

[Document Name] SPECIFICATION

[Title of Invention] ELECTRONICALLY CONTROLLED ELEVATOR

[Technical Field]

[0001]

5 The present invention relates to an electronically controlled elevator using electronically operated safety switches with higher functionality in place of safety devices installed inside a hoistway or elsewhere. In particular, the invention is suitable for an electronically controlled elevator that suffers no degradation of its serviceability, while enhanced safety of maintenance workers engaged in inspection is provided.

[Background Art]

[0002]

15 For conventional elevators, their safety system is comprised of mechanical safety switches and relay circuits. Outputs of the safety switches are received by the relay circuits (safety circuits) and, by breaking a relay circuit, shutting off a power supply and actuating a brake are performed. The mechanical safety switches are such as a switch that detects opening/closing of the door of a car, a switch that detects opening/closing of a landing door, a limit switch that detects an overrun of the car, a top clearance ensuring switch for ensuring a space for maintenance, a pit switch that makes sure
20 a maintenance person has entered a pit, and an access door switch
25

that makes sure of opening/closing of an access door for inspection.

[0003]

The safety of an elevator is ensured through periodical
5 inspection of the safety switches and relay circuits, which
is performed by maintenance workers. Periodical inspection
is performed generally after stopping the elevator in order
to ensure the safety of maintenance workers.

[0004]

10 It is also known that an arrangement is made to protect
a maintenance person who works inside the hoistway in safety,
in which the arrangement detects the presence of a maintenance
person in a given location inside the hoistway and, if detected,
disables response to a given call so as to restrain the car
15 from moving to a given floor associated with a location where
the detected person is present, which is described in, e.g.,
Patent Literature 1.

[0005]

It is further known that, if a person is present in a
20 dangerous space in the hoistway (at shaft bottom or shaft head)
or is going to enter such space, a protective zone is formed
at shaft bottom or shaft head by shortening the entire travel
path of the elevator car and setting a speed target curve, which
is described in, e.g., Patent Literature 2.

25 [Prior Art Documents]

[Patent Literature]

[0006]

[Patent Literature 1] Japanese Patent Laid open No.2006-44844

[Patent Literature 2] Japanese Translation of PCT International

5 Application Publication No. JP-T-2004-534707 (Figs. 5 and 6)

[Summary of Invention]

[Problem to be solved by the Invention]

[0007]

In the prior art arrangements noted above, the service
10 of the elevator is stopped during a maintenance operation, thus
resulting in service degradation with a transportation
efficiency of 0.

[0008]

Since the arrangement described in Patent Literature 1
15 disables response to a given call, degradation of serviceability
remains unchanged and, especially in a case where the travel
distance of the elevator is long and maintenance work takes
long time, as in a high-rise building, there would be a
significant decrease in the traveling efficiency of the
20 elevator.

[0009]

According to the description in Patent Literature 2, the
entire travel path of the elevator car is simply shortened enough
to provide a space at shaft bottom or shaft head. This produces
25 a good result for a case where maintenance is performed in a

space at the upper end or lower end of the shaft, but is not useful for maintenance at an intermediate floor. If maintenance is performed each at an intermediate floor of a high-rise building, there would be a significant decrease in the traveling efficiency of the elevator.

[0010]

For an elevator whose hoistway is long as in a high-rise building, if users who use the elevator only between certain floors increase, or are anticipated to increase, more efficient traveling of the elevator would become feasible by causing the elevator to service only a range of floors where a lot of people use the elevator. But, in a range of floors which are out of service of the elevator, it becomes difficult to ensure safety.

[0011]

An object of the present invention is to solve the problems of the prior art arrangements noted above and perform more efficient and safe elevator traveling even for a high-rise building in which the travel distance of the elevator is long. In particular, an object of the present invention is to ensure safety, especially, during inspection by maintenance workers and avoid service degradation of the elevator even during such inspection.

[Means for Solving the Problem]

[0012]

To solve the foregoing problems, the present invention

resides in an electronically controlled elevator whose car services a plurality of floors and equipped with a safety controller that gives a command to shut off a power supply or actuate a brake by an input from a safety switch installed inside
5 a hoistway. The electronically controlled elevator includes a position and speed detecting device that detects a position and speed of the car and a database for distance between floors having floor-to-floor distances stored therein and is implemented to set a scope of fallback to perform a fallback
10 operation across a series of floors with the exception of a particular floor; determine with respect to the scope of fallback a speed monitoring curve that defines a limiting speed as a function of the position of the car in the scope of fallback, based on the database for distance between floors; (and, if
15 the speed of the car has exceeded the limiting speed, carry out shutting off the power supply and actuating the brake by the safety controller).

[Advantageous Effect of Invention]

[0013]

20 According to the present invention, with respect to a scope of fallback, a speed monitoring curve is determined that defines a limiting speed as a function of the position of the car, based on the database for distance between floors. It is thus possible to enhance safety in a region out of service
25 of the elevator. In particular, it is possible to avoid service

degradation, while ensuring safety, even if maintenance work is performed at a particular floor.

[Brief Description of Drawings]

[0014]

5 Fig. 1 is an overall structural diagram representing an embodiment according to the present invention.

 Fig. 2 is a block diagram representing processes according to an embodiment.

 Fig. 3 is a graph representing a speed monitoring curve
10 (particular floor: 1st floor) according to an embodiment.

 Fig. 4 is a graph representing a speed monitoring curve (particular floor: 6th floor) according to an embodiment.

 Fig. 5 is a block diagram representing processes according to another embodiment.

15 Fig. 6 is an overall structural diagram representing another embodiment.

 Fig. 7 is a diagram representing a database for distance between floors according to an embodiment.

 Fig. 8 is a graph representing a relation between a speed
20 monitoring curve and a working zone according to an embodiment.

 Fig. 9 is a graph representing a relation between a speed monitoring curve and a working zone according to an embodiment.

[Mode for Carrying out the Invention]

[0015]

25 In the following, an embodiment will be described in detail

with reference to the drawings.

Fig. 1 is an overall structural diagram depicting an elevator system in which the movement of an elevator car 105 is controlled by an elevator controller 100. The car 105 moves inside a hoistway formed in a building from floor to floor to service a plurality of floors and it is connected through a rope to a weight which is called a counterweight for counterbalancing the car 105.

[0016]

The car 105 is provided with a car door that opens and closes in conjunction with a landing door. The movement of the car 105 takes place with a sheave 104 being driven by a motor 103. To the motor 103, electric power for driving is supplied by a power transducer 101. The power transducer 101 outputs electric power for controlling the motor according to a car position control command from an elevator controller 100. A pulse generator such as an encoder is installed on the motor 103. By counting pulses produced by rotation of the motor 103, the elevator controller 100 computes, the speed of the motor 13, a direction in which the car 105 moves in the hoistway, and the car position and travel distance.

[0017]

When braking the car 105, the elevator controller 100 outputs a stop command to a power supply for braking 2 and a power supply for motor power 3. The stop command causes the

power supply for braking 2 to actuate a brake 102 and the power supply for motor power 3 to shut off power supply to the power transducer 101, so that the car 105 is braked. The power supply for braking 2 and the power supply for motor power 3 are circuits
5 that are each configured including an electromagnetic contactor which is called a contactor.

[0018]

A safety controller 1 is a controller which is component of a safety system and brakes the car 105 by shutting of the
10 power supply for braking 2 and the power supply for motor power 3 independently of the elevator controller 100, according to output of safety device switches such as a top clearance ensuring switch 8 for ensuring a space for maintenance and a final limit switch 9 that detects an overrun of the car. The safety
15 controller 1 is a microprocessor assembly including, as a core, a CPU (Central Processing Unit) that executes processing, and, besides, a watchdog timer for detecting if the CPU goes out of order and a circuit that monitors if the power supply goes out of order. To detect a CPU processing error, dual CPUs are
20 used and their processing results are compared mutually.

[0019]

The safety controller 1 takes inputs from a fallback operation enabling means 4, a scope of fallback setting means 5, an operation mode setting means 6, a car position and speed
25 detecting device 7, etc.

[0020]

The operation mode setting means 6 sets one of operation modes such as normal operation, maintenance operation, rescue operation, and test operation.

5 [0021]

The position and speed detecting device 7 is a pulse generator that outputs a pulse according to a height position of the car 105 and is depicted as a governor pulley to which an encoder is installed, the governor pulley moving with the
10 car 105. Others are such as a type that detects a travel of the car by pressing a roller directly against guide rails and a type that detects it by magnetizing the rails; those capable of detecting an absolute or relative position of the car are preferable.

15 [0022]

The safety controller 1 produces an output to shut off the power supply for braking, an output to shut off the power supply for motor power, an output to enable fallback operation, and an output of a scope of fallback; besides, it produces an
20 output of an emergency stop provided on the car.

[0023]

Fig. 2 mainly depicts a block diagram of the safety controller 1. A fallback operation detecting process 20 detects that the fallback operation enabling means 4 has been
25 actuated with an input from it to the safety controller 1. An

operation mode detecting process 21 detects that an output for setting an operation mode by the operation mode setting means 6 of the elevator has been input. A scope of fallback detecting process 22 detects a scope of fallback which is input from the scope of fallback setting means 5. The scope of fallback setting means 5 sets a scope of fallback within which fallback operation is to be performed inside the hoistway.

[0024]

A safety device detecting process 23 detects if a safety switch has been actuated. A pulse input process 24 counts pulses output by the position and speed detecting device 7, based on CPU clock of the safety controller 1. A car position detecting process 25 calculates the current position of the car 105 by a displacement of the car 105 per pulse and the number of pulses counted. A car speed detecting process 26 detects the speed of the car 105 by the number of pulses detected per unit time.

[0025]

A fallback operation request process 27, when a fallback operation request has been generated by the combination of the fallback operation detecting process 20 and the operation mode detecting process 21, outputs a request for fallback operation to a scope of fallback setting process 28. A request for fallback operation is generated, if the operation mode is maintenance operation and fallback operation is commanded by the fallback operation enabling means 4.

[0026]

The scope of fallback setting process 28 takes an input from the scope of fallback detecting process 22 and, if a scope of fallback has been set that makes a series of floors serviceable with the exception of a particular floor (where maintenance is performed), determines in the scope of fallback a speed monitoring curve that defines a limiting speed as a function of the position of the car 105, based on a database for distance between floors 29. Because a particular floor can also be set arbitrarily, if the scope of fallback has changed, the speed monitoring curve will be rearranged accordingly. The database for distance between floors 29 stores data of floor-to-floor distances in table form, since the distances between floors individually differ depending on the structure of a building.

15 [0027]

In a speed monitoring curve, preferably, the limiting speed of the car 105 should become zero at a position that is at a certain distance from the particular floor; that is, the position is set so that at least a distance L that is required for a working zone for maintenance workers should be provided relative to the particular floor where maintenance work or the like should be performed. If maintenance work is performed at a particular floor, the distance L is determined to provide the working zone as much as the height of the landing door.

25 If maintenance work is performed at a pit or top portion, the

distance L is determined to provide the working zone as much as a height (e.g., 2 m) allowing a maintenance person to stand without hitting the head against a structural part. The working zone may be set with the addition of a margin in order to ensure
5 more safety.

[0028]

A region in which a constant limiting speed is monitored, which corresponds to a middle region of a scope of fallback, is determined with reference to a rated speed value; for example,
10 110% to 130%, preferably, 120% of a rated speed value.

[0029]

Moreover, a position at which deceleration starts is determined as an intersection of a gradient from a limiting speed zero point with the line of a constant limiting speed, in
15 which the gradient is defined based on a rated speed of the car, an average acceleration during an operating delay time from the detection of an abnormality until the brake 102 is actuated, and an average deceleration during braking of the brake 102 (it may be principally based on an average deceleration
20 during braking of the brake 102).

[0030]

A fallback operation decision process 30 decides whether or not a fallback operation can be performed, based on information as to whether a safety switch (safety device) is
25 actuated, which is obtained from the safety device detecting

process 23 as a prechecking process, information on the scope of fallback which has been set, and information on the current position and speed of the car. That is, if any of safety devices is placed in an actuated state, the decision process does not
5 permit the fallback operation. Also, the decision process decides whether the scope of fallback is appropriate as the setting for the fallback operation.

[0031]

If a safety device is placed in an actuated state, usually
10 the elevator needs to be stopped; the decision process does not permit the fallback operation when an operation phase to stop the elevator has already been entered. This prevents that an actuated safety device is disabled in a dangerous condition and the elevator restarts to move. Even during a fallback
15 operation, it can be checked if a safety device existing in the scope of fallback is actuated and, therefore, maintenance work can be carried out in a state when a fallback operation is performed.

[0032]

20 In Fig. 8, a process for deciding whether the scope of fallback is appropriate as the setting for the fallback operation is explained for a case in which maintenance is performed at a terminating floor. A line 40 is a speed monitoring curve and a limiting speed allowing the car to stop surely is plotted
25 as a function of position. A line 41 is a car travel pattern.

[0033]

A distance L denotes a distance from the bottom of the pit to a start position of a scope of fallback, which defines a working zone for maintenance workers. The distance L
5 corresponds to a distance for preventing a maintenance worker from being caught between the car and a structural part or hitting the head against it. As this distance, a value that is specified in building standards or EN81 standards is generally applied. A distance M denotes a distance from the bottom of the pit to
10 a termination portion of the scope of fallback which has been set. As presented in Fig. 8, for a case in which the distance M up to the termination portion of the scope of fallback which has been set cannot fulfill the distance L ($L > M$), the fallback operation decision process 30 does not perform the fallback
15 operation.

[0034]

Fig. 9 explains a process for deciding whether the scope of fallback is appropriate as the setting for the fallback operation for a case where maintenance is performed at an
20 intermediate floor. A region N presented in Fig. 9 denotes a working zone for maintenance workers to perform maintenance work safely at an intermediate floor. The width of the working zone N is set, for example, on the basis of the height of a door structure. To stop the elevator more safely, the working
25 zone N is set with the addition of a margin to its set dimensions.

If the termination portions of car speed monitoring curves 40A and 40B enter the working zone N, the fallback operation decision process 30 does not perform the fallback operation.

[0035]

5 As described above, the fallback operation decision process 30 checks in advance for the appropriateness of the scope of fallback that is set, so that the fallback operation can be performed safely.

[0036]

10 If having permitted the fallback operation, then, the fallback operation decision process 30 always decides if the fallback operation is executed in safe condition, based on the car speed monitoring curve set by the scope of fallback setting process 28 and depending on whether the current position and
15 speed of the car are not greater than a limiting speed; if no abnormality is observed, it outputs an output to enable the fallback operation and an output of the scope of fallback to the elevator controller. Upon receiving the output to enable the fallback operation and the output of the scope of fallback,
20 the elevator system controls the car to travel only within the scope of fallback. If abnormality has occurred during traveling (for example, if the current speed of the car has exceeded the limiting speed defined by the car speed monitoring curve), the decision process outputs an output to shut off the
25 power supply for braking and an output to shut off the power

supply for motor power to stop the elevator.

[0037]

A safety device disabling process 31 takes an input
pertinent to a safety device, obtained from the safety device
5 detecting process 23, and an input of a scope of fallback from
the scope of fallback setting process 28, disables a safety
device that lies within the scope of fallback, and outputs
information on the disabled safety device. For example, if
a bottom floor is set to fall within the scope of fallback a
10 control station to operate the elevator during a maintenance
operation and a final limit switch are disabled.

[0038]

A process for indicating disabled safety device and
operation 32 outputs information indicating what safety device
15 has been disabled and information that the safety device is
functionally disabled, but it is operative as hardware.
Thereby, in a case in which the scope of fallback has been set
to include a bottom floor and a final limit switch has been
disabled, a maintenance worker can inspect the final limit switch
20 and check its mechanical operation.

[0039]

Disabling the control station is required to avoid such
an event that the car 105 comes to an abrupt stop, as a maintenance
worker operates the control station during a fallback operation,
25 which impacts on passengers who use the car as usual.

[0040]

A safety device actuation handling process 33 receives information on safety devices disabled by the safety device disabling process 31 and, if a safety device not disabled is placed in an actuated state, outputs an output to shut off the power supply for braking and an output to shut off the power supply for motor power.

[0041]

Fig. 3 represents a car speed monitoring curve 40 and a car travel pattern 41 with speed on the ordinate and position on the abscissa. An explanation is provided about the scope of fallback setting process 28. Fig. 3 exemplifies a building with four floors in which a scope of fallback is set for the elevator to service a series of 2nd to 4th floors with the exception of a 1st floor. The car 105 is made to travel at changing speed as indicated by the car travel pattern 41.

[0042]

In a normal operation which is not a fallback operation, the car speed monitoring curve 40 is set as a car speed monitoring curve from and to termination portions, namely, a pit floor face and a ceiling. However, because the 1st floor is appointed as a particular floor that is out of service by the scope of fallback setting means 5, the car speed monitoring curve 40 is set again to override the car speed monitoring curve 40 in normal operation from a position that a top clearance for

maintenance workers can be ensured (the position corresponds to a distance L for preventing a maintenance worker from being caught between the car and a structural part or hitting the head against it) so that the car 105 can stop surely and safely, even when maintenance work is performed at the 1st floor.

[0043]

Consequently, as long as the car 105 runs within the scope of the speed monitoring curve 40 in Fig. 3, even when maintenance work is performed at the 1st floor, the car stops at a distance not affecting the maintenance work being performed at the 1st floor and, thus, the elevator can continue to service other floors, though it stops serving the 1st floor.

[0044]

Fig. 4 exemplifies a building with eight floors in which a scope of fallback is set for service continuation with the exception of a 6th floor. In the case of Fig. 4, a particular floor is an intermediate floor and a plurality of scopes of fallback can be set; however, a fallback operation is performed preferentially for a scope of fallback in which the car travels a longer distance in the hoistway. Thus, the scope of fallback setting process 28 outputs a speed monitoring curve 44 to the fallback operation decision process 30 and, in turn, the elevator controller 100, so that the car 105 will be made to travel within the scope of fallback in which the car travels a longer distance in the hoistway, namely, solely from a 1st floor to a 5th floor.

[0045]

A scope of fallback in which floors have a larger traffic flow may be determined as the one in which a fallback operation is performed first, not giving priority to a scope of fallback in which the car travels a longer distance in the hoistway. That is, in Fig. 4, if upper 7th and 8th floors have a larger traffic flow, as compared with 1st to 5th floors in a region below the 6th floor, the car will travel within a scope of fallback across the 7th and 8th floors.

10 [0046]

Fig. 5 depicts a block diagram in which a traffic flow database 34 has been added. The traffic flow database is a database of statistics counting the number of persons getting in the car and the number of persons exiting the car at each floor on a per time zone basis. As such database, an OD matrix (Origin-Destination matrix) is known. The traffic flow database may be any other one that makes it possible to understand or estimate a traffic flow.

[0047]

20 For an elevator whose hoistway is long, if users who use the elevator only between certain floors increase, or are anticipated to increase, e.g., at lunch time in a high-rise building and for a large group meeting held there, a scope of fallback across the floors where a lot of people use the elevator would be set by using the traffic flow database 34. In this

25

way, more efficient traveling of the elevator would become feasible, while safety is ensured in a region out of service of the elevator.

[0048]

5 The scope of fallback setting means 5 may be an assembly of switches corresponding to all floors. If it is desirable to specify a scope of fallback more elaborately, the safety controller may be connected to an external terminal such as a personal computer and a more granular scope of fallback may
10 be specified via the external terminal.

[0049]

Fig. 6 is an overall structural diagram depicting an elevator system in which an indication means at landing hall 10 at each landing hall and an indication means for maintenance
15 persons 11 are connected to the safety controller 1. During a fallback operation, floors that are serviced by the elevator are limited differently from a normal operation. Therefore, if a fallback operation is not indicated to users, there is a possibility that users may wait long or maintenance workers
20 may be unaware of the fallback operation and mistake their work. To prevent this, a notice that a fallback operation is performed and floors to be serviced in the fallback operation are indicated by the indication means at landing hall 10 and the indication means for maintenance persons 11 or a display device inside
25 the car. These indication means may preferably be implemented

as such devices as, e.g., a liquid crystal monitor, LED, and announcement through a loudspeaker. Thereby, it is possible to advise users that the elevator can be used, but its service is degraded to some extent.

5 [List of Reference Numerals]

[0050]

1 Safety controller

2 Power supply for breaking

4 Fallback operation enabling means

10 5 Scope of fallback setting means

6 Operation mode setting means

7 Position and speed detecting device

8 Safety switch (Top clearance ensuring switch)

9 Safety switch (Final limit switch)

15 29 Database for distance between floors

40, 44, 46 Speed monitoring curve

105 Car

[Document Name] Scope of Claims

[Claim 1]

An electronically controlled elevator whose car services a plurality of floors and equipped with a safety controller
5 that gives a command to shut off a power supply or actuate a brake by an input from a safety switch installed inside a hoistway,

the electronically controlled elevator comprising:

a position and speed detecting device that detects a
10 position and speed of the car; and

a database for distance between floors having floor-to-floor distances stored therein,

wherein the elevator is implemented to set a scope of fallback to perform a fallback operation across a series of
15 floors with the exception of a particular floor; determine with respect to the scope of fallback a speed monitoring curve that defines a limiting speed as a function of the position of the car in the scope of fallback, based on the database for distance between floors; and, if the speed of the car has exceeded the
20 limiting speed, carry out shutting off the power supply and actuating the brake by the safety controller.

[Claim 2]

The electronically controlled elevator according to claim 1, wherein the speed monitoring curve defines the limiting speed
25 that should become zero at a position that is at a certain distance

from the particular floor.

[Claim 3]

The electronically controlled elevator according to claim 1, wherein the speed monitoring curve should be constant at 110 to 130% of a rated speed of the car in a middle region of the scope of fallback and the limiting speed should become zero at a position that is at a certain distance from the particular floor, based on an average deceleration during braking of the brake.

10 [Claim 4]

The electronically controlled elevator according to any one of claims 1 to 3, wherein, if the particular floor is an intermediate floor and a plurality of scopes of fallback can be set, a fallback operation is performed preferentially in a scope in which the car travels a longer distance in the hoistway.

[Claim 5]

The electronically controlled elevator according to any one of claims 1 to 3, wherein, if the particular floor is an intermediate floor and a plurality of scopes of fallback can be set, a fallback operation is performed in a scope in which floors have a larger traffic flow.

[Claim 6]

The electronically controlled elevator according to any one of claims 1 to 3, wherein the elevator further comprises a traffic flow database as a database of statistics counting

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the number of persons getting in the car and the number of persons exiting the car at each floor and is implemented to set the scope of fallback based on the traffic flow database.

[Claim 7]

5 The electronically controlled elevator according to any one of claims 1 to 3, wherein the elevator is implemented to decide whether a fallback operation can be performed, based on information as to whether the safety switch is actuated, information on the scope of fallback, and information on the
10 current car position and speed.

[Claim 8]

 The electronically controlled elevator according to any one of claims 1 to 3, wherein the elevator is implemented to, when the fallback operation is to be performed, indicate a notice
15 that a fallback operation is performed and floors to be serviced in the fallback operation.