

TITLE OF THE INVENTION

CONTROLLER FOR ELEVATOR

FIELD OF THE INVENTION

5 The present invention relates to an elevator in
which an elevator car rises and lowers in a hoistway,
and more particularly to a controller for an elevator
that preferably identifies a location at which landing
precision is abnormal when the elevator car arrives at
10 an intended floor.

BACKGROUND OF THE INVENTION

 In an elevator, the position of the elevator car
has been detected in the hoistway. To prevent an
15 increase in cost and a reliability drop and to improve
landing precision, a plurality of position detection
sensors provided on the elevator car side and a
plurality of to-be-detected objects provided on the
elevator hall side are used, for example, to detect a
20 door zone that indicates an area through which a
passenger can get on and get off the elevator car when
the position of the elevator car matches the
raising/lowering position, at which the door can be
opened and closed. Landing with a less level difference
25 is achieved by having a microcomputer perform counting

according to the number of output pulses of a pulse generator that generates pulses according to the raising or lowering of the elevator car to infer the elevator car position and by calculating the amount of control to make the floor surface of the elevator car flush with the floor surface of the elevator hall.

That is, if a detection timing generated by the position detection sensors disposed on the elevator car side and the to-be-detected objects disposed on the hoistway side causes large landing error due to some kind of abnormality that is caused because, for example, the to-be-detected objects were improperly attached or were displaced due to an earthquake or the like, the elevator user may fall down when getting on or off the elevator car.

Accordingly, when the elevator is operated in a maintenance operation state intended for inspection so that the elevator car stops at each floor, the maintenance person usually performs visual inspection to identify abnormal locations. This has prolonged a time taken for maintenance.

As disclosed in patent literature (PTL) 1, a technology is known that determines a switch abnormality when a plurality of elevator car detection switches (limit switches) provided in the vicinity of

an end floor operate outside a normal operation range.

PRIOR TWCHNICAL DOCUMENT

PATENT DOCUMENT

5 PATENT DOCUMENT 1: Japanese Patent Laid-open
Publication No. 2008-7322

SUMMARY OF THE INVENTION

10 The conventional technology disclosed in PTL 1 is
an abnormality decision method that can be used only
when the elevator car detection switches are disposed
at positions for which a normal operation range can be
set. The conventional technology cannot determine
abnormalities of the detection switches disposed at
15 many places in the hoistway.

If an attempt is made to determine abnormalities of
many elevator car detection switches by extending this
method, the system structure becomes complex and labor
taken in maintenance is increased.

20 An object of the present invention is to provide a
controller for an elevator that enables a place with
abnormal landing precision to be found at a glance
during, for example, elevator inspection, without
having to add special devices.

25 Accordingly, an object of the present invention is

to provide an elevator abnormality detection apparatus
that can shorten inspection time taken during
restoration and further can shorten the unavailable
time of the elevator in the event of a disaster such as
5 an earthquake.

In a controller for an elevator, in one aspect of
the present invention, that has a position detection
sensor attached to an elevator car and to-be-detected
objects that are placed in a hoistway in correspondence
10 to, for example, stopping floors and are detected by
the position detection sensor, the position of the
elevator car being detected by an output signal of the
position detection sensor, the position detection
sensor is attached to the elevator car so that the
15 position detection sensor passes positions opposite to
the to-be-detected objects, the position detection
sensor having at least four sensor units arranged side
by side; the to-be-detected objects are disposed at a
plurality of places in the hoistway, each of the to-be-
20 detected object having a plurality of to-be-detected
units that are detected at the same time by at least
two sensor units of the four sensor units arranged side
by side underneath the elevator car; an abnormality is
detected in response to a difference between output
25 timings of the at least two sensor units in the

position detection sensor.

In an embodiment of the present invention, if the door of the elevator is open when an abnormality is detected in response to the difference between the output timings of the sensor units, an announcement
5 indicating that there is a step between floors is preferably made. When the door of the elevator is to be closed, a buzzer preferably sounds.

In a preferable embodiment of the present invention,
10 landing error of the elevator is detected in response to a first difference among the output timings of the position detection sensor and the operation of the elevator is stopped in response to a second difference among the output timings of the position detection
15 sensor, the second difference being larger than the first difference.

According to a preferable embodiment of the present invention, an abnormality in elevator car position detection that would cause abnormal landing error can
20 be detected with desired precision, landing error being a difference between the floor surface of the elevator hall on a floor and the floor surface of the elevator car.

According to a preferable embodiment of the present
25 invention, non-specialists such as, for example, the

owner of the building can easily notice abnormal landing error of the elevator.

Therefore, in case of a disaster such as an earthquake, time taken for inspection can be shortened and the unavailable time of the elevator can be significantly reduced.

Other objects and feature of the present invention will be clarified in embodiments described below.

10 BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates the entire structure of an elevator apparatus that includes a controller for an elevator according to an embodiment of the present invention.

15 FIG. 2 shows perspective views of a position detection sensor attached to an elevator car and of to-be-detected objects disposed on elevator hall sills, the position detection sensor and to-be-detected object being part of the controller for an elevator according to an embodiment of the present invention.

20 FIG. 3 illustrates exemplary combination patterns of to-be-detected units of a to-be-detected object according to an embodiment of the present invention on different floors and also illustrates the combination patterns of outputs from the position detection sensor

25

underneath the elevator car.

FIG. 4 outlines the structure of a safety controller according to an embodiment of the present invention and illustrates its connection to the
5 position detection sensor.

FIG. 5 illustrates an elevator operation trace, which is used to explain operation according to an embodiment of the present invention.

FIG. 6 illustrates changes of combination patterns
10 of position detection sensor outputs, which are used to explain operation according to an embodiment of the present invention.

FIG. 7 is a flowchart of processing executed by the safety controller in the controller for an elevator
15 according to an embodiment of the present invention.

FIG. 8 is a flowchart illustrating details in a particular processing step in FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

20 Embodiments of the present invention will be described below with reference to FIGs. 1 to 8.

FIG. 1 illustrates the entire structure of an elevator apparatus that includes a controller for an elevator according to an embodiment of the present
25 invention. The drawing illustrates the entire structure of an electronic safety assurance elevator having an

electronic software-based safety system instead of a conventional safety system structured with mechanical elements.

5 An elevator car 1 moves up and down in a hoistway
when a motor 2 drives a main rope 10 connected to a
counter weight 11. The motor 2 is driven by an inverter
5 connected to an AC power supply 7 through a breaking
circuit 6. When, for example, the operation of an
elevator car door switch 70 or one of car-free elevator
10 hall door switches 71 to 73 is detected during the
movement of the elevator car, the breaking circuit 6
operates for safety and shuts off electric power to the
motor 2. Thus, the driving force of the motor 2 is lost
and a hoisting machine brake 3 operates. The hoisting
15 machine brake 3 is of a normally operating type, the
brake of which is released when it is turned on.

A governor rope 12 is pulled by the elevator car 1
due to its movement, rotating a governor 13. The
governor 13, which includes a gripping device 14 and a
20 rotary encoder 21, grips the governor rope 12 when the
gripping device 14 operates. If the elevator car 1 is
moving at that time, an emergency stop device 15
urgently stops the elevator car by holding a rail 16.
The rotary encoder 21 rotates along with the governor
25 13 and generates pulse signals. Amounts by which pulse

signals have changed are accumulated to determine the position of the elevator car 1, and the time-average of the amounts of changes is calculated to determine the speed of the elevator car 1; the determined position and speed of the elevator car 1 are used for control.

A position detection sensor 80 is attached to the elevator car 1. When the elevator car 1 arrives at the target floor, the position detection sensor 80 faces a to-be-detected object 81, 82, or 83 attached on the target floor on the hoistway side and changes its output and sends a signal corresponding to a stop position (door openable zone) to a safety controller 40 in an elevator controller 50.

Even if the elevator car 1 cannot be completely stopped by the braking forces of the hoisting machine brake 3 and emergency stop device 15, a bumper 17, which is placed at the lower end of the hoistway, receives the elevator car 1 and absorbs shock.

A final limit switch 22 is disposed near the lower end of the hoistway, and a final limit switch 23 is disposed near the upper end. These final limit switches are normally tuned off. If the elevator car 1 enters an area below the final limit switch 22, it is turned on and detects that the elevator car 1 has exceeded the normal operation range. Similarly, if the elevator car

1 enters an area above the final limit switch 23, it is turned on and detects that the elevator car 1 has exceeded the normal operation range.

The elevator controller 50 of electronic safety assurance type in the vicinity of the hoistway includes a governing controller 30 and a safety controller 40.

The governing controller 30 controls the inverter 5 and operates the elevator car 1 according to the input information from a destination floor button on an

operation panel 60 with an elevator car position display unit and from one of elevator hall buttons 61, 62, and 63 and to other information. The safety

controller 40 receives outputs of the rotary encoder 21 and final limit switches 22 and 23 to detect an event indicating an exceeded speed or exceeded position of

the elevator car at a prescribed position and applies a brake to the elevator car 1 by using an emergency stop device 15 operated through the hoisting machine brake 3, breaking circuit 6, and gripping device 14.

FIG. 2 shows perspective views of the position detection sensor attached to the elevator car and of to-be-detected objects disposed on elevator hall sills, the position detection sensor and to-be-detected object being part of the controller for an elevator according to an embodiment of the present invention.

FIG. 2(A) shows a perspective view and plan view of the position detection sensor 80 attached to the elevator car 1. The position detection sensor 80 is structured with four sensor units 80A to 80D that
5 detect the to-be-detected objects 81 to 83 described below. The four sensor units 80A to 80D are arranged side by side. The drawing shows an example in which photoelectric sensors are used; the four photoelectric sensors with one axis are arranged side by side beneath
10 the elevator car. Reference characters 80a to 80d indicate light beams from the photoelectric sensor units; the light beams are blocked due to the entrance of the to-be-detected units of the to-be-detected object described below.

15 FIGS. 2(B) to 2(D) are perspective views that respectively illustrate the to-be-detected objects 81 to 83 disposed on elevator hall sills on individual floors. The reference characters 81e to 83e indicate the elevator hall sills, to which the to-be-detected
20 objects 81 to 83 formed with, for example, plastic are respectively attached.

The structure of the position detection sensor 80 beneath the elevator car in FIG. 2(A) is a specific example in which the four sensors 80A to 80D are
25 arranged. Outputs from the sensor units 80A to 80D are

input to the safety controller 40 in the elevator controller 50. The safety controller 40 includes microcomputers, which carry out logical operation. The safety controller 40 detects the stop position (door
5 openable zone) on each floor through the logical operation.

The to-be-detected objects 81 to 83 on the hoistway side, which are detected by the position detection sensor 80, are respectively formed with two or four to-
10 be-detected units (shielding plates, for example) 81a to 81d, 82a and 82d, and 83a to 83d. The positions of the four to-be-detected units correspond to the positions of the four sensor units of the position detection sensor 80 beneath the elevator car. If the
15 to-be-detected units are present, light beams from light emitting parts of the sensor units to light receiving parts are blocked. The vertical lengths of the to-be-detected objects 81 to 83 match the door openable zone in which the door can be opened at each
20 elevator hall.

FIG. 3 illustrates exemplary combination patterns of the to-be-detected units of the to-be-detected object according to an embodiment of the present invention on different floors and also illustrates the
25 combination patterns of outputs from the position

detection sensor underneath the elevator car. The drawing illustrates examples of the arrangements of the to-be-detected units of the to-be-detected objects 81 to 83, which identify the door zones on the first to fifth floors and also identify the upper-end floor and lower-end floor, under the assumption that four sensor units are included in the position detection sensor 80 in FIG. 2.

For the to-be-detected object 81, illustrated in FIG. 2(B), attached to the elevator hall sill 81e at the elevator hall on the first floor, when the elevator car 1 is present at the normal stop position on the first floor, the sensor units 80C and 80D are respectively shielded from light by the to-be-detected units 81c and 81d, so the output from the position detection sensor 80 becomes "0, 0, 1, 1" as shown at the right end in FIG. 3.

In this embodiment, the to-be-detected object 81 attached to the elevator hall sill 81e at the elevator hall on the first floor doubles as a function of identifying the lower-end floor. That is, when the elevator car 1 is lowered to the lower end of the door zone at the elevator hall on the first floor, the sensor units 80A to 80D are respectively shielded from light by the to-be-detected units 81a to 81d,

identifying the fact that the elevator car 1 is approaching the lower-end floor. Accordingly, the output from the position detection sensor 80 becomes "1, 1, 1, 1" as shown at the right end in FIG. 3. In the
5 identification of the fact that the elevator car 1 is approaching the lower-end floor, a change from a pattern "0, 0, 1, 1", indicating that the elevator car 1 has been present on the first floor, to this pattern "1, 1, 1, 1" is added to identification conditions.

10 For the to-be-detected object 82, illustrated in FIG. 2(C), attached to the elevator hall sill 82e at the elevator hall on the third floor, when the elevator car 1 is present in the door zone on the third floor, the sensor units 80A and 80D are respectively shielded
15 from light by the to-be-detected units 82a and 82d. Accordingly, the output pattern from the position detection sensor 80 becomes "1, 0, 0, 1" as shown at the right end in FIG. 3.

For the to-be-detected object 83, illustrated in
20 FIG. 2(D), attached to the elevator hall sill 83e at the elevator hall on the fifth floor, when the elevator car 1 is present at the normal stop position on the fifth floor, the sensor units 80A and 80B are respectively shielded from light by the to-be-detected
25 units 83a and 83b. Accordingly, the output pattern from

the position detection sensor 80 becomes "1, 1, 0, 0" as shown at the right end in FIG. 3.

In this embodiment, the to-be-detected object 83 attached to the elevator hall sill 83e at the elevator hall on the fifth floor doubles as a function of identifying the upper-end floor. That is, when the elevator car 1 is raised to the upper end of the door zone at the elevator hall on the fifth floor, the sensor units 80A to 80D are respectively shielded from light by the to-be-detected units 83a to 83d, identifying the fact that the elevator car 1 is approaching the upper-end floor. In the identification of the fact that the elevator car 1 is approaching the upper-end floor, a change from a pattern "1, 1, 0, 0", indicating that the elevator car 1 has been present on the fifth floor, to this pattern "1, 1, 1, 1" is added to conditions to distinguish the upper-end floor from the lower-end floor described above.

In FIG. 3, when the elevator car is present in the door zone on the second floor, it is apparent that the sensor units 80B and 80D are shielded from light by the to-be-detected units, which are not assigned reference characters, in the b and d columns and the output pattern of the position detection sensor 80 becomes "0, 1, 0, 1". Similarly, when the elevator car is present

in the door zone on the fourth floor, it is apparent that the sensor units 80A and 80C are shielded from light by the to-be-detected units, which are not assigned reference characters, in the a and c columns
5 and the output pattern of the position detection sensor 80 becomes "1, 0, 1, 0".

As described above, the to-be-detected object corresponding to the position detection sensor 80 is structured so that a particular combination pattern can
10 be output on each floor, which is a particular position. Therefore, when the safety controller 40 recognizes a particular combination pattern, it can recognize the floor.

If the shape of the to-be-detected object is
15 devised, it can also have a function of a limit switch that detects, for example, an overrun at an end floor, as described above.

As is clear from FIGs. 2 and 3, the to-be-detected units of the to-be-detected objects 81 to 83 in an
20 embodiment of the present invention are disposed so that when they are normal, two to-be-detected units are always detected at the same time by two (a plurality of) sensor units. This is used in the principle of abnormality detection by the safety controller, which
25 will be described below.

FIG. 4 outlines the structure of the safety controller according to an embodiment of the present invention and illustrates its connection to the position detection sensor. The safety controller 40 is structured with two microcomputers, each of which receives the outputs from the position detection sensor 80. The two microcomputers constitute a mutual abnormality diagnosis system that detects software errors and hardware errors through mutual comparison.

The safety controller 40 outputs, to the governing controller 30, a signal corresponding to the door openable zone, sensor failure detection signal, and a result signal indicating that a particular position has been reached. In addition, when the safety controller 40 by itself needs to stop the operation of the elevator, it supplies an output used to execute commands to turn off the power supply and operate the brake and also sends an output signal that notifies the governing controller 30 that processing to turn off the power supply and other processing has been executed.

FIG. 5 illustrates an elevator operation trace, which is used to explain operation according to an embodiment of the present invention. For example, the operation trace indicates a case in which one elevator departed from the second floor in an arbitrary time

zone, temporarily stopped at the third floor, and departed toward the fourth floor. By using this operation trace as an example, an abnormality detection operation according to an embodiment of the present invention will be described with reference to FIG. 6.

FIG. 6 illustrates changes of combination patterns of position detection sensor outputs, in the case in FIG. 5, which are used to explain operation according to an embodiment of the present invention.

Now, output pattern changes are considered with reference to FIGs. 3 and 5, assuming that the elevator car passed the second floor, stopped at the third floor, and then was raised toward the fourth floor, in which case output patterns from the position detection sensor were monitored once per 10 ms. Then, if normal, changes of output patterns from the position detection sensor, as illustrated in case 1 in FIG. 6, are obtained. That is, when no to-be-detected object is present, the output pattern of the position detection sensor is "0, 0, 0, 0". When the elevator car reaches a position at which a to-be-detected object is present, its two to-be-detected units are detected at the same time. When the elevator car moves apart from the position at which the to-be-detected object is present, the two to-be-detected units are not detected at the same time.

Case 1 in FIG. 6 indicates changes of output patterns from the position detection sensor according to the operation trace in FIG. 5 when the sensor output pattern at the time of arrival (a state in which the elevator is in a door openable zone) at the third floor is (1, 0, 0, 1) shown in FIG. 3 and the to-be-detected object has no attachment error. As illustrated in the drawing, the sensor output immediately before the elevator car arrives at the third floor is the first pattern (0, 0, 0, 0) from the beginning in case 1. Immediately after the elevator has arrived at the third floor, the sensor output becomes the second pattern (1, 0, 0, 1). After that, the sensor output remains at the fourth last pattern (1, 0, 0, 1) until immediately before the elevator leaves the third floor toward the fourth floor. Immediately after the elevator has left the third floor, the sensor output becomes the third last pattern (0, 0, 0, 0).

Cases 2 and 3 described next are cases that include attachment error. Case 2, for example, indicates a state in which there is slight error in sensing, in which two sensor units originally have to sense to-be-detected units at the same time, because attached to-be-detected units are inclined or their attachment position is deviated.

As illustrated in the drawing, assuming that a point in time when the elevator has arrived at the third floor is the current diagnosis cycle, the output pattern (0, 0, 0, 1) indicated by (a) at the second position from the beginning, which originally should not be present, appears after the output pattern (0, 0, 0, 0) before the last one, which is indicated at the first position. After that, the normal output (1, 0, 0, 1) indicated at the third position appears. Since the elevator moves toward the upper floor, however, the output pattern (1, 0, 0, 0) indicated by (b), which originally should not be present, appears when the elevator leaves the third floor.

Case 3 indicates a state in which the attachment state is extremely bad, that is, a state in which there is a large step between floors at the time of landing and thereby a passenger may fall down. Therefore, the sensor output before the last one, the last sensor output, and the current sensor output at time of arrival at the third floor are the same output pattern (0, 0, 0, 1) indicated by (c) at the second and third positions from the beginning, which is followed by a normal pattern (1, 0, 0, 1) indicated at the fourth position from the beginning. Since the elevator then moves toward the upper floor, an abnormal output

pattern (1, 0, 0, 0) indicated by (d) is similarly detected twice when the elevator leaves the third floor.

These abnormal output patterns (a) to (d) of the position detection sensor 80 can be used to know error in the arrangement of the to-be-detected units and an abnormality in the detection of the elevator car position, including a failure of the position detection sensor 80 itself. However, as in case 2, a slight deviation due to which the abnormal pattern (a) or (b) appears only in one diagnosis cycle (10 ms, for example) is assumed to be negligible as landing error of the elevator car. In this case, it is only necessary to detect a deviation due to which the abnormal pattern (c) or (d) appears over two diagnosis cycles (20 ms, for example) as in case 2. An embodiment in which an abnormality is detected on the basis of this concept will be described below.

FIG. 7 is a flowchart of processing executed by an elevator abnormality detection apparatus according to an embodiment of the present invention. It is assumed here that, as illustrated in FIGs. 2 and 3, the position detection sensor 80 includes four sensor units and the to-be-detected objects 81 to 83 include two or four to-be-detected units. FIG. 7 illustrates a flow of processing by the governing controller 30 in FIG. 1 in

a case in which a first allowable operation time, which indicates landing precision that eliminates the possibility that the passenger falls down, is up to one diagnosis cycle (10 ms, for example) as described above.

5 First, the current output of the position detection sensor is stored in a temporary storage area in step 701, after which the sequence proceeds to step 702 to decide whether there is a detection by at least one of the four sensor units. If there is a detection by at
10 least one sensor unit, the sequence proceeds step 703. If not, the sequence proceeds to steps 710 to 712 to decide the state of the position detection sensor and perform processing such as making preparation for next processing, after which the processing is terminated.

15 In step 703, whether a value stored in the temporary storage area matches a particular combination pattern is decided. If there is a match, the sequence proceeds to steps 713 and 723 in which whether the elevator car is already present in the door zone,
20 within which the door is openable, is decided, after which the sequence proceeds to step 704 or 705. If it is decided in step 703 that there is no match, the sequence proceeds to step 707. If there is a detection by the position detection sensor in the diagnosis cycle
25 before the last one and the last diagnosis cycle and

the last value stored in the position detection sensor storage area does not match a particular combination pattern, this means that an abnormality has been continuing over two diagnosis cycles (20 ms, for

5 example). Since there is a risk that landing error due to which the passenger may fall down is generated, it is therefore decided in step 708 that the position detection sensor has an abnormality including a deviation of a position at which a to-be-detected
10 object has been attached. Then, the breaking circuit 6 is activated to stop the elevator car and assure safety, after which the sequence proceeds to step 710.

In step 704, the last state of the position detection sensor is decided. If there is no detection,
15 the sequence proceeds to step 705 and it is decided that the position detection sensor is normal. This step indicates "sensor status without attachment position error" in case 1 in FIG. 6.

If there is a detection in step 704, the sequence
20 proceeds to step 706. If there is no detection by the position detection sensor in the diagnosis cycle before the last one, in which case the last detection is the detection in the first allowable operation time in case 2 in FIG. 6, so the sensor output is decided to be
25 normal and the sequence proceeds from step 709 to steps

710 to 712.

If there is a detection by the position detection sensor in the diagnosis cycle before the last one in step 706, it indicates that there is a deviation over
5 two diagnosis cycles, so there is a risk that landing error due to which the passenger may fall down is generated. As in step 707, therefore, the sequence proceeds to step 708 to activate the breaking circuit 6 to stop the elevator car and assure safety, after which
10 the sequence proceeds to steps 710 to 712.

In step 710, the state of the position detection sensor is output to the governing controller, and the governing controller then indicates the place of the abnormality. When, for example, the maintenance person
15 manipulates a maintenance switch to start a maintenance operation, it is possible to notify the maintenance person of an elevator hall at which a landing abnormality would occur by detecting the fact that the maintenance switch has been manipulated and then by,
20 for example, having a position detection device operate the destination button, in the elevator car, corresponding to the elevator hall for which an abnormality has been detected so that the lamp of the destination button blinks.

25 A series of processing described above is

cyclically activated by using a timer of the CPU in the safety controller, and carries out diagnosis. Therefore, even if a plurality of allowable operation times are set, the processing load is minimized and landing error can be easily detected at an early stage. If, for example, the processing in FIG. 7 is activated at 10-ms intervals, the last output of the position detection sensor indicates a pattern that was output 10 ms earlier and the output of the position detection sensor before the last one indicates a pattern that was output 20 ms earlier. Although depending on the operation speed of the elevator, error within one diagnosis cycle is often negligible as landing error.

FIG. 8 is a flowchart illustrating details in processing step 708 in FIG. 7.

First, it is decided in step 801 whether a position detection sensor abnormality, including an attachment position deviation of a to-be-detected object, has been detected. If no abnormality has been detected, the processing is terminated. If an abnormality has been detected, processing is carried out according to the open state of the door of the elevator in the flow from step 802 to step 804. In step 805, the door is closed and the elevator moves to a normal floor and automatically lands.

In step 806, after the door has been opened, the lighting in the elevator car is turned off and the lamp of the open button is turned on to guide the passengers to get off the elevator car, as preparation for steps
5 807 to 813.

Processing in steps 807 to 811 is to have the passengers being stuck in the elevator car get off on a normal floor, close the door, and then stop the operation of the elevator. If the door open button has
10 not been pressed in step 810, processing to stop the operation of the elevator is continued in step 812. The processing to stop the operation of the elevator is continued until maintenance by a maintenance person is detected in step 813 and the sequence is returned to
15 step 810 so that the passengers do not encounter a situation in which they are stuck in the elevator car.

As described above, the embodiment of the present invention enables detection of an abnormality of the elevator car position detection device with desired
20 precision; the abnormality would otherwise generate abnormal landing error, which is error between the surface of a floor and the floor surface on the elevator car side.

If an abnormality, of the elevator car position
25 detection device, that would otherwise generate

abnormal landing error is detected, the user is notified through an announcement that there is a step, so a risk such as falling can be prevented.

Furthermore, if an abnormality, of the elevator car position detection device, that would otherwise generate abnormal landing error is detected, the operation of the elevator can be automatically stopped and the operation can be resumed after inspection by a maintenance person, so safety operation of the elevator can be achieved.

Particularly, in the preferred embodiment of the present invention described above, if an abnormality is detected, the place of the abnormality can be indicated by an announcement or a buzzer without installing a special display unit to identify the location of the abnormality. Therefore, non-specialists such as, for example, the owner of the building can easily identify the floor with abnormal landing error at a glance.

Furthermore, in case of a disaster such as an earthquake, time taken for inspection can be shortened, so it can be expected that the unavailable time of the elevator is significantly reduced.

WHAT IS CLAIMED IS:

1. A controller for an elevator that has a position
detection sensor attached to an elevator car and to-be-
detected objects that are placed in a hoistway in
5 correspondence to, for example, stopping floors and are
detected by the position detection sensor, the position
of the elevator car being detected by an output signal
of the position detection sensor, wherein:

the position detection sensor is attached to the
10 elevator car so that the position detection sensor
passes positions opposite to the to-be-detected objects,
the position detection sensor having at least four
sensor units arranged side by side;

the to-be-detected objects are disposed at a
15 plurality of places in the hoistway, each of the to-be-
detected object having a plurality of to-be-detected
units that are detected at the same time by at least
two sensor units of the four sensor units arranged side
by side underneath the elevator car; and

20 an abnormality is detected in response to a
difference between output timings of the at least two
sensor units of the sensor units in the position
detection sensor.

2. The controller for an elevator according to
25 Claim 1, wherein in a case that the door of the

elevator is open when an abnormality is detected in response to the difference between the output timings of the at least two sensor units of the sensor units in the position detection sensor, an announcement
5 indicating that there is a step between floors is made.

3. The controller for an elevator according to Claim 1 or 2, wherein when the door is closed after an abnormality has been detected in response to the difference between the output timings of the sensor
10 units, a buzzer sounds.

4. The controller for an elevator according to any one of Claims 1 to 3, wherein landing error of the elevator is detected in response to a first difference among the output timings of the plurality of sensor
15 units and an operation of the elevator is stopped in response to a second difference among of the output timings of the plurality of sensor units, the second difference being larger than the first difference.

5. The controller for an elevator according to any
20 one of Claims 1 to 4, wherein an abnormality is detected by cyclically monitoring with timer interrupts the difference among the output timings of the plurality of sensor units in the position detection sensor.

25 6. The controller for an elevator according to

Claim 5, wherein a first difference among the output timings of the plurality of sensor units is detected within a first prescribed monitoring period, and when a second difference among the output timings of the sensor units, which is larger than the first difference, continues over a second monitoring cycle, which is longer than the first prescribed monitoring period, the operation of the elevator is stopped.

7. The controller for an elevator according to any one of Claims 1 to 6, wherein when an abnormality is detected in response to the difference between the output timings of the at least two sensor units in the position detection sensor, the elevator is operated so as to move toward another floor and the operation of the elevator is stopped at a floor where an abnormality is not detected in response to the difference between the output timings of the sensor units in the position detection sensor.

8. The controller for an elevator according to any one of Claims 1 to 7, wherein when an abnormality is detected in response to the difference between the output timings of the plurality of sensor units in the position detection sensor and an event that a prescribed switch has been manipulated is detected, a floor at which the abnormality has been detected is

indicated by a destination floor button, in the elevator car, that corresponds to the floor at which the abnormality has been detected.