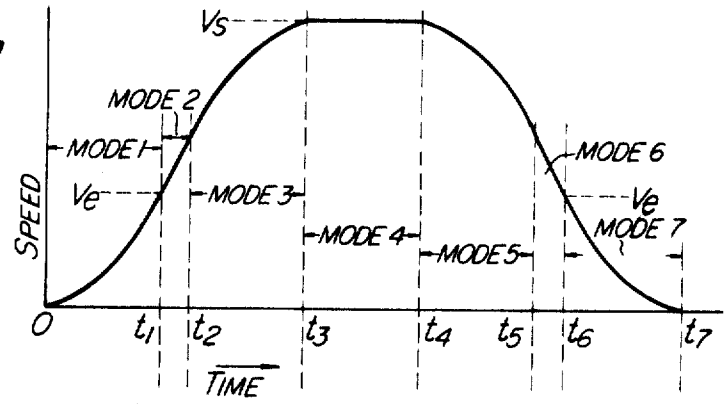


FIG. 1b

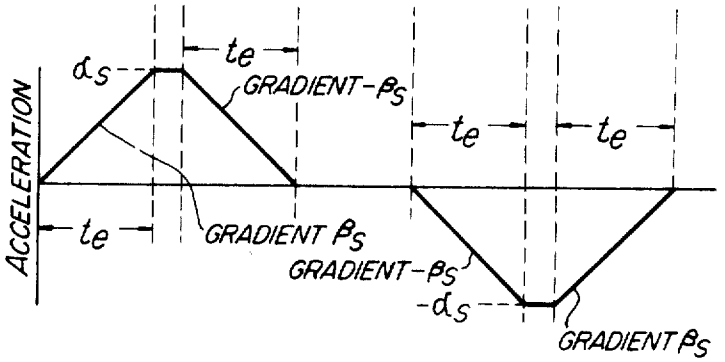
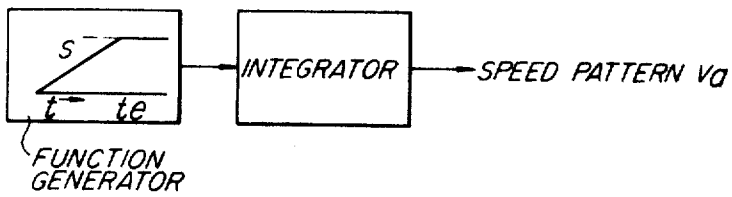


FIG. 2



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FIG. 3a

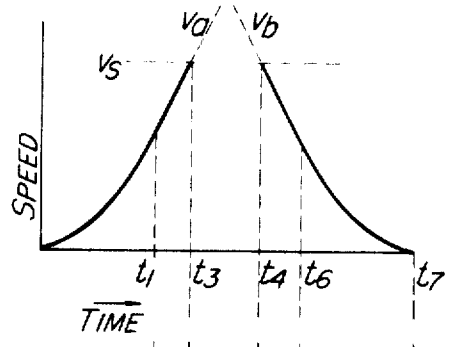


FIG. 3b

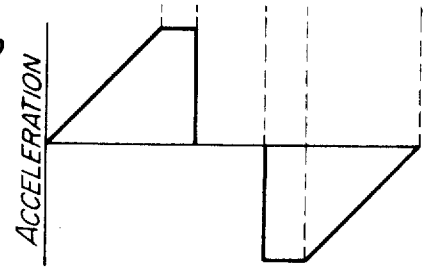
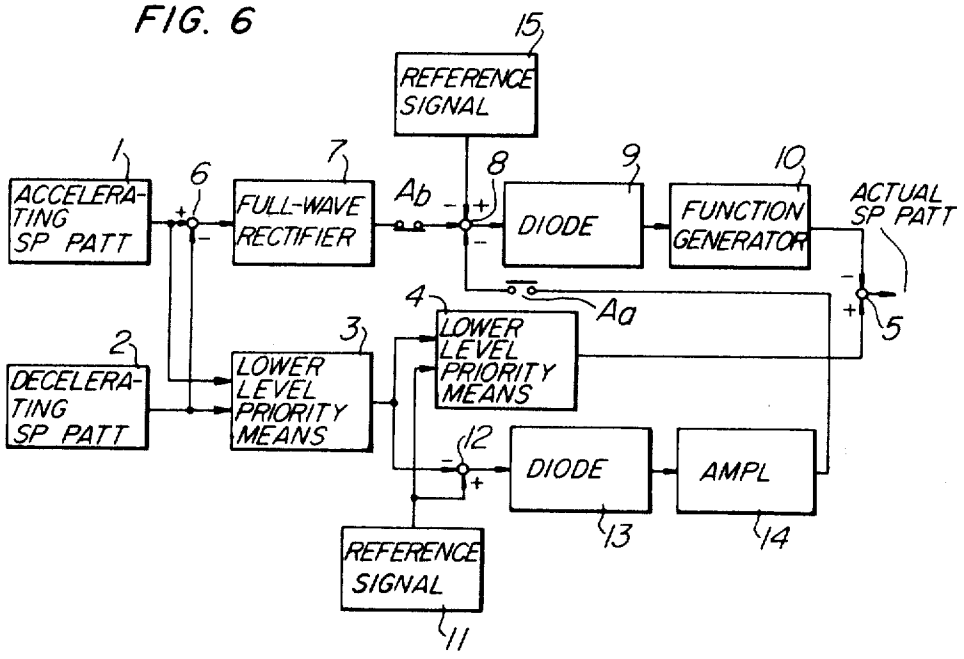


FIG. 6



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FIG. 4a

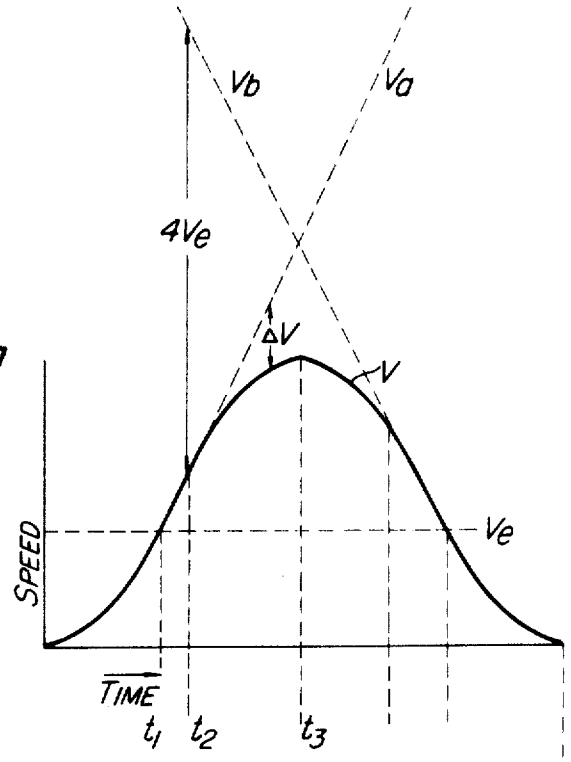


FIG. 4b

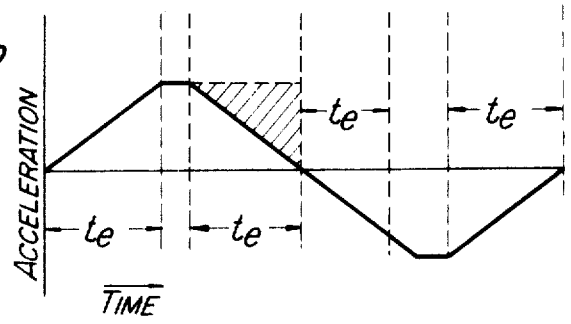
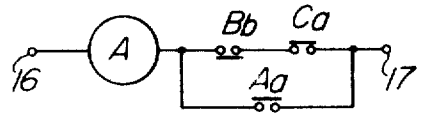


FIG. 7



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FIG. 5a

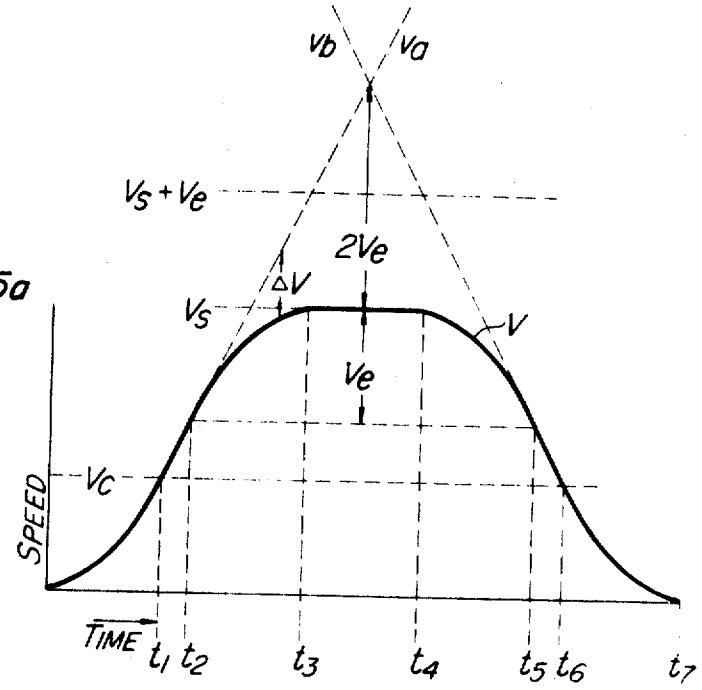
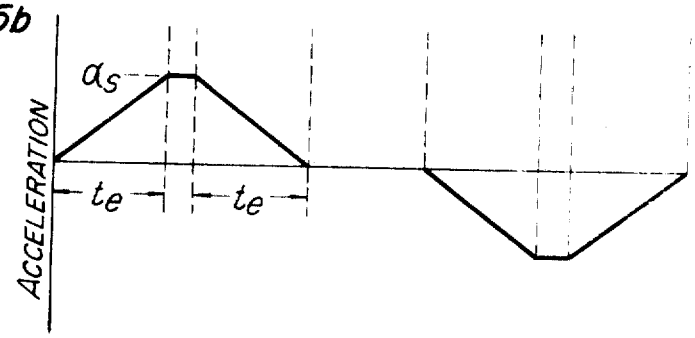


FIG. 5b



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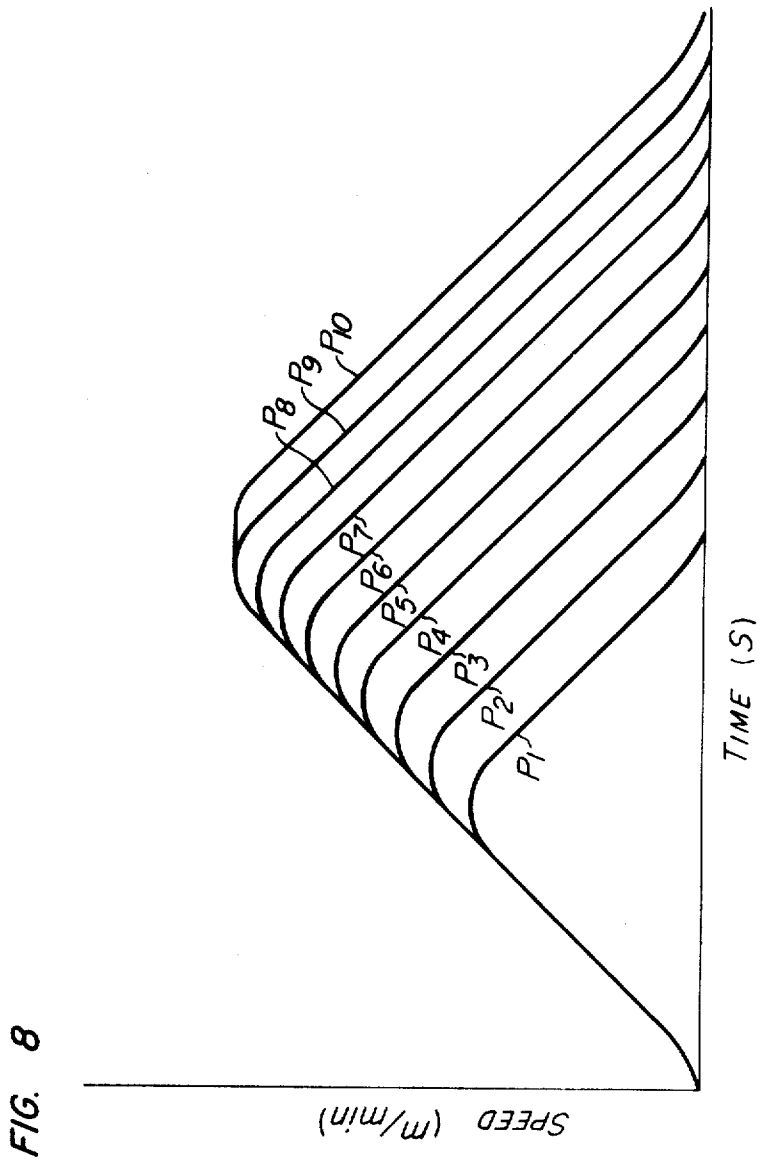


FIG. 8

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SPEED PATTERN GENERATOR FOR ELEVATOR CONTROL SYSTEM

This invention relates to improvements in a speed pattern generator for an elevator control system.

A comfortable ride is demanded for elevators carrying passengers. To meet this demand, it is desirable that the speed pattern supplied to the speed control system for an elevator increases monotonously as a function of time during acceleration until the elevator speed reaches the rated speed and the rated speed is maintained for a certain period of time thereafter (or the speed may be immediately decreased), while during deceleration, the speed pattern is a function of the distance or deceleration distance between the elevator and the desired floor level and decreases monotonously with the decrease in the deceleration distance.

A speed pattern generator for an elevator control system commonly presently in use comprises means for generating an accelerating speed pattern which is a function of time and increases monotonously, means for generating a decelerating speed pattern which is a function of the distance between the elevator and the desired floor level, and decreases monotonously, and a circuit having a time lag of first order for ensuring a smooth transition from the accelerating speed pattern to the decelerating speed pattern. However the prior art speed pattern generator has been defective in that the accuracy of the actual speed pattern generated thereby is quite low due to the provision of the time lag circuit therein.

It is therefore a primary object of the present invention to provide an improved speed pattern generator which can minimize the rate of variation of acceleration without employing a circuit having a time lag of first order and yet shows a high leveling accuracy.

The above and other objects, features and advantages of the present invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1*a* is a graph showing an ideal speed curve for an elevator;

FIG. 1*b* is a graph showing an ideal acceleration curve for the elevator driven according to the ideal speed pattern shown in FIG. 1*a*;

FIG. 2 is a block diagram showing the basis structure of means for generating an accelerating speed pattern;

FIGS. 3*a* and 3*b* are graphs showing a speed and an acceleration curve, respectively, in an elevator equipped with a prior art speed pattern generator;

FIGS. 4*a* and 4*b* are graphs showing a speed and an acceleration curve, respectively, representing a first speed pattern obtained by a speed pattern generator according to the present invention;

FIGS. 5*a* and 5*b* are graphs showing a speed and an acceleration curve, respectively, representing a second speed pattern obtained by the speed pattern generator according to the present invention;

FIG. 6 is a block diagram of an embodiment of the present invention;

FIG. 7 is a diagram of a relay circuit employed in the embodiment shown in FIG. 6; and

FIG. 8 is a graphic representation of the first and second speed patterns.

The acceleration α m/sec^2 and the rate of variation of acceleration β m/sec^3 in an elevator have their limits in order that man riding in the elevator feels a comfortable sense of ride. These limits are designated herein by α_s m/sec^2 and β_s m/sec^3, respectively.

FIGS. 1*a* and 1*b* show an ideal speed curve and an ideal acceleration curve, respectively, taken as a function of time in the case of the maximum acceleration α_s m/sec^2 and maximum rate of variation of acceleration β_s m/sec^3. In FIG. 1*a*, the horizontal and vertical axes represent the time and the speed, respectively, while in FIG. 1*b*, the horizontal and vertical axes represent the time and the acceleration, respectively.

The ideal speed curve and the ideal acceleration curve shown in FIGS. 1*a* and 1*b* will now be discussed in detail. In

the range of from time 0 to t_1 (hereinafter to be referred to as mode 1), the acceleration is increased linearly and the rate of variation of acceleration is maintained at the constant value β_s. In the range of from time t_1 to t_2 (hereinafter to be referred to as mode 2), the acceleration is maintained at the constant value α_s and the rate of variation of acceleration is zero. In the range of from time t_2 to t_3 (hereinafter to be referred to as mode 3), the acceleration is decreased linearly and the rate of variation of acceleration is maintained at the constant value $-\beta_s$. Throughout these ranges, the elevator is accelerated.

In the range of from time t_3 to t_4 (hereinafter to be referred to as mode 4), the elevator is driven at the rated speed V_s. In the range of from time t_4 to t_5 (hereinafter to be referred to as mode 5), the acceleration is increased in the negative direction and the rate of variation of acceleration is maintained at $-\beta_s$. In the range of from time t_5 to t_6 (hereinafter to be referred to as mode 6), the acceleration is maintained at $-\alpha_s$. In the range of from time t_6 to t_7 (hereinafter to be referred to as mode 7), the rate of variation of acceleration is maintained at β_s. Throughout these ranges, the elevator is decelerated.

The speed pattern described above is classified into a first speed pattern which does not include the mode 4 and a second speed pattern which includes the mode 4. The first speed pattern is generated when the distance between the floor level at which the elevator is presently at rest and the desired floor level to be reached by the elevator is shorter than the distance required for the acceleration and deceleration of the elevator according to the speed pattern shown in FIGS. 1*a* and 1*b*, that is, the distance run by the elevator during the period of from time 0 to t_3 and from time t_4 to t_7. The second speed pattern is generated when the distance between the floor level at which the elevator is presently at rest and the desired floor level to be reached by the elevator is longer than the distance required for the acceleration and deceleration of the elevator according to the speed pattern shown in FIGS. 1*a* and 1*b*. Theoretically, there may be a third speed pattern which does not include the modes 2, 4 and 6. However, when the maximum allowable acceleration α_s is set at 1 m/sec^2 and the maximum rate of variation of acceleration β_s is set at 1 m/sec^3 according to common practice, the running distance of the elevator according to the third speed pattern must be less than 2.3 m, whereas the minimum distance between the adjacent floor levels is commonly of the order of 2.6 m. Thus, the third speed pattern is not considered herein because the third speed pattern is not generated during normal operation.

An accelerating speed pattern V_a for the modes 1 and 2 is generated by a function generator so that it is a function of time t seconds lapsed after the elevator is started at time $t=0$. More precisely, in the range $t < t_e$ (t_e corresponding to t_1 in FIGS. 1*a* and 1*b*), the accelerating speed pattern V_a for the mode 1 can be obtained by generating a function

$$V_a = \tfrac{1}{2}\beta_s t^2 \text{ (m/sec)} \quad 1$$

by integrating the rate of variation of acceleration β_s with time. In the range $t \geq t_e$, the accelerating speed pattern V_a for the mode 2 can be obtained by generating a function

$$V_a = \alpha_s t - V_e \text{ (m/sec)} \quad 2$$

Further, t_e and V_e are given by the following equations:

$$t_e = \beta_s/\alpha_s \text{ (sec)} \quad 3$$

$$V_e = \tfrac{1}{2} \cdot \alpha_S^2/\beta_s \text{ (m/sec)} \quad 4$$

The equation (4) can be obtained by substituting t in the equation (1) by t_e in the equation (3). Referring to FIG. 2, the output from a function generator FG generating a saturated ramp function may be applied to and integrated by an integrator IG with time to obtain the accelerating speed pattern described above.

A decelerating speed pattern V_b for the modes 6 and 7 can be obtained by generating a function which includes a parameter L which is the deceleration distance in meters. More precisely, a function

$$V_b = \tfrac{1}{2}\beta_s(6L/\beta_s)^{2/3} (m\text{sec}) \quad 5$$

may be generated in the range of from time t_6 to t_7 where $L < L_e$, while a function

$$V_b = \sqrt{2\alpha_s (L - L_e/4)} \, (m\text{sec}) \quad 6$$

may be generated in the range of from time t_s to t_e where L L_e. The point L_e in distance in the above equations (5) and (6) is determined by the maximum acceleration α_s and the maximum rate of variation of acceleration and deceleration α_s and is given by

$$L_e = \alpha_s^3/6\beta_s^2 \ (m) \quad 7$$

The equations (5) and (6) giving the decelerating speed pattern V_b are determined in a manner as described below. Suppose that the elevator is brought to a halt at time $t = 0$, then the decelerating speed pattern V_b may be obtained by replacing the time t in the equations (1) and (2) by $-t$. Thus, the decelerating speed pattern V_b can be expressed as

$$V_b = \tfrac{1}{2}\beta_s t^2 \quad 8$$

when $|T| \leqq t_e$, and as

$$V_b = \alpha_s(-t) - V_e \quad 9$$

when $|t_1| > t_e$. t_e corresponds to $t_7 - t_6$. By integrating the equation (8) with time, the deceleration distance L is given by

$$L = 1/6\,\beta_s|t^3| \quad 10$$

when $|t| \leqq t_e$. From the equations (8) and (10), the actual speed pattern V can be expressed as a function of the deceleration distance L as follows:

$$V = \tfrac{1}{2}\beta_s(6L/\beta_s)^{2/3} \quad 11$$

On the other hand, when $|t| > t_e$, the deceleration distance L is given by

$$L = \int_t^{-t_e}(-\alpha_s t - V_e)dt + L_e \quad (12)$$

where L_e represents the deceleration distance when $t = -t_e$ and is given by

$$L_e = 1/6\,\beta_s t_e^3 = 1/6\,\alpha_s^3/\beta_s^2 \quad 13$$

From the above equations, the actual speed pattern V can be expressed as a function of the deceleration distance L as follows:

$$V = \sqrt{2\alpha_s(L - L_e/4)}$$

More precisely, the deceleration distance L is expressed as

$$L = \int_t^{-t_e}(-\alpha_s t - V_e)dt + L_e = \left[\frac{\alpha_s t^2}{2} V_e t\right]_t^{-t_e} + L_e$$

By substituting t, t_e and V_e in the above equation by $t = -V_b - V_e/\alpha_s$ obtained from the equation (9) and t_e and V_e in the equations (3) and (4), the deceleration distance L is now expressed as

$$L = \left[-\frac{\alpha_s}{2}\cdot\frac{\alpha_s^2}{\beta_s^2} + \frac{\alpha_s^2}{2\beta_s}\cdot\frac{\alpha_s}{\beta_s}\right]$$

$$-\left[-\frac{\alpha_s}{2}\cdot\left(\frac{-V_b - V_e}{\alpha_s}\right)^2 - V_e\left(\frac{-V_b - V_e}{\alpha_s}\right)\right] + L_e$$

$$= \frac{V_b^2 - V_e^2}{2\alpha_s} + L_e = \frac{V_b^2}{2\alpha_s} - \frac{3}{4}L_e + L_e$$

The decelerating speed pattern V_b is sought from the above equation as

$$V_b = \sqrt{2\alpha_s(L - L_e/4)}$$

The above function can be obtained by continuously detecting the deceleration distance L and operating the function generator. It will be apparent that the speed pattern supplied to the speed control system for the elevator can ensure a comfortable sense of ride if the accelerating speed pattern represented by the equations (1) and (2) makes a smooth transition to the decelerating speed pattern represented by the equations (5) and (6).

FIG. 3*a* shows the speed curve obtained as a result of the above calculation, in which the accelerating speed pattern V_a, the decelerating speed pattern V_b and the rated speed V_s are shown by broken lines, while the actual speed pattern V is shown by the solid lines. FIG. 3*b* shows the corresponding acceleration curve. It will be seen from FIG. 3*a* that the speed pattern does not include the modes 3 and 5 unlike the speed pattern shown in FIG. 1*a*. Due to the absence of the modes 3 and 5, the rate of variation of acceleration and deceleration is quite great at a point t_3 where the speed reaches the rated actual speed pattern V for such a range. This range corresponds to the mode 5 in FIG. 1 *a*.

According to the first speed pattern shown in FIGS. 4*a* and 4*b*, the actual speed pattern V starts to decrease at time t_3 at which the decelerating speed pattern V_b intersects the accelerating speed pattern V_a. Therefore, the left-hand and right-hand sections of the actual speed pattern V is symmetri- external disturbance. In another attempt which has been made heretofore, a function of time as shown in FIG. 1*b* is applied to an integrator so as to derive an ideal speed pattern as shown in FIG. 1*a* from the output of the integrator. However, the speed pattern in this case is a function of time throughout the acceleration and deceleration regions. This method has therefore been defective in that the decelerating speed pattern is not related with the position of the elevator and thus the elevator cannot accurately stop at the desired floor level.

FIGS. 4*a* and 4*b* and FIGS. 5*a* and 5*b* show two kinds of speed patterns generated by a speed pattern generator of the present invention. FIGS. 4*a* and 4*b* show a first speed pattern which does not include the mode 4, while FIGS. 5*a* and 5*b* show a second speed pattern which includes the mode 4.

Referring to FIG. 4*a*, the symbols V_a and V_b designate the accelerating speed pattern given by the equations (1) and (2) and the decelerating speed pattern given by the equations (5) and (6), respectively. According to the present invention, the actual speed pattern V coincides with the accelerating speed pattern V_a in the range in which the difference between the accelerating speed pattern V_a and the decelerating speed pattern V_b is greater than $4V_e$, that is, $V_b - V_a > 4V_e$. This range corresponds to the modes 1 and 2 in FIG. 1*a*. The speed pattern V according to the present invention will be discussed in more detail below. The difference in time $(t_3 - t_2)$ between time t_2 at which the acceleration starts to decrease and time t_3 at which the acceleration becomes zero is equal to a period of time t_e during which the acceleration is increased from zero to the maximum value α_s as will be apparent from FIG. 4*b*. (This is quite natural since the rate of variation of acceleration β_s is the same in both ranges.) Since the gradient of the accelerating speed pattern V_a is α_s, the difference between the value of the accelerating speed pattern V_a at time t_3 at which the accelerating speed pattern V_a intersects the decelerating speed pattern V_b as shown in FIG. 4*a* and the value of the accelerating speed pattern V_a at time t_2 at which the acceleration starts to decrease as shown in FIG. 4*b* is given by

$$\alpha_s t_e = \alpha_s^2/\beta_s = 2\,V_e \quad 14$$

Due to the fact that the decelerating speed pattern V_b and the accelerating speed pattern V_a have the same gradient of opposite sign, the difference between the two speed patterns at time t_2 is given by $V_b - V_a = 4V_e$. Thus, the actual speed pattern V shown in FIG. 4*a* may be generated in such a manner that the acceleration starts to decrease when $V_b - V_a = 4V_e$ and is decreased to zero when the accelerating speed pattern V_a intersects the decelerating speed pattern V_b.

In the range in which the difference between the decelerating speed pattern V_b and the accelerating speed pattern V_a is decreased to an extent that $V_b - V_a < 4V_e$, a compensating speed pattern V_c is generated and the difference between the accelerating speed pattern V_a and the compensating speed pattern V_c or $V_a - V_c$ is utilized as the actual speed pattern for such a range. This range corresponds to the mode 3 in FIG. 1*a*.

In the deceleration region, the accelerating speed pattern V_a is greater than the decelerating speed pattern V_b. In the range in which the difference between the accelerating speed pattern V_a and the decelerating speed pattern V_b is greater than $4V_e$ or $V_a - V_b > 4V_e$, the actual speed pattern V coincides with the decelerating speed pattern V_b. This range corresponds to the modes 6 and 7 in FIG. 1*a*.

In the range in which the difference between the accelerating speed pattern V_a and the decelerating speed pattern V_b is smaller than $4V_e$ or $V_a - V_b < 4V_e$, the compensating speed pattern V_c is generated as in the case of the acceleration so that the difference between the decelerating speed pattern V_b and the compensating speed pattern V_c or $V_b - V_c$ is utilized as the

speed V_s and at a point t_4 where the speed starts to reduce from the rated speed V_s as seen in FIG. 3*b*. An attempt has been made to reduce the rate of variation of acceleration and deceleration by supplying the speed pattern to the elevator speed control system through a circuit having a time lag of first order. However, this method has been defective in that the presence of the time lag circuit results in a large degree of cal about time t_3 due to the fact that the rate of variation of acceleration is the same in both the sections. Thus, the actual speed pattern V during the deceleration may be selected as in the case of acceleration depending on whether the difference $V_b - V_a$ between the decelerating speed pattern V_b and the accelerating speed pattern V_a is larger or smaller that $4V_e$.

The compensating speed pattern V_c used in the modes 3 and 5 is obtained in a manner as described below. The difference ΔV between the accelerating speed pattern V_a and the actual speed pattern V in the range in which the acceleration is decreased linearly as shown in FIG. 4*b* and the actual speed pattern V is increased smoothly as shown in FIG. 4*a* can be obtained by calculating the area of the hatched portion in FIG. 4*b*. The difference ΔV is given by

$$\Delta V = \int \beta_s (t - t_2)\, dt = \tfrac{1}{2}\beta_s (t - t_2)^2 \qquad (15)$$

On the other hand, the following equation holds due to the fact that the gradient of the accelerating speed pattern V_a is α_s and the gradient of the decelerating speed pattern V_b is $-\alpha_s$:

$$4V_e + V_a - V_b = 2\alpha_s (t - t_2) \qquad 16$$

From the equations (15) and (16), ΔV is expressed as

$$\Delta V = \frac{1}{2}\beta_s \frac{(4V_e + V_a - V_b)^2}{4\alpha_s^2} = \frac{(4V_e + V_a - V_b)^2}{16V_e} \qquad (17)$$

It is apparent that ΔV given by the equation (17) is nothing but the compensating speed pattern V_c itself. Therefore, the actual speed pattern V for the mode 3 is given by

$$V = V_a - V_c = V_a - (4V_e + V_a - V_b)^2/16 \qquad 18$$

Similarly, the actual speed pattern V for the mode 5 is given by

$$V = V_b - V_c = V_b - (4V_e + V_b - V_a)^2/16 \qquad 19$$

FIGS. 5*a* and 5*b* show a second speed pattern which includes the mode 4. In this case, the circumstances are quite different from those shown in FIGS. 4*a* and 4*b* because the second speed pattern includes a portion corresponding to the rated speed and therefore it is insignificant to decrease the acceleration to zero at a point at which the accelerating speed pattern V_a intersects the decelerating speed pattern V_b.

As will be apparent from FIG. 5*a*, the value of the accelerating speed pattern V_a at time t_3 where the rated speed V_s is reached is given by

$$V_a = V_s - V_e + 2V_e = V_s + V_e \qquad 20$$

According to the present invention, the speed $V_s + V_e$ is taken as a reference and the actual speed pattern V coincides with the accelerating speed pattern V_a when $V_s + V_e - V_a > 2V_e$, that is, $Va < V_s - V_e$. The speed enters the mode 3 when the value of the accelerating speed pattern V_a attains the level of $V_s - V_e$ at time t_2 even when a difference of greater than $4V_e$ exists between the accelerating speed pattern V_a and the decelerating speed pattern V_b or $V_b - V_a > 4V_e$. In this mode 3, a smooth transition to the rated speed V_s cannot be carried out unless the acceleration is decreased. Accordingly, the value obtained by subtracting ΔV given by the equation (15) from V_a must be taken as the actual speed pattern V when the difference between the accelerating speed pattern V_a and the decelerating speed pattern V_b is greater than $4V_e$ or $V_b - V_a > 4V_e$ at the time at which the value of the accelerating speed pattern V_a attains the level of $V_s - V_e$. On the other hand, the following equation holds in this case:

$$2V_e - (V_s + V_e - V_a) = V_e + V_a - V_s = \alpha_s (t - t_2) \qquad 21$$

From the equations (17) and (21), ΔV is given by

$$\Delta V = \frac{1}{2}\beta_s \frac{(V_e + V_a - V_s)^2}{\alpha_s^2} = \frac{(V_e + V_a - V_s)^2}{4V_e} \qquad (22)$$

Accordingly, the actual speed pattern V in this range is given by

$$V = V_a - V_c' = V_a - (V_e + V_a - V_s)^2/4V_e \qquad 23$$

In the range in which the values of both the speed patterns V_a and V_b are greater than $V_s + V_e$, the mode 4 appears and the actual speed pattern V in this range coincides with the rated speed V_s. The mode 5 appears in the range in which the value of the decelerating speed pattern V_b is smaller than $V_s + V_e$. The actual speed pattern V in this range is given by

$$V = V_b - V_c' = V_b - (V_e + V_b - V_s)^2/4V_e$$

as in the case of the mode 3.

FIG. 6 is a block diagram of an embodiment of the present invention for generating the ideal speed pattern described above, and FIG. 7 is a diagram of a relay circuit employed in the embodiment shown in FIG. 6.

Referring to FIG. 6, an accelerating speed pattern generating means 1 generates accelerating speed patterns V_{a1} and V_{a2} which are the functions of time given by the equations (1) and (2). Thus, V_{a1} and V_{a2} are given by

$$V_{a1} = \tfrac{1}{2}\beta_s t^2$$
$$V_{a2} = \alpha_s t - V_e$$

A decelerating speed pattern generating means 2 generates decelerating speed patterns V_{b1} and V_{b2} which are the functions of time given by the equations (5) and (6). Thus, V_{b1} and V_{b2} are given by

$$V_{b1} = \tfrac{1}{2}\beta_s (6L/\beta_s)^{2/3}$$
$$V_{b2} = \sqrt{2\alpha_s (L - L_e/4)}$$

Lower level priority means 3 and 4 are adapted to deliver an output which corresponds to an input of the lower level between two inputs applied thereto, and adders 5, 6, 8 and 12 add two inputs applied thereto. A full-wave rectifier 7 delivers an output which is the absolute value of an input signal applied thereto, and diodes 9 and 13 block the passage of a negative signal. A function generator 10 generates an output corresponding to a function $(1/16)\ (1/V_e)\ x^2$ in response to an input signal x. A reference signal generating means 11 generates a reference signal representative of $V_s + V_e$. An amplifier 14 acts to double the signal delivered from the adder 12. Another reference signal generating means 15 generates a reference signal representative of $4V_e$. A relay A shown in FIG. 7 has make contacts A_a and A_a' and a break contact A_b.

The system shown in FIG. 6 generates the first speed pattern in a manner as described below. It will be apparent from the description given with reference to FIGS. 4*a* and 4*b* that, in the case of the first speed pattern, the difference $V_b - V_a$ between the decelerating speed pattern V_b and the accelerating speed pattern V_a becomes smaller than $4V_e$ before the value of the accelerating speed pattern V_a attains the level of $V_s - V_e$. In this case, the break contact A_b of the relay A is in its closed position since the relay A is deenergized. In response to the starting of the elevator, the value of the accelerating speed pattern V_a is successively increased. However, in the modes 1 and 2 in which the difference between the decelerating speed pattern V_b and the accelerating speed pattern V_a is larger than $4V_3$ or $V_b - V_a > 4V_e$, the output from the full-wave rectifier 7 is larger than $4V_e$ and no output is delivered from the diode rectifier 9, hence no output is delivered from the function generator 10.

In the meantime, the lower level priority means 3 and 4 select the accelerating speed pattern V_a so that the accelerating speed pattern V_a appears at the output of the system. When the value of $V_b - V_a$ becomes smaller than $4V_e$ as the value of the accelerating speed pattern V_a is further increased, the adder 8 delivers an output representative of $4V_e - |V_a - V_b|$ and the function generator 10 delivers an output representative of $(1/16)\ (1/V_e)\ (4V_e - |V_a - V_b|)^2$. Since the lower level priority means 3 and 4 select the smaller one of the accelerating speed pattern V_a and the decelerating speed pattern V_b, the actual speed pattern V appearing at the output of the system is represented by a value obtained by subtracting

$(1/16)\ (1/V_e)\ (4V_e - |V_a - V_b|)^2$ from the smaller one of V_a and V_b. As the value of the accelerating speed pattern V_a is further increased until it becomes larger than $V_b + 4V_e$, no output is delivered from the diode rectifier **9**, and the lower level priority means **3** and **4** now select the decelerating speed pattern V_b so that the decelerating speed pattern V_b appears at the output of the system as the actual speed pattern V.

The system shown in FIG. **6** generates the second speed pattern in a manner as described below. The operation of the system is the same as the case of the first speed pattern in the ranges in which the value of the accelerating speed pattern V_a is smaller than $V_s - V_e$. In the case of the second speed pattern, the relay A is energized to open the break contact A_b and close the make contact A_b when the value of the accelerating speed pattern V_a attains the level of $V_s - V_e$ and yet the difference $V_b - V_a$ between the decelerating speed pattern V_b and the accelerating speed pattern V_a is larger than $4V_e$.

The relay A is combined with relays B (not shown) and C (not shown) which are connected to the output side of the diode rectifier **9** and to the output side of the accelerating speed pattern generating means **1**, respectively, so as to constitute a circuit as shown in FIG. **7**. The relay B has a contact B_b which is closed in response to the appearance of an output from the diode rectifier **9** and holds itself. The relay C has a contact C_a which is momentarily closed when $V_a = V_s - V_e$ and is then urged to its open position again. The relay A is connected to a power supply through terminals **16** and **17**. Thus, the relay A is energized when $V_a = V_s - V_e$ and the contact B_b is in its closed position due to $V_b - V_a > 4\ V_e$. The relays A and B are released from their self-holding state in response to the stoppage of the elevator at the desired floor. Thus, the mode **3** is started when the relay A is energized and is ended when V_a equals $V_s + V_e$. The accelerating speed pattern V_a is selected by the lower level priority means **3** and **4** and the amplifier **14** delivers an output representative of $2(V_s + V_e - V_a)$. Consequently, the comparator **8** delivers an output representative of $2(V_e + V_a - V_s)$ and the function generator **10** delivers an output representative of $(¼)\ (1/V_e)\ (V_e + V_a - V_s)^2$. Therefore, the actual speed pattern V appearing at the output of the system is represented by $V_a - (¼)\ (1/V_e)\ (V_e + V_a - V_s)^2$. The mode **4** begins when the values of both the accelerating speed pattern V_a and the decelerating speed pattern V_b are larger than $V_s + V_e$. In this case, the lower level priority means **4** delivers an output representative of $V_s + V_e$ and a negative output is delivered from the comparator **12**. Thus, no output is delivered from the diode rectifier **13** and the comparator **8** delivers an output representative of $4V_e$ with the result that the function generator **10** delivers an output representative of V_e and the actual speed pattern V appearing at the output of the system is represented by the rated speed V_s. In the range in which $V_s + V_e > V_b > V_s - V_e$, that is, in the mode **6**, the operation of the system is similar to that in the case of the mode **4** so that the actual speed pattern V appearing at the output of the system is now represented by $V_b - (¼)(1/V_e)\ (V_e + V_b - V_s)^2$. In the range in which $V_b < V_s - V_e$, that is, in the mode **7**, the output from the comparator **12** is larger than $2V_e$ and the output from the amplifier **14** is larger than $4V_e$ with the result that no output is delivered from the diode rectifier **9**. In this range, the lower level priority means **3** and **4** select the decelerating speed pattern V_b and thus the actual speed pattern V appearing at the output of the system is represented by the decelerating speed pattern V_b.

In the embodiment described above by way of example, the rate of variation of acceleration is kept constant and the compensating speed pattern V_c is supplied when the difference between the accelerating speed pattern V_a and the decelerating speed pattern is equal to $4V_e$. However, these values may be suitably varied within a certain range. The same applies also to the compensating speed pattern V_c'.

FIG. **8** shows a plurality of first speed patterns P_1 through P_9 and a second speed pattern P_{10} generated by the system according to the present invention. It will be seen from FIG. **8** that the speed of the elevator during deceleration is variable depending on the relative distance between the floor level at which the elevator is at rest and the desired floor level in the case of the first speed pattern.

What is claimed is:

1. A speed pattern generator for an elevator control system comprising means for generating a monotonously increasing accelerating speed pattern, means for generating a decelerating speed pattern which is a function of the distance between the elevator and the desired floor level, and decreases monotonously, and means for generating a compensating speed pattern which is a function of the difference between said accelerating speed pattern and said decelerating speed pattern and decreases monotonously, wherein said accelerating speed pattern or said decelerating speed pattern is selected as the actual speed pattern in the range in which the difference between said accelerating speed pattern and said decelerating speed pattern is larger than a predetermined setting, while the value obtained by subtracting said compensating speed pattern from said accelerating speed pattern or said decelerating speed pattern is selected as the actual speed pattern in the range in which the difference between said accelerating speed pattern and said decelerating speed pattern is smaller than the predetermined setting.

2. A speed pattern generator for an elevator control system as claimed in claim **1**, in which said accelerating speed pattern is a function of time.

3. A speed pattern generator for an elevator control system comprising means for generating an accelerating speed pattern which is a function of time and increases monotonously, means for generating a decelerating speed pattern which is a function of the distance from the elevator to a floor and decreases monotonously, and means for generating a compensating speed pattern which is a function of the difference between said accelerating speed pattern and said decelerating speed pattern and decreases monotonously, wherein said accelerating speed pattern is selected as the actual speed pattern in the range in which the difference between said accelerating speed pattern and said decelerating speed pattern is larger than a predetermined setting, while the value obtained by subtracting said compensating speed pattern from said accelerating speed pattern is selected as the actual speed pattern in the range in which the difference between said accelerating speed pattern and said decelerating speed pattern is smaller than the predetermined setting.

4. A speed pattern generator for an elevator control system comprising means for generating an accelerating speed pattern which is a function of time and increases monotonously, means for generating a decelerating speed pattern which is a function of the distance from the elevator to a floor and decreases monotonously, and means for generating a compensating speed pattern which is a function of the difference between said accelerating speed pattern and said decelerating speed pattern and decreases monotonously, wherein said decelerating speed pattern is selected as the actual speed pattern in the range in which the difference between said accelerating speed pattern and said decelerating speed pattern is larger than a predetermined setting, while the value obtained by subtracting said compensating speed pattern from said decelerating speed pattern is selected as the actual speed pattern in the range in which the difference between said accelerating speed pattern and said decelerating speed pattern is smaller than the predetermined setting.

5. A speed pattern generator for an elevator control system comprising means for generating an accelerating speed pattern which is a function of time and increases monotonously, means for generating a decelerating speed pattern which is a function of the distance from the elevator to a floor and decreases monotonously, and means for generating a compensating speed pattern which is a function of the difference between a first predetermined speed higher than the rated speed and said accelerating speed pattern or said decelerating speed pattern and decreases monotonously, wherein the value obtained by subtracting said compensating speed pattern from

the smaller one of said accelerating speed pattern and said decelerating speed pattern is selected as the actual speed pattern in the range in which the difference between said accelerating speed pattern having attained the level of a second predetermined speed lower than the rated speed and said decelerating speed pattern is not smaller than a predetermined setting, while the rated speed is selected as the actual speed pattern in the range in which the values of both said accelerating speed pattern and said decelerating speed pattern are larger than the value of the first predetermined speed.

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