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# Apparatus for opening and closing elevator doors

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FIG. 1

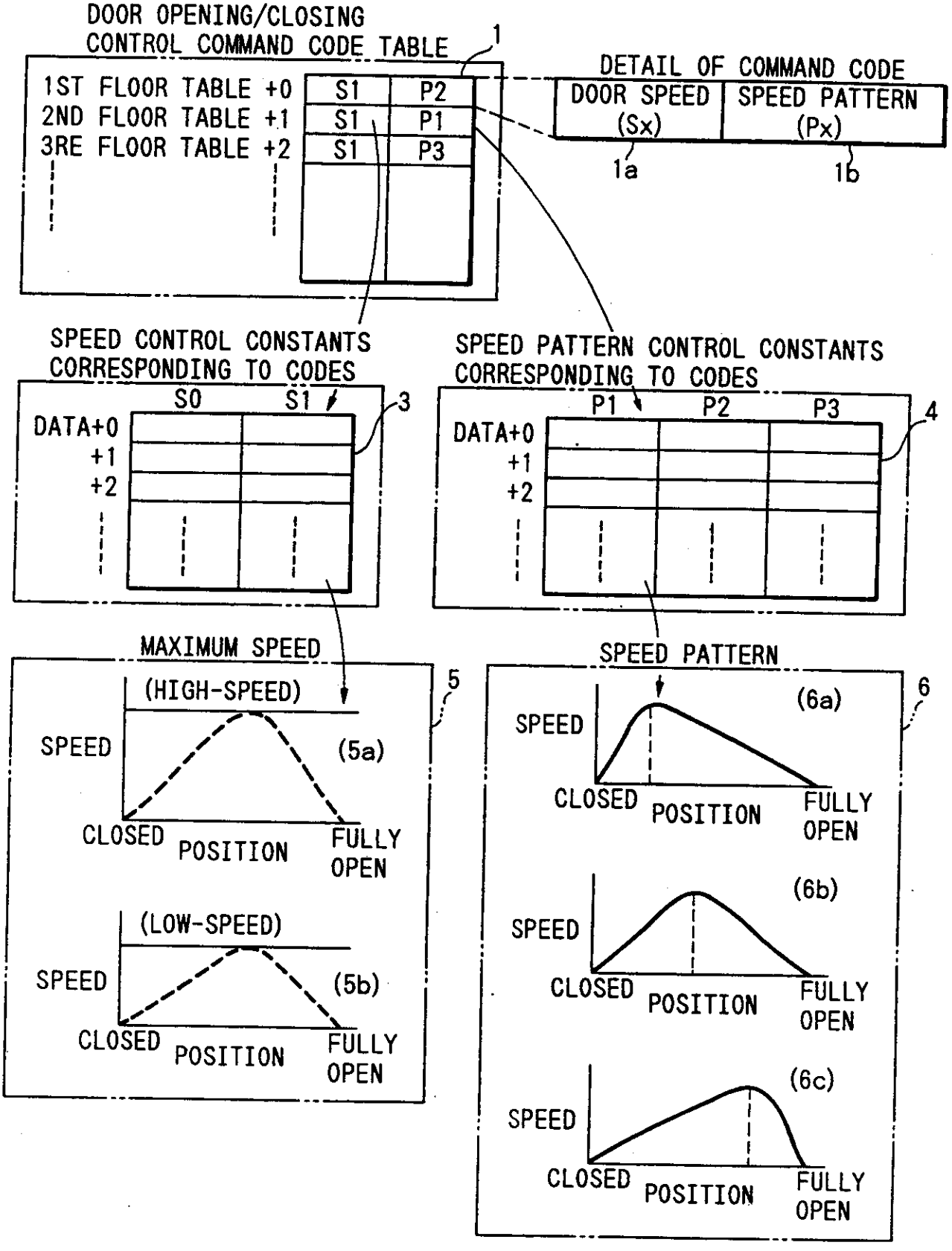

DOOR OPENING/CLOSING
CONTROL COMMAND CODE TABLE
1
1ST FLOOR TABLE +0
2ND FLOOR TABLE +1
3RE FLOOR TABLE +2
S1
P2
S1
P1
S1
P3
DETAIL OF COMMAND CODE
DOOR SPEED
(Sx)
SPEED PATTERN
(Px)
1a
1b
SPEED CONTROL CONSTANTS
CORRESPONDING TO CODES
S0
S1
3
DATA+0
+1
+2
SPEED PATTERN CONTROL CONSTANTS
CORRESPONDING TO CODES
P1
P2
P3
4
DATA+0
+1
+2
MAXIMUM SPEED
5
(HIGH-SPEED)
SPEED
(5a)
CLOSED
POSITION
FULLY
OPEN
(LOW-SPEED)
SPEED
(5b)
CLOSED
POSITION
FULLY
OPEN
SPEED PATTERN
6
SPEED
(6a)
CLOSED
POSITION
FULLY
OPEN
SPEED
(6b)
CLOSED
POSITION
FULLY
OPEN
SPEED
(6c)
CLOSED
POSITION
FULLY
OPEN

FIG. 2

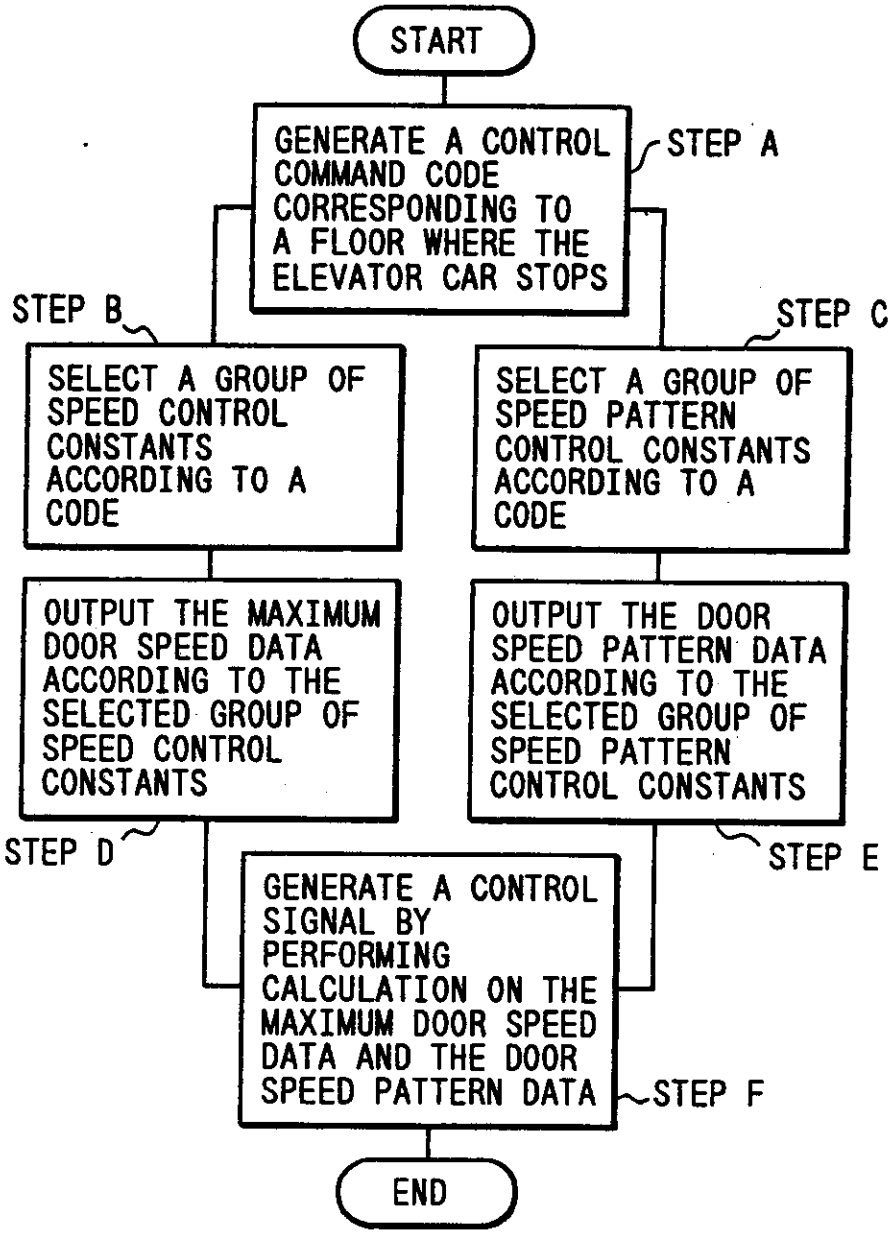

START
GENERATE A CONTROL COMMAND CODE CORRESPONDING TO A FLOOR WHERE THE ELEVATOR CAR STOPS
STEP A
STEP B
SELECT A GROUP OF SPEED CONTROL CONSTANTS ACCORDING TO A CODE
STEP C
SELECT A GROUP OF SPEED PATTERN CONTROL CONSTANTS ACCORDING TO A CODE
OUTPUT THE MAXIMUM DOOR SPEED DATA ACCORDING TO THE SELECTED GROUP OF SPEED CONTROL CONSTANTS
STEP D
OUTPUT THE DOOR SPEED PATTERN DATA ACCORDING TO THE SELECTED GROUP OF SPEED PATTERN CONTROL CONSTANTS
STEP E
GENERATE A CONTROL SIGNAL BY PERFORMING CALCULATION ON THE MAXIMUM DOOR SPEED DATA AND THE DOOR SPEED PATTERN DATA
STEP F
END

FIG. 3

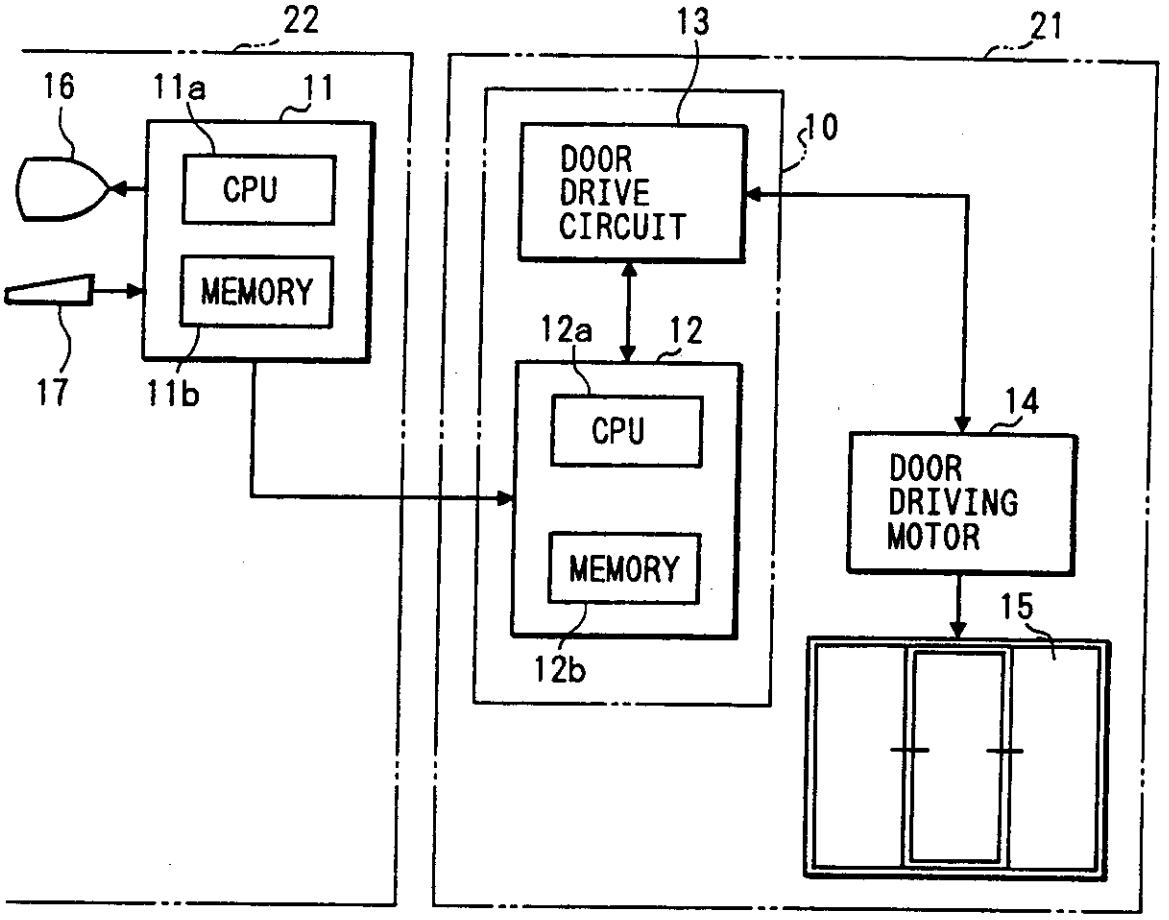

22
13
21
16
11a
11
10
CPU
DOOR
DRIVE
CIRCUIT
MEMORY
12a
12
17
11b
CPU
14
DOOR
DRIVING
MOTOR
MEMORY
15
12b

FIG. 4

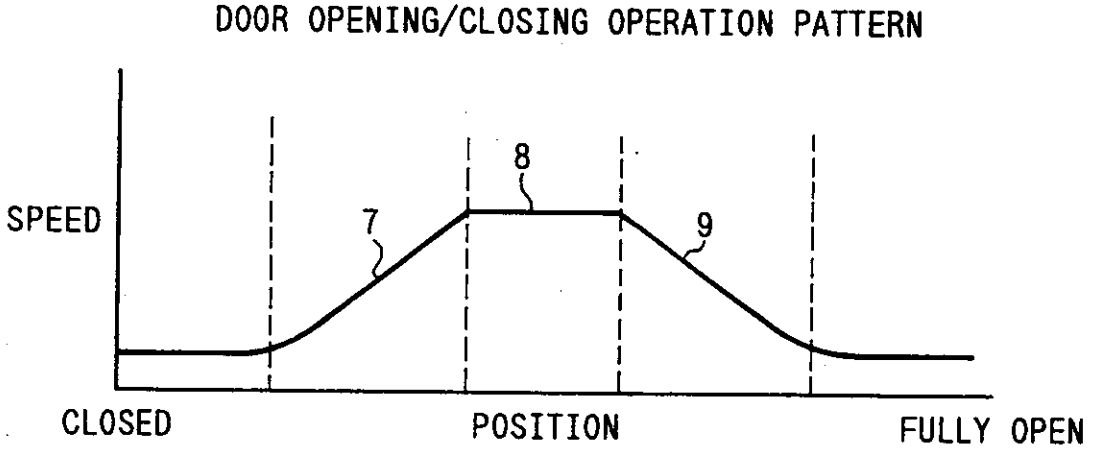

DOOR OPENING/CLOSING OPERATION PATTERN
SPEED
7
8
9
CLOSED
POSITION
FULLY OPEN

FIG. 5

<EXAMPLE WITH THE SAME SPEED PATTERN BUT WITH DIFFERENT TOP SPEEDS>

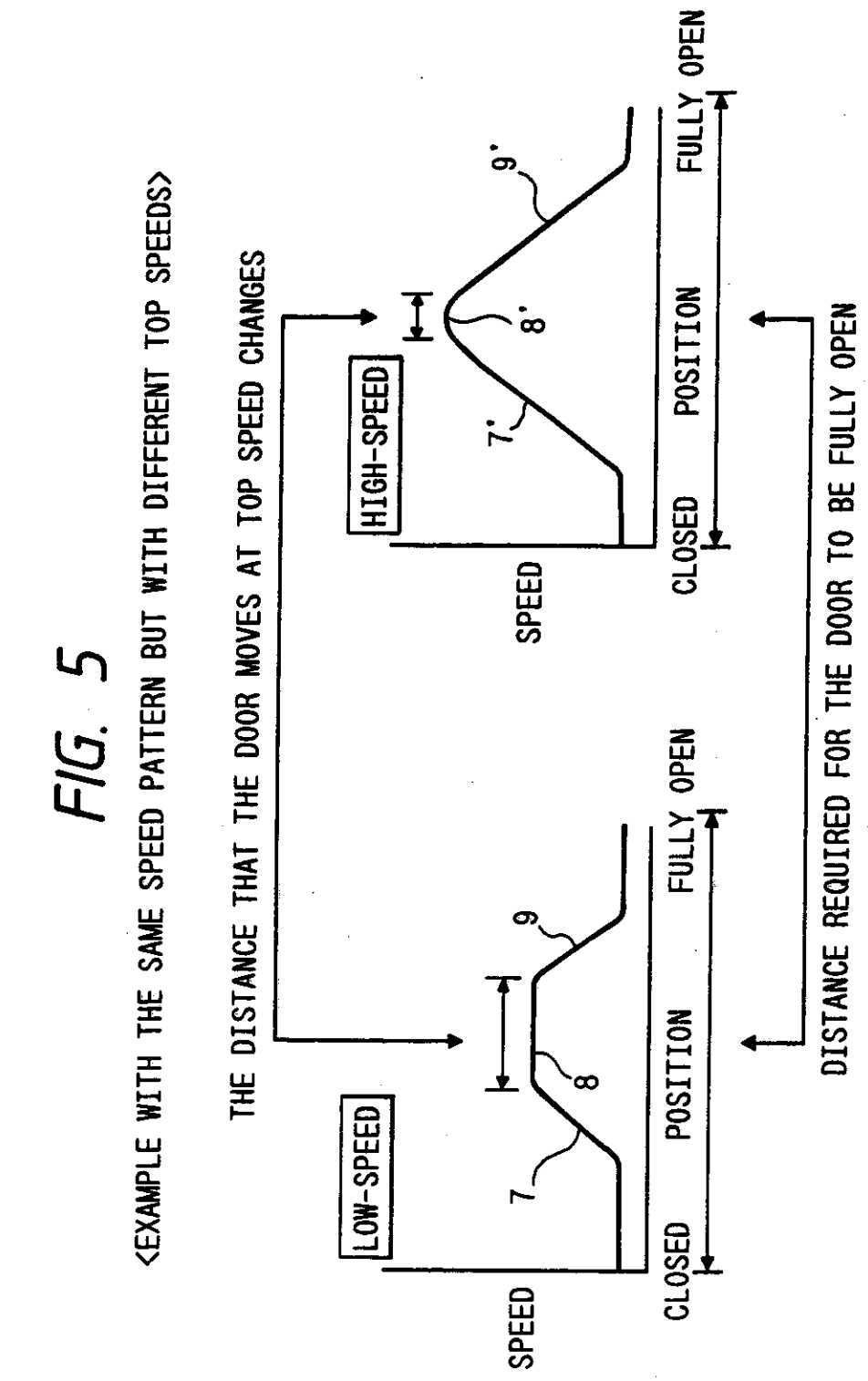


FIG. 6

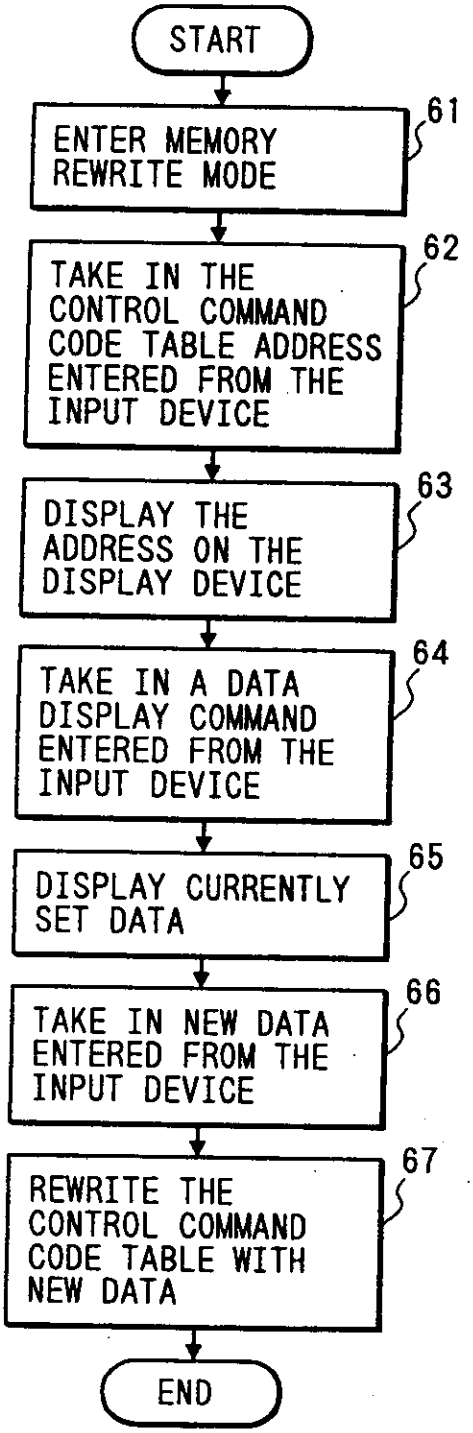

START
ENTER MEMORY REWRITE MODE
61
TAKE IN THE CONTROL COMMAND CODE TABLE ADDRESS ENTERED FROM THE INPUT DEVICE
62
DISPLAY THE ADDRESS ON THE DISPLAY DEVICE
63
TAKE IN A DATA DISPLAY COMMAND ENTERED FROM THE INPUT DEVICE
64
DISPLAY CURRENTLY SET DATA
65
TAKE IN NEW DATA ENTERED FROM THE INPUT DEVICE
66
REWRITE THE CONTROL COMMAND CODE TABLE WITH NEW DATA
67
END

FIG. 7

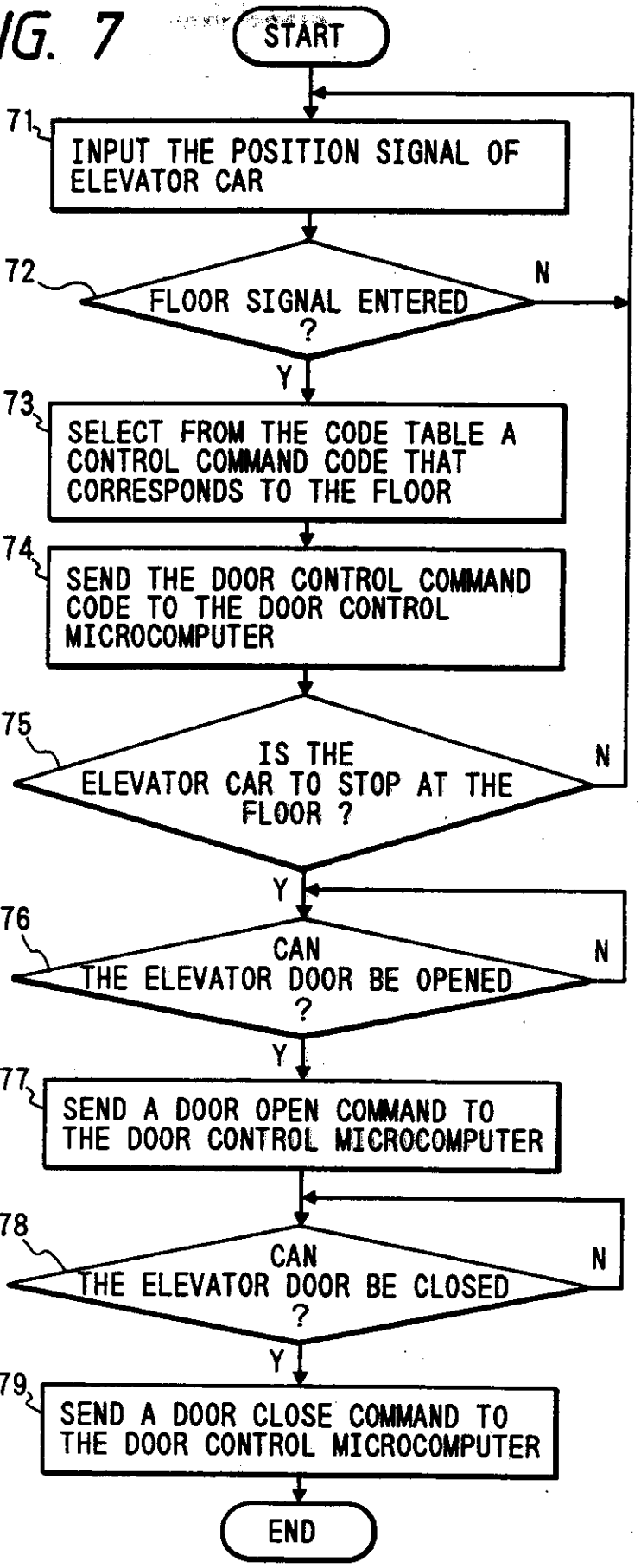
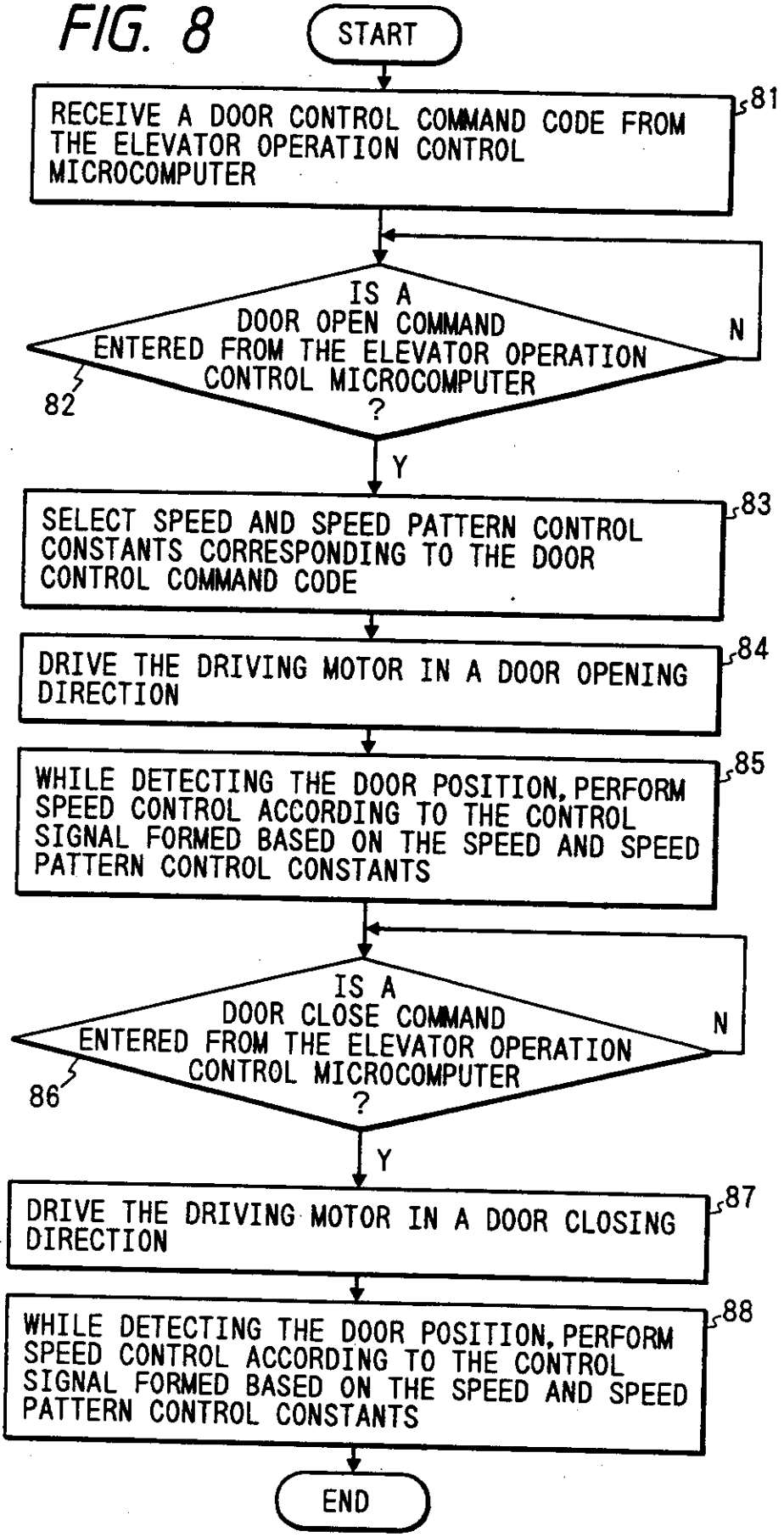

START
71
INPUT THE POSITION SIGNAL OF ELEVATOR CAR
72
FLOOR SIGNAL ENTERED ?
N
Y
73
SELECT FROM THE CODE TABLE A CONTROL COMMAND CODE THAT CORRESPONDS TO THE FLOOR
74
SEND THE DOOR CONTROL COMMAND CODE TO THE DOOR CONTROL MICROCOMPUTER
75
IS THE ELEVATOR CAR TO STOP AT THE FLOOR ?
N
Y
76
CAN THE ELEVATOR DOOR BE OPENED ?
N
Y
77
SEND A DOOR OPEN COMMAND TO THE DOOR CONTROL MICROCOMPUTER
78
CAN THE ELEVATOR DOOR BE CLOSED ?
N
Y
79
SEND A DOOR CLOSE COMMAND TO THE DOOR CONTROL MICROCOMPUTER
END

FIG. 8


START
RECEIVE A DOOR CONTROL COMMAND CODE FROM THE ELEVATOR OPERATION CONTROL MICROCOMPUTER
81
IS A DOOR OPEN COMMAND ENTERED FROM THE ELEVATOR OPERATION CONTROL MICROCOMPUTER ?
82
N
Y
SELECT SPEED AND SPEED PATTERN CONTROL CONSTANTS CORRESPONDING TO THE DOOR CONTROL COMMAND CODE
83
DRIVE THE DRIVING MOTOR IN A DOOR OPENING DIRECTION
84
WHILE DETECTING THE DOOR POSITION, PERFORM SPEED CONTROL ACCORDING TO THE CONTROL SIGNAL FORMED BASED ON THE SPEED AND SPEED PATTERN CONTROL CONSTANTS
85
IS A DOOR CLOSE COMMAND ENTERED FROM THE ELEVATOR OPERATION CONTROL MICROCOMPUTER ?
86
N
Y
DRIVE THE DRIVING MOTOR IN A DOOR CLOSING DIRECTION
87
WHILE DETECTING THE DOOR POSITION, PERFORM SPEED CONTROL ACCORDING TO THE CONTROL SIGNAL FORMED BASED ON THE SPEED AND SPEED PATTERN CONTROL CONSTANTS
88
END

# APPARATUS FOR OPENING AND CLOSING ELEVATOR DOORS

The present invention relates to an elevator apparatus and more particularly to an elevator door opening/closing control performed by an elevator door opening and closing apparatus.

The door opening/closing control in elevators is generally performed based on a predetermined, fixed door opening and closing speed change pattern, and it is difficult to set or modify the door opening and closing speed change pattern individually for a particular elevator door installed at a particular floor. In recent years, however, as door opening/closing control apparatuses which control a drive motor using an inverter control has come into use with elevators and microcomputers have come to be used for control processing, it is now possible to change the door opening/closing speeds.

Japanese Patent Laid-Open No. 158382/1991 discloses an elevator door opening/closing apparatus, which stores a door opening/closing speed for each floor as control target data in an electrically erasable and programmable read-only memory (EEPROM) to perform the opening/closing speed control on the elevator door according to the floor at which the elevator is to stop.

This elevator door opening/closing apparatus, however, simply makes alterable the door opening and closing speed at each floor (the maximum speed of the door opening/closing operation). This system has a drawback that setting the opening/closing speed high will increase the danger of passengers being caught by the door when the door is closed at high speed.

Japanese Patent Laid-Open No. 235186/1987 and 51292/1988 disclose an elevator door control apparatus, which permits the door opening/closing pattern data to be rewritten for each floor. With this apparatus, however, to set a variety of opening/closing operation patterns or make changes to them requires a large number of data to be rewritten, lowering the work efficiency.

An object of the present invention is to provide an elevator door opening/closing apparatus, which can set or alter the door opening/closing operation characteristic easily in a variety of ways.

Another object of this invention is to provide an elevator door opening/closing apparatus, which facilitates setting or altering of a control characteristic so as to realize a door opening/closing characteristic which is safe and convenient to the passengers.

Still another object of this invention is to mount a control apparatus that realizes such a door opening/closing

characteristic in the elevator equipment in a suitable form.

The present invention is characterized as follows.

An elevator door opening/closing control apparatus of this invention comprises:

a door driving means; and

a door control means to control the door driving means;

wherein the door control means selects from two or more kinds of preset door opening/closing speed information and of speed change pattern information according to a floor where the elevator car stops, in order to generate a control signal that controls the door driving means.

To describe in more detail, the door control means comprises:

a door opening/closing control information memory means to store two or more kinds of preset door opening/closing speed information and of speed change pattern information; and

a control signal generating means to read the door opening/closing speed information and speed change pattern information from the door opening/closing control information memory means according to a floor where the elevator car stops and to generate a control signal that controls the door driving means.

Alternatively, an elevator door opening/closing control

apparatus comprises:

an elevator operation control apparatus installed in a building; and

a door driving means and a door control means for controlling the door driving means, both installed in an elevator car;

wherein the door control means includes:

a door opening/closing control information memory means to store two or more kinds of preset door opening/closing speed information and of speed change pattern information; and

a control signal generating means to read the door opening/closing speed information and speed change pattern information from the door opening/closing control information memory means according to a selection signal and to generate a control signal that controls the door driving means; and

wherein the elevator operation control apparatus includes:

a selection signal generating means, which generates the selection signal that specifies one kind each from the two or more kinds of door opening/closing speed information and from the two or more kinds of speed change pattern information according to a floor where the elevator car stops, and which supplies the

generated selection signal to the control signal generating means.

The control apparatus with such configurations can perform a door opening/closing control based on the maximum opening/closing speed and speed change pattern optimum for each floor, ensuring that the elevator door is opened and closed safely and conveniently for passengers.

In the accompanying drawings:

Figure 1 is a block diagram that illustrates functions of the control circuit for the elevator door opening/closing apparatus according to the present invention;

Figure 2 is a flowchart that illustrates a control signal generating function of the control circuit for the elevator door opening/closing apparatus according to the present invention;

Figure 3 is a block diagram of one embodiment of the control circuit for the elevator door opening/closing apparatus according to the present invention;

Figure 4 is a characteristic diagram showing one example of an elevator door opening/closing operation pattern;

Figure 5 is a characteristic diagram showing changes in the door opening/closing pattern when the maximum speed is changed;

Figure 6 is a flowchart for setting or modifying control command code data that is executed by an elevator operation control microcomputer;

Figure 7 is a flowchart of the control processing that

generates door opening/closing control commands to be executed by the elevator operation control microcomputer; and

Figure 8 is a flowchart of the door driving motor control processing that is executed by a door control microcomputer.

One embodiment of the present invention will be described by referring to the accompanying drawings.

Figure 3 is a block diagram of the elevator door opening/closing apparatus. A door control device 10 mounted on an elevator car 21 has a door control microcomputer 12 and a door drive circuit 13 and controls a door driving motor 14. The door control microcomputer 12 includes a CPU 12a and a memory 12b, which stores a control program for the door opening/closing control, opening/closing speed information, and speed change pattern information. The door control microcomputer 12 generates control signals according to command signals supplied from an elevator operation control microcomputer 11 installed in a building 22 and feeds the control signals to the door drive circuit 13. The door drive circuit 13 includes a gate circuit for controlling the output of an inverter which supplies the door driving motor 14, and controls rotation of the door driving motor 14 according to the control signals from the door control microcomputer 12. The door driving motor 14 has an encoder that is used for the opening/closing speed control and for checking the door opening/closing position and whose output signal is transferred through the door drive circuit 13 to the door

control microcomputer 12.

The elevator operation control microcomputer 11 installed in the building 22 includes a CPU 11a and a memory 11b, which stores a control program for elevator operation control and also kind selection information that selectively specifies for each floor the kind of the opening/closing speed information and speed change pattern information used for door open/close control. The elevator operation control microcomputer 11 gives command signals to the door control microcomputer 12. The elevator operation control microcomputer 11 is connected with a display device 16 and a key input device 17 so that the kind selection information for each floor can be set or modified. Therefore, the area in the memory 11b for storing the kind selection information is preferably formed of an electrically programmable and erasable read-only memory or EEPROM.

Next, the control function of the elevator door opening/closing apparatus is explained by referring to Figure 1.

Reference numeral 1 represents a door opening/closing control command code table for each floor, which is set in the memory 11b of the elevator operation control microcomputer 11. The door opening/closing control command code is a coded form of the kind selection information that selects the kind of the opening/closing speed information and speed change pattern information, and includes an opening/closing speed information selection command code Sx and a speed change pattern

information selection command code Px. Thus, the door opening/closing control command code table 1 has, for each floor, a speed code region 1a for storing the opening/closing speed information selection command code Sx and a pattern code region 1b for storing the speed change pattern information selection command code Px. In the opening/closing control command code for the first floor shown in the figure, the opening/closing speed information selection command code Sx is set with S1 and the speed change pattern information selection command code Px is set with P2. The command code data Sx and Px can be set or modified by manipulating the key input device 17 according to the requirements of the user at the site where the elevator is installed. This embodiment performs control on the door opening/closing operation by using a combination of two kinds of opening/closing speed information and three kinds of speed change pattern information. While the door opening/closing control command code table 1 can be set in the memory 12b of the door control microcomputer 12, it is advantageous to store the table in the memory 11b of the elevator operation control microcomputer 11 in setting or modifying the command code data by the key input device 17 while watching the display device 16.

The two kinds of speed control constants or opening/closing speed information, and the three kinds of speed change pattern control constants or speed change pattern information, both types of constants being selected according to the control command code data for each floor, are set in

data tables 3, 4 respectively in the memory 12b of the door control microcomputer 12. These control constants are set standard in memory during the process of manufacturing the equipment. The door control microcomputer 12 selects and reads a group of speed control constants and a group of speed change pattern control constants according to the control command code supplied from the elevator operation control microcomputer 11, and then performs calculation (multiplication) on the selected data to produce a control signal. The tables 3, 4 can be set in the memory 11b in the elevator operation control microcomputer 11. To perform real-time processing involving the steps of reading data, i.e. a group of speed control constants and a group of speed change pattern control constants, and processing them to produce a control signal, it is advantageous to set the tables 3, 4 in the memory 12b of the door control microcomputer 12.

Reference numeral 5 signifies maximum speed characteristics of the door controlled by the speed control constant group read out from the speed control constant table 3, with 5a representing a high-speed characteristic and 5b a low-speed characteristic. Reference numeral 6 represents speed change patterns of the door controlled by the speed change pattern control constant group read out from the speed change pattern control constant table 4, with 6a showing a speed change pattern in which the maximum door speed lies in the first half of the door opening operation, 6b showing the maximum speed at the center position and 6c showing the

maximum speed in the latter half.

Next, the procedure for generating the control signals will be described by referring to the flowchart of Figure 2. First, at step A a control command code which corresponds to a floor at which the elevator car 21 stops is read out from the door opening/closing control command code table 1. For example, in the control command code table 1 of Figure 1, floors are represented by rows in the table such that TABLE+0 represents a first floor, TABLE+1 a second floor, and TABLE+2 a third floor, these rows in table assigned with selection command codes (S1, P2), (S1, P1) and (S1, P3) respectively. Suppose that the elevator car 21 rests at the second floor. Execution of the step A causes the selection command code (S1, P1) to be selected and output.

Next, at step B, a group of speed control constants that corresponds to the selection command code picked up at the step A is selected from the speed control constant table 3. In the example shown, a group of speed control constants which corresponds to the selection command code S1 in the control command code table 1 is selected. Similarly, at step C, a group of speed change pattern control constants corresponding to the selection command code is selected from the speed change pattern control constant table 4. In the example shown, a group of speed change pattern control constants corresponding to the selection command code P1 in the control command code table 1 is selected. In this way, the control data corresponding to the selection command code S1 is

selected for the maximum speed and, for the speed change pattern, the control data corresponding to the selection command code P1 is selected.

Next, step D outputs the maximum door opening/closing speed data set in the group of speed control constants selected at the step B or, in the example shown, the maximum speed data of the high-speed characteristic. Step E outputs the speed change pattern data set in the group of speed change pattern control constants selected at the step C or, in the example shown, the speed change pattern data of the speed change pattern characteristic in which the maximum speed is located at the center position of the door opening/closing operation. Then step F performs calculation on these two control data to generate a control signal that controls the door drive circuit 13 which drives the door driving motor 14.

Now, let us explain about the door opening/closing operation pattern based on the control signal, which is produced by performing calculation on the maximum door opening/closing speed data and the speed change pattern data.

Figure 4 is one example of door opening/closing operation pattern, showing the speed curve as the door is opened, with the ordinate representing the speed and the abscissa the door position. Denoted 7 is an acceleration region of the door, 8 is a constant speed region, and 9 is a deceleration region. The constants of acceleration and deceleration differ from one speed change pattern to another and the door speed is calculated and controlled at specified time intervals. In

Figure 4, the door is accelerated in the acceleration region 7 up to the maximum speed set by the acceleration of the speed change pattern data specified until it reaches the constant speed region 8. In this case, if the maximum speed is set at a higher value, the acceleration is continued at an inclination of the acceleration region 7 until it reaches the higher maximum speed. In the deceleration region 9 the door motion is decelerated according to the deceleration set in each speed change pattern. The door control microcomputer 12 always monitors the position of the door 15 by referencing the output signal from the encoder installed in the door driving motor 14 to perform speed control according to the door span. Since each speed change pattern has a unique inclination of deceleration, the span of the constant speed region 8 can be determined by this deceleration, i.e. the speed change pattern.

In this way, by selecting from two or more kinds of maximum speed data and of speed change pattern data, both of which were set independently of each other, and performing calculation on these data, it is possible to carry out control with a variety of opening/ closing operation characteristics, the control characteristics being as varied as the combinations of selected data.

As an example, the door opening/closing operation patterns which have the same speed change patterns but with different maximum speeds are explained by referring to Figure 5. The speed change pattern employed is one in which the

maximum speed is located at the center position of the opening/closing operation (the speed change pattern 6b in Figure 1) and the maximum speed is set to "low speed" (low-speed characteristic 5b of Figure 1) and to "high speed, (high-speed characteristic 5a of Figure 1).

When the acceleration in the acceleration region and the deceleration in the deceleration region are set equal and the "low-speed, characteristic is employed, the maximum speed is reached in a short time in the acceleration region 7, so that the constant speed region 8 at low speed is long, causing the door to open or close slowly. When the maximum speed is set to the "high-speed, characteristic, the acceleration region 7' is long, shortening the constant speed region 8' and causing the door to close or open quickly.

The above description concerns the case where the maximum speed setting is changed while keeping the speed change pattern unchanged. When the maximum speed is kept unchanged while changing the speed change pattern, the door operation looks as follows. For example, with the speed change pattern 6a in Figure 1 selected by the selection command code P1 representing the group of speed change pattern control constants, the door movement looks fast. Conversely, with the speed change pattern 6c selected by the selection command code P3, the door motion look slow.

If the maximum speed and the speed change pattern are both changed, the door movement can be finely adjusted by combining desired characteristics.

To realize the door opening/closing operation with a variety of characteristics mentioned above, the elevator operation control microcomputer 11 performs the processing for setting or modifying the door opening/closing control command code and the processing for generating the door opening/closing command and the door control microcomputer 12 performs the door driving motor control processing. Now, these processing will be described by referring to Figure 6 to Figure 8.

When a serviceman sets or modifies the control command code data in the door opening/closing control command code table 1 to provide a desired door operation that meets the requirements of the customer, the elevator operation control microcomputer 11 performs the following control processing, which is described below by referring to Figure 6.

When an operator manipulates the key input device 17 to specify setting or modification of the door opening/closing control command code, the CPU 11a of the elevator operation control microcomputer 11 enters the memory rewriting mode at step 61, a mode in which the control command code data in the door opening/closing control command code table 1 stored in the memory 11b is set or written over.

At step 62, the microcomputer takes an address of the control command code table 1 entered from the key input device 17.

At step 63, the microcomputer displays the address entered from the key input device 17 and, at step 64, takes

a data display command entered from the key input device 17.

At step 65, the microcomputer displays the control command code data set in the address, at step 66 takes a new control command code data entered from the key input device 17, and at step 67 rewrites the opening/closing control command code table 1 with the new control command code data.

Next, the door opening/closing control command generation processing as performed by the elevator operation control microcomputer 11 is explained by referring to Figure 7.

The CPU 11a, at step 71, takes in the position signal of the elevator car and at step 72 checks if the floor signal is entered.

When the floor signal is taken in, step 73 picks up from the control command code table 1 control command code data corresponding to the floor. Then at step 74 the microcomputer 11 sends the control command code data to the door control microcomputer 12.

Then at step 75 the processing checks whether the elevator car will stop at the floor and, if it is found that the car will not stop, returns to step 71. If it is decided that the car will stop at the floor, the processing proceeds to the step 76 to check if the door can be opened. If so, the processing moves to step 77 to send the door open command to the door control microcomputer 12.

After this, the processing moves to step 78 to determine if the door can be closed. In this check, the processing monitors the time which has elapsed from the opening of the

door or monitors an input signal from a door closing button switch. When the door can be closed, the processing moves to step 79 to send a door close command to the door control microcomputer 12.

Next, the door driving motor control processing executed by the door control microcomputer 12 will be described by referring to Figure 8.

The CPU 12a, at step 81, receives the door control command code data from the elevator operation control microcomputer 11 and moves to the next step 82.

At step 82 the CPU checks if a door open command signal is entered. When the door open command signal is given, the processing goes to the next step 83.

At step 83 the CPU references the speed control constant table 3 and the speed change pattern control constant table 4 to select a group of speed control constants Sx and a group of speed change pattern control constants Px according to the door control command code supplied from the elevator operation control microcomputer 11.

Next, the CPU moves to step 84 to generate a control signal that will control the door drive circuit 13 in such a way as to drive the door 15 in an opening direction. Then, the CPU moves to step 85 where it reads data of the selected speed control constant group Sx and speed change pattern control constant group Px and performs calculation on these data while at the same time detecting the door position, to change the control signal and thereby control the door so that

the door will open in the selected operation pattern.

At step 84, the CPU 12a monitors the door close command signal sent from the elevator operation control microcomputer 11. When the door close command signal is supplied, the processing proceeds to the next step 87.

At step 87, the CPU produces a control signal that controls the door drive circuit 13 to cause the door 15 to close. Then, the CPU moves to step 88 where it reads data of the selected speed control constant group Sx and speed change pattern control constant group Px and performs calculation on these data while at the same time detecting the door position, to change the control signal and thereby control the door so that the door will close in a selected operation pattern.

In this way, by combining appropriate speed control constants and speed change pattern control constants, it is possible to provide a fine control of the door opening/closing operation pattern according to requirements of each floor. For example, even with the same maximum door speed set, the door operation can be made to look fast at a floor like lobby where there are many passengers getting into the elevator car or to look slow at floors where there are few passengers or children getting in. The door opening/closing control can therefore be performed in accordance with the requirements of each floor.

Because the speed control constant group and speed change pattern control constant group used for performing such controls are selected from among the preset constant groups,

the setting and modification of the opening/closing operation characteristic can be made very easily, making it possible to meet the requirements of the customer swiftly at the site where the elevator is installed.

CLAIMS

1. An elevator door opening/closing control apparatus, comprising:

a door driving means; and

a door control means to control the door driving means;

wherein the door control means selects from two or more kinds of preset door opening/closing speed information and of speed change pattern information according to a floor where the elevator car stops, in order to generate a control signal that controls the door driving means.

2. An elevator door opening/closing control apparatus, comprising:

a door driving means; and

a door control means to control the door driving means;

wherein the door control means comprises:

a door opening/closing control information memory means to store two or more kinds of preset door opening/closing speed information and of speed change pattern information; and

a control signal generating means to read the door opening/closing speed information and speed change pattern information from the door opening/closing control information memory means according to a floor where the elevator

car stops and to generate a control signal that controls the door driving means.

3. An elevator door opening/closing control apparatus according to claim 2, wherein the control signal generating means has a door opening/closing speed control pattern table containing kind selection information that specifies the door opening/closing speed information and speed change pattern information for each floor.

4. An elevator door opening/closing control apparatus according to claim 3, wherein the control signal generating means includes: a rewritable memory to store the door opening/closing speed control pattern table information; and a memory rewriting control means.

5. An elevator door opening/closing control apparatus, comprising:

an elevator operation control apparatus installed in a building; and

a door driving means and a door control means for controlling the door driving means, both installed in an elevator car;

wherein the door control means includes:

a door opening/closing control information memory means to store two or more kinds of preset door opening/closing speed information and of

speed change pattern information; and

a control signal generating means to read the door opening/closing speed information and speed change pattern information from the door opening/closing control information memory means according to a selection signal and to generate a control signal that controls the door driving means; and

wherein the elevator operation control apparatus includes:

a selection signal generating means, which generates the selection signal that specifies one kind each from the two or more kinds of door opening/closing speed information and from the two or more kinds of speed change pattern information according to a floor where the elevator car stops, and which supplies the generated selection signal to the control signal generating means.

6. An elevator door opening/closing control apparatus according to claim 5, wherein the selection signal generating means includes:

a rewritable memory which stores a door opening/closing speed control pattern table containing selection signals assigned to each floor that specify the kind of door opening/closing speed information and

speed change pattern information to be read out from the door opening/closing control information memory means; and

a memory rewriting means to rewrite the contents of the memory.

7. An elevator door opening/closing control apparatus, substantially as herein described with reference to the accompanying illustrative drawings.

8. An elevator, including an elevator door opening/closing control apparatus according to any one of the preceding claims.

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Title APPARATUS FOR OPENING AND CLOSING ELEVATOR DOORS

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