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APPARATUS FOR DECELERATING ELEVATOR
AT TERMINATING FLOOR

BACKGROUND OF THE INVENTION

The present invention relates to an improved
5 apparatus for generating a decelerating command at the
terminating floor of an elevator.

The speed of an elevator cage is controlled in
accordance with a speed command value. A terminating
deceleration command value is produced for protecting
10 the speed command value at the terminating floor. This
is shown in Figs. 1 to 3.

In Figs. 1 to 3, numeral 1 designates a speed
instructing unit which generates a normal speed command
value V_p , numeral 2 a selecting circuit which selects
15 either a smaller value than the speed command value V_p
or a terminating deceleration command value V_s , which
will be described later, numeral 3 an adder which adds
the output of the selecting circuit 2 and a speed signal,
which will be described later, and which outputs a
20 deviation signal between the output of the selecting
circuit 2 and the speed signal, numeral 4 a speed
controller which outputs a speed control signal in
response to the deviation signal, numeral 5 a thyristor
converter which comprises thyristors and which has its
25 output voltage controlled in accordance with the speed
control signal, numeral 6 an armature of a winding D.C.
motor which is connected to the thyristor converter 5,

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numeral 7 a tachometer generator which is coupled directly to the armature 6 and which produces a speed signal which is inputed to the adder 3, numeral 8 a sheave for a winch which is driven by the armature 6, numeral 9 a deflector wheel, numeral 10 a main cable which is engaged with the sheave 8 and the deflector wheel 9, numeral 11 a cage which is coupled to one end of the main cable 10, numeral 12 a balance weight which is similarly coupled to the other end of the main cable 10, numeral 13 a cam which is fixedly secured to the cage 11, numeral 14 the top floor, numeral 15 the bottom floor, numerals 16 to 20 terminating detectors which are respectively provided in an elevational passage so as to be sequentially disposed toward the top terminating floor 14 and which successively operate when each is engaged with the cam 13, numerals 16a to 20a their normally closed contacts (in Fig. 2), numerals 21 to 25 terminating detectors which are similarly respectively provided in the elevational passage so as to be sequentially disposed toward the bottom terminating floor 15, numerals 21a to 25a their normally closed contacts (in Fig. 2), and numeral 26 a terminating deceleration instructing unit which produces the terminating deceleration command value V_s in accordance with the outputs of the detectors 16 to 26. In Fig. 2, numeral 27 designates an ascending operation relay contact which closes when the cage 11 ascends, numeral 28 a descending operation relay contact which closes when the

cage 11 similarly descends, numeral 29 an operational amplifier, characters R_1 to R_5 , R_{11} to R_{15} and R_s resistors, character C a capacitor, and character $-V_{ee}$ a D.C. negative power voltage.

5 As shown in Fig. 3, since the voltages V_p and V_s are normally set to the relationship of $V_p < V_s$, the selecting circuit 2 selects the speed command value V_p , the speed controller 4 operates in accordance with this speed command value V_p , thereby operating the thyristor
10 converter 5, which in turn applies a voltage to the armature 6 of the motor. Thus, the armature 6 rotates, thereby running the cage 11 through the sheave 8 and the main cable 10. The speed of the cage 11 is detected by the tachometer generator 7, the speed signal of the
15 tachometer generator 7 is compared by the adder 3 with the speed command value V_p , and the cage 11 is accurately controlled in accordance with the speed command value V_p .

When the cage 11 is, on the other hand, ascending along an intermediate floor, the ascending
20 operation relay contact 27 remains closed, and the terminating detectors 16 to 20 are not activated. Accordingly, their contacts 16a to 20a are all closed. Therefore, the terminating deceleration command value V_s becomes, as shown in Fig. 3, $V_s = V_1$. When the cage 11
25 continues to ascend and reaches a point S_1 , the detector 16 engages with the cam 13, allowing the contact 16a to open. Thus, the input resistor R_1 of the amplifier 29 is disconnected from the power voltage $-V_{ee}$, and the

terminating deceleration command value V_s decrease, as shown in Fig. 3, at a time constant which is determined by the resistor R_s and the capacitor C and eventually becomes a voltage V_2 . When the cage 22 further ascends and reaches a point S_2 , the detector 17 operates, allowing the contact 17a to open. Thus, the terminating deceleration command value V_s similarly decreases at the time constant and eventually becomes a voltage V_3 . Similarly, the detectors 18, 19 operate, and the terminating deceleration command value V_s decreases. When the cage 11 thus finally reaches a point at a distance S_5 before the top floor 14, the detector 20 operates, allowing the contact 20a to open, and the terminating deceleration command value V_s decreases toward zero.

When the speed command value V_p does not decrease and the values V_p and V_s becomes $V_p < V_s$ even if a malfunction occurs in the speed instructing unit and the cage 11 approaches the vicinity of the top floor 14, the selecting circuit 2 selects the terminating deceleration command value V_s . Thus, the cage 11 decelerates and stop at the top floor 14 in accordance with the terminating deceleration command value V_s .

In case of the descending operation, the operation is performed similarly to the case of the ascending operation except that the descending operation relay contact 28 closes and the terminating detectors 21 to 25 operate.

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In this case, the deceleration of the terminating deceleration command value V_s should be set as low as possible so as to protect the thyristor and the motor against an excessively large current at the decelerating time. For that purpose, a number of terminating detectors 16 to 25 should be provided. Since the detectors 16 to 25 are, on the other hand, restricted in their disposition, the number of the detectors should be limited. Accordingly, the deceleration of the terminating deceleration command value V_s cannot be reduced to a sufficient value, and the thyristor and the motor employed become rigid and expensive.

An object of the present invention is to avoid the above-mentioned complexity and high cost and to provide an apparatus for decelerating an elevator at the terminating floor, enabling the deceleration of the terminating deceleration command value to be set to a sufficiently low value and requiring a lesser number of terminating detectors.

The present invention resides in an apparatus for decelerating an elevator at a terminating floor having a plurality of terminating detectors provided in the vicinity of the terminating floor for generating a terminating deceleration command value gradually decreasing upon successive operations of the detectors when a cage of the elevator approaches the terminating floor, comprising:

a pulse generator which generates pulses corresponding in number to the distance travelled by the cage;

memories which store distances from the terminating floor to the respective terminating detectors;

a counter in which, when the cage starts an ascending or descending operation from an intermediate floor not provided with a terminating detector, the stored distance information of the terminating detector
5 arranged to be the first detector operated after the start of the operation is pre-set from memory, on operation of said detector the pulses of distance travelled are subtracted from the preset distance, and thereafter, on operation of a further detector, the
10 distance information of the memory corresponding to said further terminating detector is set in the counter and the said pulses are subtracted therefrom; and
a distance-to-speed converter which calculates the terminating deceleration command value corresponding to
15 the output of said counter.

In accordance with the invention, the apparatus generates a pulse from terminating detectors in response to the travel distance of the cage, sets a value corresponding to the distance from the terminating floor
20 at the terminating detectors when each detector operates, counts the pulses and subtracts the pulse from the set value, and calculates the terminating deceleration command value from the subtracted value.

BRIEF DESCRIPTION OF THE DRAWINGS

25 Fig. 1 is a diagram showing the construction of a conventional apparatus for decelerating an elevator at a terminating floor;

Fig. 2 is a circuit diagram of the terminating detectors and the terminating deceleration instructing
30 unit section in Fig. 1;

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Fig. 3 is a diagram showing speed command value vs. time curves;

Fig. 4 is a diagram illustrating the construction of an apparatus for decelerating an elevator at a terminating floor according to an embodiment of the present invention;

Fig. 5 is a block circuit diagram illustrating terminating detectors, a pulse generator and terminating deceleration instructing unit section in Fig. 4;

Fig. 6 is a diagram showing a speed command value vs. distance curve;

Fig. 7 is a diagram showing speed command value vs. time curves; and

Fig. 8 is a block circuit diagram illustrating the use of a computer for performing the present invention.

An embodiment of the invention will be described below in conjunction with the accompanying drawings, wherein the same symbols indicate the same or corresponding parts as in Fig. 1.

In Fig. 4, numeral 41 designates a rope which is coupled at both ends to a cage 11 in an endless loop and which is disposed in an elevator shaft, numeral 42 a tension wheel which imparts a downward tension on the rope 41, numeral 43 a disc which is driven by the rope 41 and in which are formed fine holes 43a at equal intervals on the periphery thereof, and numeral 44

a pulse generator which is provided on the disc 43 and which generates a pulse 44a every time a fine hole 43a of the disc 43 passes the pulse generator, thereby creating a pulse train which is applied to a terminating
5 deceleration instructing unit 26.

In Fig. 5, character V_{cc} designates a D.C. positive power voltage, numerals 16b to 20b normally open contacts of the respective terminating detectors 16 to 20 (in Fig. 4), numerals 21b to 26b normally open
10 contacts of the respective terminating detectors 21 to 25, numeral 45 an AND gate, numerals 461 to 465 monostable elements, hereinafter referred to as "OSM", which produce an output "H" for a predetermined period of time when its input becomes "H", numeral 47 an OR gate, numerals 481
15 to 485 memory devices which respectively store data (binary) corresponding to the distances S_1 to S_5 from the terminating floors 14 and 15 to the terminating detectors 16 to 20 and 21 to 25, numerals 491 to 495 multiplexers, hereinafter referred to as "MPX", which
20 respectively transfer the contents from the memories 481 to 485 when an input G becomes "H", numeral 50 a subtraction counter which is preset to a new value according to the inputs from the MPX 491 to 495 when an input L becomes "H" and which respectively subtracts
25 the preset value by the pulse of an input I, numeral 51 a distance-to-speed converter which has a read-only memory (ROM) for storing speed command values corresponding to the distances, and numeral 52 a digital-analogue converter

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which converts a digital amount into an analog amount and which generates a terminating deceleration command value V_s . The remaining components not mentioned above are the same as those in Fig. 1. The cam 13 has a length
5 which can simultaneously engage the detectors 16 to 20 or 21 to 25. The relation of the disposition (or distance) of the detectors 16 to 20 to the top floor 14 is the same as that of the disposition (or distance) of the detectors 21 to 25 to the bottom floor 15.

10 For the case where all the detectors are not simultaneously engaged by the cam 13, electric circuits may be utilized to maintain the contacts in an open or closed state. For example, in Fig. 2, the contacts
16a, 17a, ..., 20a are kept open by said electric circuits
15 and are caused to close only when the cage moves downward and the cam 13 comes into contact with the detectors 16, 17, ..., 20, respectively.

The operation of this embodiment will be described here below.

20 When the cage 11 starts ascending from any one intermediate floor, the ascending operation relay contact 27 closes. Since the detector 17 is not yet operated at this time and its contact 17a is closed, the output of the OSM 461 becomes "H" for a predetermined short time
25 (e.g., several sec.), and the MPX 491 will be activated. The output of the OR gate 47 simultaneously becomes "H", and the content of the memory 481 is accordingly preset in the counter 50. Since a binary number corresponding

to the distance S_1 shown in Fig. 6 is stored in the memory 481, the output of the counter 50 indicates the distance S_1 , and this output is inputted to the address line of the ROM which forms the distance-to-speed converter 51. On the other hand, a function of distance S vs. speed command value V shown in Fig. 6, generally $V = \sqrt{2\alpha S}$, where α represents a deceleration, is stored in the converter 51, and a binary number corresponding to the speed command value V_1 is outputted from its data line. The D/A converter 52 converts the binary number into an analog amount, and sets it to the terminating deceleration command value $V_s = V_1$.

When the cage 11 is continuously ascending and the detector 16 is engaged with the cam 13 at a time t_1 in Fig. 7, its contact 16b closes. Accordingly, the AND gate 45 is opened, and its output becomes a pulse 44a. Thus, a pulse is subtracted from the distance S_1 of the binary number thus preset in the counter, and the counted value is delivered to the address line of the converter 51. The converter 51 extracts the speed command value corresponding to its value every time the counted value of the counter 50 is altered, the speed command value is outputted through the converter 52, and the terminating deceleration command value V_s starts decreasing as shown in Fig. 7.

When the cage 11 further ascends and the detector 17 is engaged with the cam 13 at a time t_2 in Fig. 7, its contact 17b closes. Since the contact 18a

is closed at this time, the output of the OSM 462 becomes "H" for a predetermined short time. Thus, the MPX 492 and the OR gate 47 similarly operate, and the content of the memory 482 is transferred to the counter 50. Since
5 the binary number corresponding to the distance S_2 shown in Fig. 6 is stored in the memory 482, the output of the counter 50 indicates the distance S_2 , and the terminating deceleration command value V_s is similarly corrected to $V_s = V_2$. In this case, a slight difference would be
10 produced at the command value V_s as shown in Fig. 7, but this is not practically affected.

Since the detector 16 is engaged with the cam 13 even after the time t_2 , the counter 50 continues subtracting the pulses 44a, and the command value V_s
15 further continues decreasing.

When the detector 20 is eventually engaged with the cam 13 at a time t_5 and its contact 20b is closed, the command value V_s is similarly corrected to $V_s = V_5$. Thereafter, the command value V_s is reduced toward zero
20 by the pulses 44a.

In case of the descending operation, the operation is similarly to the ascending operation except that the descending operation relay contact 28 is closed and the detectors 21 to 25 are operated. At this time,
25 the memories, the MPX, the counter, the distance-to-speed converter and the D/A converter are employed in the same manner as described above.

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Since the detection of the position in the zones between one terminating detector and an adjacent terminating detector is related to the number of directly generated pulses, the position of the cage as described above is directly proportional to the number of terminating detectors and pulses generated which indirectly implies that the number of terminating detectors has been increased accordingly.

The apparatus of the invention may comprise a computer such as a microcomputer which performs the functions described with reference to Fig. 5. Fig. 8 shows a block diagram of apparatus incorporating such a computer, with a central processing unit 55, hereinafter referred to as a "CPU", a read-only memory 56, whereinafter referred to as a "ROM", which stores programs and fixed value data, a random access memory 57, hereinafter referred to as a "RAM", which temporarily stores data, a bus 58 such as an address bus or a data bus, an input converter 59 which forms a converter for allowing the CPU 55 to read the operating states of the ascending operation relay contact 27 and the descending operation relay contact 28, an input converter 60 which forms a converter for similarly reading the pulses 44a, and an output converter 61 for converting the digital command value V_s calculated by the CPU 55 into an analog value.

The operation states of the detectors 16 to 25 are read to the CPU 55 through the converter 59. The

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pulse 44a is read to the CPU 55 through the converter 60.
The value which is calculated through the elements after
the AND gate 45 in Fig. 5 is calculated by the CPU 55,
the ROM 56 and the RAM 57. The calculated result is
5 outputted as the terminating deceleration command value
 V_s through the converter 61.

According to the present invention, as mentioned
above, a pulse corresponding to the moved distance of the
cage is generated, the value corresponding to the distance
10 from the top floor detector is set when the detector is
operated, the pulse is subtracted from the set value,
and a terminating deceleration command value
corresponding to the subtracted value is calculated.
Therefore, the deceleration of the terminating deceleration
15 command value can be set to a sufficiently low value while
utilizing a minimum number of terminating detectors, as
well as allowing the use of inexpensive thyristors and
motor.

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CLAIMS:

1. An apparatus for decelerating an elevator at a terminating floor having a plurality of terminating detectors provided in the vicinity of the terminating floor for generating a terminating deceleration command value gradually decreasing upon successive operations of the detectors when a cage of the elevator approaches the terminating floor, comprising:

a pulse generator which generates pulses corresponding in number to the distance travelled by the cage;

memories which store distances from the terminating floor to the respective terminating detectors;

a counter for which, when the cage starts an ascending or descending operation from an intermediate floor not provided with a terminating detector, the stored distance information of the terminating detector arranged to be the first detector operated after the start of the operation is pre-set from memory, on operation of said detector the pulses of distance travelled are subtracted from the preset distance, and thereafter, on operation of a further terminating detector, the distance information of the memory corresponding to said further terminating detector is set in the counter and the said pulses are subtracted therefrom; and



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a distance-to-speed converter which calculates the terminating deceleration command value corresponding to the output of said counter.

2. An apparatus for decelerating an elevator at a terminating floor as set forth in claim 1, wherein the pulses continue to be supplied to said counter from the time at which the terminating detector first operated after the start of the operation detects the presence of the cage, till the time at which the terminating detector operated last detects the presence of the cage.

3. An apparatus for decelerating an elevator at a terminating floor as set forth in claim 2, wherein said counter is preset by an element which produces an output signal for a predetermined time upon the start of the ascending or descending operation of the cage.

4. An apparatus for decelerating an elevator at a terminating floor as set forth in any preceding claim, wherein the terminating detectors are installed in the vicinities of both the top floor and the bottom floor, and said memories, said counter and said distance-to-speed converter are started operating by any of said terminating detectors.



5. An apparatus for decelerating an elevator at a terminating floor as set forth in claim 4, wherein the relation of the distances to the top floor, of the respective terminating detectors provided in the vicinity of the top floor is equal to that of the distances to the bottom floor, of the respective terminating detectors provided in the vicinity of the bottom floor.

6. An apparatus for decelerating an elevator at a terminating floor as set forth in any preceding claim, wherein in accordance with a signal produced upon acknowledgement of the presence of the cage by a said further terminating detector, the distance information corresponding to said terminating detector which is a production source of said signal is set in said counter from the memory storing said distance information.

7. An apparatus for decelerating an elevator at a terminating floor as set forth in any preceding claim, wherein said distance-to-speed converter is a memory device which stores a speed command value corresponding to the distance, and it sequentially outputs speed command values corresponding to the distance signals from said counter.



8. An apparatus for decelerating an elevator at a terminating floor as set forth in any preceding claim, wherein the distance information corresponding to each of said further terminating detectors is set in
5 said counter by an element which produces an output signal for a predetermined time in response to the operation of each said terminating detector.

9. Apparatus as claimed in any of the preceding claims in which the said memories, counter and
10 distance-to-speed converter comprise a computer.

10. Apparatus for decelerating an elevator at a terminating floor, substantially as herein described with reference to Figures 4 to 7 or Figure 8 of the accompanying drawings.

