

ERROR JUDGEMENT METHOD FOR ELEVATOR CAR POSITION DETECTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an error judgement method for an elevator car position detector, and in particular to an improved error judgement method for an elevator car position detector which is capable of more accurately judging an error of a position detector provided for detecting the current position of an elevator car in accordance with a position of a sensor plate disposed in a car moving path of each floor, whereby an operator of an elevator system can more easily detect the error of the elevator by judging the error of the position detector when the erroneous position detector passes through the sensor plate.

2. Description of the Conventional Art

Figure 1 is a view illustrating a conventional elevator operation control apparatus.

As shown therein, a motor 17 is disposed for supplying an operational force to components of the system. A sheave 15 rotates by the motor 17. An elevator car 11 is connected with the sheave 15 by a rope and upwardly and downwardly moves in cooperation with the rotation of the sheave 15. A counter

weight 16 is disposed for balancing the elevator car 11. A pulse generator 18 generates a pulse proportional to the number of rotations of the motor 17. A counter 19 is disposed for counting and outputting the number of pulses generated by the pulse generator 18. A position detector 13 is attached to an upper portion of the elevator car 11 for detecting the position of the sensor plate 12 disposed in an elevator car moving path. A controller 20 is disposed for operating the counting value of the counter 19, computing the moving distance of the elevator car 11, controlling the system, judging the error of the position detector 13 based on the detection result of the position detector 13. A display unit 23 having an alarm light 21 and an error light 22 is disposed for outputting the error judgement result from the position detector 13 of the controller 20.

Figure 2 is a view illustrating the construction of a controller of Figure 1.

As shown therein, a random access memory (RAM) 28 is disposed for storing a floor position data of the elevator. A read only memory (ROM) 27 is disposed for storing an operational program. An input interface 25 and an output interface 26 are disposed for a data input/output operation in cooperation with an externally connected component. A central processing unit (CPU) 24 is disposed for processing data by receiving signals from the RAM 28, the ROM 27, and the input

interface 25 and for outputting the processed result to the output interface 26.

The operation of the conventional elevator operation control apparatus will now be explained with reference to the accompanying drawings.

The sheave 15 is driven by the motor 17, and the elevator car 11 moves to a predetermined floor. The pulse generator 18 generates a pulse proportional to the number of rotations of the motor 17. The counter 19 counts the number of pulses and outputs the number to the controller 20. The controller 20 computes the moving distance of the elevator car 11 based on the number of counted pulses, compares the moving distance with the moving distance of the elevator car 11 stored in the ROM 27, and outputs a signal so that it is judged where the elevator car 11 is opened.

In addition, during the operation of the elevator car 11, when the position of the position detector 13 disposed on the upper portion of the elevator car 11 matches with the position of the sensor plate 12 disposed in the car moving path of each floor, the control signal "OS" is outputted to the controller 20. In the controller 20, the control signal "OS" is supplied to the CPU 24 through the input interface 25. Here, when the control signal is on, the CPU 24 judges that the elevator car 11 is arrived at a desired floor, and outputs a signal in order for the door of the elevator car to be opened.

However, if the moving distance of the elevator car 11 is erroneously computed, or if the position detector 13 has an error, the door of the elevator car 11 is erroneously opened at a predetermined position, for thus causing serious accidents to passengers in the elevator car.

In order to overcome the above-described problems, another error judgement apparatus for a conventional elevator position detector was introduced in the industry.

Figure 3 is a view illustrating the construction of an error judgement apparatus of a conventional elevator position detector.

As shown therein, a position detector 36 is connected for detecting the current position of the elevator car 11 in accordance with the position of the sensor plate 12. A position operation unit 31 is connected for operating the position of the elevator car 11 in accordance with the rotation of the motor 17. An error operation detector 32 is connected for detecting an error operation in accordance with the lapse of time from a deceleration to a stop of the elevator car. A remaining distance operation unit 33 is connected for detecting the remaining distance to a desired floor in accordance with the operation result of the position operation unit 31. An interval detector 34 for operating an interval which is different based on a detection operation and a non-operational state of the position detector in accordance

with the operation result of the remaining distance operation unit 33. An error detection unit 35 is connected for checking the detection result of the position detector 36 and detecting an error of the position detector 36 in accordance with the detection result of the position detector 34.

The operation of the conventional position detector for an elevator will now be explained with reference to Figure 4.

First, when a desired floor of the elevator car 11 is selected, the position operation unit 31 computes the value of the desired floor from a value table containing a floor-to-floor distance value of each floor stored in the ROM 27. The remaining distance operation unit 33 computes the remaining distance in accordance with the difference between the floor-to-floor distance value and the current position of the elevator car 11. The moving distance of the elevator car 11 is computed in cooperation with the motor 17, the pulse generator 18, and the counter 19, and then the remaining distance is reduced one by one.

In addition, a reference speed command corresponding to the reducing remaining distance is retrieved from the table of the ROM 27, and the speed of the elevator car 11 is controlled, and the elevator car 11 moves to a predetermined floor.

Meanwhile, the elevator floor position data is stored in the RAM 28, and the position data may have a predetermined

difference between the position data and the data stored in the RAM 28 due to the noise and the error of the pulse generator 18 having an encoder (not shown) when turning on/off the electric power. Here, this difference is called a selector mismatch. Since the elevator car arriving floor is erroneously set, or the current position of the elevator car 11 is erroneously inputted, when the selector mismatch occurs, the remaining distance is erroneously computed.

Therefore, the error operation detector 32 detects that there is a selector mismatch in steps S41 and S42. When the selector is mismatched, the error judgement of the position detector 13 is disregarded in step S47, and when the selector is normal, the error judgement of the position detector 13 is performed.

Namely, the remaining distance is computed in step S43. for example, if the remaining distance is within a range from 1050mm to 1350mm from the bottom in step S44, it is judged that the control signal is on in step S45. When the control signal is on, the position detector 13 is judged to be erroneous in step S46, for thus causing an impossible operation of the elevator.

As described above, the conventional elevator system is directed to computing the distance between the elevator car 11 and the selector floor based on the remaining distance; however, since the error is judged based on a condition that

the position detector 13 is not in a turned-on state within a range of 1050-1350mm, the error judgement may be disregarded.

In addition, since the error is judged within only 1050-1350mm which is a detection interval before arriving at the desired floor, the error detection is performed except for the above-described interval, for thus causing an erroneous error judgement.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an error judgement method for an elevator car position detector which overcomes the problems encountered in the conventional art.

It is another object of the present invention to provide an improved error judgement method for an elevator position detector which is capable of more accurately judging an error of a position detector provided for detecting the current position of an elevator car in accordance with a position of a sensor plate disposed in a car moving path of each floor, whereby an operator of an elevator system can more easily detect the error of the elevator by judging the error of the position detector when the erroneous position detector passes through the sensor plate.

To achieve the above objects, there is provided a error

judgement method for an elevator position detector which includes the steps of a first step for issuing an alarm when a position detector of an elevator car does not depart from a sensor plate of a start floor within a first predetermined time after the elevator car starts from the start floor, a second step for issuing an alarm when the position detector does not depart from the sensor plate for a second predetermined time after the position detector enters the range of a sensor plate of a predetermined floor between the current floor and a desired floor, a third step for issuing an alarm when the time which is required in order for the position detector enters the range of the sensor plate of the second step and departs therefrom is shorter than the third predetermined time, and a fourth step for comparing the number of previously set floors with the number that the elevator car moved when the elevator car arrives at a desired floor and for alarming when there is a predetermined difference therebetween.

Additional advantages, objects and features of the invention will become more apparent from the description which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood

from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

Figure 1 is a view illustrating a conventional elevator operation control apparatus;

Figure 2 is a view illustrating the construction of a controller of Figure 1;

Figure 3 is a view illustrating the construction of an error judgement apparatus of a conventional elevator position detector;

Figure 4 is a flow chart of a conventional elevator position detection method;

Figure 5 is a wave form of a control signal detected by a position detector and applied to a central processing unit (CPU) according to the present invention;

Figure 6 is a flow chart of an elevator operation control method according to the present invention; and

Figure 7 is a flow chart of sub-routines of Figure 6 according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The operation control method for an elevator according to the present invention will now be explained with reference to

the accompanying drawings.

Here, the operation control method for an elevator according to the present invention is performed by using the same construction as the conventional error detection apparatus of the present invention as shown in Figure 3.

When a user pushes a button for a desired floor, a floor call information is stored in the CPU 24 or the RAM 28 through the input interface 25.

The CPU 24 processes the data stored in the RAM 28 and supplies a driving command to the motor 17 through the output interface 26. The program processing time until the control signal inputted through the input interface 25 is processed before the processed signal is outputted is 50ms.

The elevator car 11 is driven in accordance with the driving command and moves to the desired floor. While the elevator car 11 moves to the desired floor, the position detector 13 attached to the upper portion of the elevator car 11 detects the position of the sensor plate 12.

Figure 5 is a wave form of a control signal detected by a position detector and applied to a central processing unit (CPU) when an elevator car upwardly moves.

As shown therein, the control signal "OS" becomes high level when an upper position detector 131 of the position detector 13 enters the range of the sensor plate, and when a lower position detector 132 departs from the range of the

sensor plate, the control signal "OS" becomes low level. Therefore, the width 1F of the high level control signal "OS" is determined based on the time during which the position detector 13 passes through the sensor plate.

Meanwhile, the elevator car 11 is accelerated in the start mode, and moves at the full speed after the start mode, and is decelerated in the elevator car arriving mode. Therefore, the control signals 1F and 4F which are high level at the start floor and the desired floor have a wider width than the control signals 2F and 3F which are high level in a predetermined interval between the start floor and the desired floor.

Identically to the driving of the elevator car 11, the time when the position detector 13 passes through the sensor plate of the start floor is obtained as follows.

After the elevator car is operated, the acceleration of the elevator car 11 is increased for 0.8 second, and then has a constant value thereafter. On the assumption that the acceleration is 0.8m/s^2 , the time "t" when the position detector 13 passes through the sensor plate of the start floor at 2500mm from the bottom is obtained by the following equation which has a predetermined relationship between the acceleration "a" and the length "s" of the end of the sensor plate.

$$s = \frac{1}{2} at^2 = \frac{v^2}{2a}, \text{ thus}$$

$$t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2 \times 0.175}{0.8}} = 0.661438 \quad \text{----- (1)}$$

When the elevator car 11 normally runs, the position detector passes through the sensor plate of the start floor after 0.66 second, about 0.7 second, after the elevator car 11 starts from the start floor. Therefore, in order to have an operational stability, a new time t_1 which is obtained by doubling 0.7 second is set. Namely, if the position detector 13 does not pass through the sensor plate of the start floor within 1.4 seconds, the CPU 24 of the controller 20 issues an alarm signal in order for the alarm light 21 of the display unit 23 to be lighted, for thus alarming that there is a predetermined error operation in the position detector 13.

The time that the position detector 13 passes through the sensor plate of the next floor after passing through the sensor plate of the start floor is obtained by the following method.

When the elevator car 11 runs at the full time, namely, at 4m/s, the time t_2 that the position detector 13 passes through the sensor plate of the next floor is obtained by the following equation wherein the length of the position detector 13 is 0.35m.

$$t_2 = \frac{0.35\text{m}}{4 \text{ m/s}} = 0.0875 \text{ second} \quad \text{-----} \quad (2)$$

Therefore, the time t_2 that the elevator car 11 normally runs and passes through the sensor plate of the next floor is set as a minimum time.

In addition, before the elevator car 11 runs at the full speed, the elevator car may run at the acceleration of 0.8m/s^2 and passes through the sensor plate of the next floor. In this case, the passing-through time is much later than 0.0875 second which is referred to the time t_2 . The passing-through time is obtained by the following formula 4 after obtaining the velocity v at the time when the elevator car passes through the sensor plate of the next floor by using the formula 3.

$$v = \sqrt{2as} = \sqrt{2 \cdot 0.8 \cdot 2.5} = 2\text{m/s} \quad \text{-----} \quad (3)$$

$$t = \frac{0.35\text{m}}{2\text{m/s}} = 0.175\text{s} \quad \text{-----} \quad (4)$$

The time of 0.35 second which is obtained by doubling the time t of 0.175 is set as the maximum time t_3 when the position detector 13 passes through the sensor plate of the next floor.

Therefore, if the position detector 13 passes through the sensor plate before the time t_2 after entering the range of the sensor plate of the next floor, or if the position

detector 13 does not depart from the sensor plate after a lapse of the time t_3 , it means that the elevator car 11 is not normally operated. Therefore, the CPU 24 lights the alarm light 21 of the display unit 23, so that an operator of the elevator system can note that there is a predetermined error in the position detector 13.

In addition, when the alarm light 21 is turned on/off several times, the CPU 24 lights an error light 22 of the display unit 23, so that the operator can note that there is a predetermined error in the position detector 13.

The error judgement method according to the present invention will now be explained in more detail with reference to figure 6.

A value OFFTIME, which will be described later, denotes the maximum time which is needed in order for the elevator car 11 to depart from the sensor plate of the start floor, namely, it is referred to the time t_1 , and a value ONTIME denotes a time that is needed in order for the elevator car 11 to pass through a predetermined floor after the elevator car starts from the start floor.

First, when the levator car 11 is not operational, since the elevator is not in the high speed automatic operation mode, step S1 is performed. Namely, the value DZSU is initialized to "0" in step S15, and the value ONTIME is initialized to "0" in step S18, and the value OFFTIME is

initialized to 28 cycles corresponding to the time t_1 in step S18.

Thereafter, the elevator runs normally, and the elevator car 11 is operated. Namely, since the current operation state of the elevator is in the high speed automatic operation mode, step S1 is performed, and steps S2, S3, and S4 are performed. When the position detector 13 does not depart from the sensor plate of the current start floor, step S5 is not performed. In step S10, one cycle is subtracted from the value OFFTIME, and the value OFFTIME becomes 27 cycles. In addition, in step S11, the value OFFTIME does not satisfy "0", the routine is returned.

Since the above-described processes are repeatedly performed until the position detector 13 departs from the sensor plate of the start floor, the value OFFTIME is decreased, and when the value OFFTIME becomes "0" in step S11, step S19 is performed. In this case, it means that the position detector 13 did not pass through the sensor plate of the start floor within the time t_1 . Therefore, as shown in Figure 7, in step S71, the value Err is increased by "1", and in step S74, an alarm signal is displayed through step S72.

When the position detector 13 enters the range of the second sensor plate (not shown), the value ONTIME is compared with "7" in step S6. Here, the value "7" denotes the maximum time of the passing-through time of a predetermined sensor

plate between the start floor and the desired floor, namely, it denotes the time t_3 . The value ONTIME of "0" is added by "1" in step S7, and step S8 is performed. The value DZSU becomes "1" in step S9. Here, the value DZSU is increased by "1" whenever the position detector 13 enters each of the remaining sensor plates except for the sensor plate of the start floor. Namely, it denotes the number of floors through which the elevator car 11 passes.

Thereafter, step S19 is performed through step S6 when the position detector 13 does not pass through the second sensor plate until the value ONTIME is greater than 7, and an alarm is issued in step S74. In this case, the position detector 13 did not pass through the sensor plate within the maximum time t_3 .

When the position detector 13 departs from the second sensor plate, step S3 is not performed. In step S16, the value ONTIME is judged to be "1". As a result of the judgement, when the value ONTIME is not "1", namely, when the value ONTIME is greater than "1", step S18 is performed. When the value ONTIME is "1", step S17 is performed, and an alarm is displayed in step S74. This routine denotes that the sensor passing-through time is shorter than the minimum time t_2 for passing through the sensor plate.

Finally, when the position detector 13 enters the range of the sensor plate of the desired floor, step S4 is

performed. The difference between the start floor and the desired floor is set as a new value FL in step S12, and it is judged that whether the value which is obtained by subtracting "1" from the value FL is identical to the value DZSU. As a result, the value is different therefrom, step S14 is performed, and an alarm signal is displayed in step S74. As a result, if the value is identical thereto, the routine is returned. Here, the start floor and desired floor of step S12 is referred to a value stored in the RAM 28 of the controller 20 when a user registers an elevator car call value. The value DZSU denotes the number of floors, through each of which the position detector 13 passes through.

In step S72 as shown in Figure 7, the position detector 13 did not pass through the sensor plate of the start floor. If the number of the above-described routines exceeds 5, step S72 is performed, and an alarm signal is displayed in step S73.

As described above, the error judgement method for an elevator car position detector according to the present invention is directed to setting the normal time for which the elevator car starts from the start floor and passes through each floor, comparing the time when the position detector enters the range of the sensor plate of each floor and departs therefrom, and judging the error of the position detector of the elevator system.

Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as recited in the accompanying claims.



What is claimed is:

1. An error judgement method for an elevator car position detector, comprising the steps of:

a first step for issuing an alarm when a position detector of an elevator car does not depart from a sensor plate of a start floor within a first predetermined time after the elevator car starts from the start floor;

a second step for issuing an alarm when the position detector does not depart from the sensor plate for a second predetermined time after the position detector enters the range of a sensor plate of a predetermined floor between the current floor and a desired floor;

a third step for issuing an alarm when the time which is required in order for the position detector enters the range of the sensor plate of the second step and departs therefrom is shorter than the third predetermined time; and

a fourth step for comparing the number of previously set floors with the number that the elevator car moved when the elevator car arrives at a desired floor and for alarming when there is a predetermined difference therebetween.

2. The method of claim 1, further comprising a fourth step for issuing an alarm when the number of alarms exceeds a predetermined number.



3. The method of claim 2, wherein said predetermined number is five (5).

4. The method of claim 1, wherein said first predetermined time is twice the time which is required in order for the position detector of the elevator passes through the sensor plate of the stat floor.

5. The method of claim 4, wherein said time which is required in order for the position detector passes through the sensor plate of the start floor is 0.7 second.

6. The method of claim 1, wherein said second predetermined time is twice the time which is required in order for the position detector passes through a sensor plate of the next floor at a predetermined acceleration before the elevator car runs at the full speed after the elevator car starts from the start floor.

7. The method of claim 6, wherein the time which is required in order for the position detector to pass through the sensor plate of the next floor is 0.175.

8. The method of claim 1, wherein said third predetermined time is the time which is required in order for



the position detector to pass through the sensor plate of a predetermined floor which is neither the start floor nor the desired floor when the elevator car runs at the full speed.