

CONTROL DEVICE OF ELEVATOR

The present invention relates to detection of the position of a to-be-rescued elevator car and, more particularly, to a control device of an elevator which is suitable for detection of the position of a to-be-rescued elevator car.

Japanese Patent Application Laid-Open Nos. 49-44448 and 57-170369 describe a control device of an elevator which detects the position of the elevator car of another elevator as follows. An electric motor rotates in accordance with the operation of a main motor for driving the elevator car and is directly connected to a pulse generator. The pulse generator generates pulse signals in accordance with the number of rotations of the electric motor. A counter counts the pulse signals from the pulse generator. The data from the counter is stored in a control device. If an elevator is designated as a rescue elevator when another elevator is damaged, the control device of the rescue elevator takes in the data stored in the control device of the damaged elevator and calculates the difference between the stored data about the positions of its own elevator car and the to-be-rescued

elevator car, i.e., the elevator car of the damaged elevator.

The control device of the rescue elevator controls the speed of its own elevator car so that the elevator car will reach the vicinity of the to-be-rescued elevator car. The pulse generator and the counter are connected to an uninterruptible power supply, so that the positions of the elevator cars can be monitored even during a power interruption.

Further, Japanese Patent Application Laid-Open No. 2-105016 describes means for sending detection signals of the position of the elevator car generated by a plurality of absolute encoders to a control unit only when the control unit sends out a gating signal to open the line driver of the absolute encoders.

The known control device of an elevator must be provided with a rotary encoder, a pulse counting memory and an uninterruptible power supply in order to continue monitoring the position of the elevator car. Detection of the position of the elevator car must be continued even during a power interruption because an elevator car is likely to move even during a power interruption due to its own inertia or weight, for example, when a power cut occurs while the elevator car is moving up or down, or when a power cut occurs while the door of the elevator car is open and then passengers get in or out during the power cut. However, an uninterruptible power supply requires maintenance, and the costs of such maintenance as well as the costs of the equipment and

installation of such a power supply are significantly high.

Further, if a passenger gets in or out when the door of an elevator car is open, the elevator car moves vibratantly up and down. An amplitude of the vibrating movements, which is added to position data when the elevator car moves up and which is subtracted from the position data when the elevator car moves down, is difficult to determine, resulting in errors in detection of the position of the elevator car. Therefore, the known elevator control devices cannot be used in elevators having functions to correct even very small landing errors.

Still further, the method in which a line driver is controlled by using gating signals has a problem in noise resistance. More specifically, noises are likely to occur between the absolute encoder and the control unit, thus causing malfunction.

Accordingly, the present invention seeks to provide a control device of an elevator which unfailingly detects the position of a to-be-rescued elevator car by a simple method even after a power interruption.

According to a first aspect of the present invention there is provided a control device for an elevator comprising:

absolute value type rotary encoders for

outputting absolute values of rotational angles thereof indicating positions of the corresponding elevator cars of elevators built side by side, the positions being along the corresponding axes of the
5 substantially vertical movements thereof;

position detecting means for comparing absolute values of rotational angles currently outputted by said absolute value type rotary encoders with the absolute values of the rotational angles
10 corresponding to the base positions of said elevator cars, respectively, and outputting elevator car position signals corresponding to said elevator cars; and

means for generating speed command signals for
15 receiving elevator car position signals from said position detecting means, and calculating the distance between one elevator car and another elevator car on the basis of the elevator car position signals, respectively, wherein one of said
20 means for generating speed command signals is arranged to control the speed of the one elevator car in accordance with the distance of said another elevator car with respect to the position of the one elevator car when there is a need for said one
25 elevator car to move to come to the rescue of said another elevator car.

According to a second aspect of the present invention there is provided a control device for an

elevator comprising:

- absolute value type rotary encoders for rotating in accordance with the substantially vertical movements of the corresponding elevator cars of elevators built side by side and digitally outputting absolute values of rotational angles thereof indicating positions of the corresponding elevator cars along the corresponding axes of the substantially vertical movements thereof;
- 10 position detecting means for receiving the absolute values of the rotational angles outputted by said absolute value type rotary encoders when base position signals are outputted by the base position detectors provided on base positions,
- 15 respectively, and for comparing absolute values of the rotational angles currently outputted by said absolute value type rotary encoders with the absolute values of the rotational angles corresponding to the base positions of said elevator cars, respectively, and outputting elevator car position signals corresponding to said elevator cars, said position detecting means being interconnected by a connecting line; and
- 20 means for generating speed command signal for receiving elevator car position signals from said position detecting means, and calculating the distance between one elevator car and another elevator car on the basis of the elevator car
- 25

position signals, respectively, wherein one of said means for generating speed command signals is arranged to control the speed of the one elevator car in accordance with the distance of said other
5 elevator car with respect to the position of said one elevator car when there is a need to said one elevator car to move to come to the rescue of said another elevator car.

According to a third aspect of the present
10 invention there is provided a control device for an elevator comprising:

absolute value type rotary encoders for rotating in accordance with the substantially vertical movements of the corresponding elevator
15 cars of elevators built side by side and digitally outputting absolute values of rotational angles thereof indicating positions of the corresponding elevator cars along the corresponding axes of the substantially vertical movements thereof;

20 position detecting means for receiving the absolute values of the rotational angles outputted by said absolute value type rotary encoders when base position signals are outputted by base position detectors provided on base positions,
25 respectively, and for comparing absolute values of the rotational angles currently outputted by said absolute value type rotary encoders with the absolute values of the rotational angles

corresponding to the base positions of said elevator cars, respectively, and outputting elevator car position signals corresponding to said elevator cars, said position detecting means being

5 interconnected by a connecting line;

means for generating speed command signals for receiving elevator car position signals from said position detecting means, and calculating the distance between one elevator car and another
10 elevator car on the basis of the elevator car position signals, respectively, wherein one of said means for generating speed command signals is arranged to control the speed of the one elevator car in accordance with the distance of said another
15 elevator car with respect to the position of said one elevator car when there is a need for said one elevator car to move to come to the rescue of said another elevator car; and

microcomputers for storing the absolute values
20 of rotational angles outputted by said absolute value type rotary encoders when the corresponding elevator cars are at the base positions, each of said microcomputers being connected to said position detecting means so as to read current absolute
25 values of rotational angles of said absolute value type rotary encoders and detect the positions of said elevator cars on the basis of differences between the current absolute values of rotational angles and

said absolute values of rotational angles at the base positions.

The position detecting means may be connected to a microcomputer which is supported by a battery
5 having a capacity required to ensure that the microcomputer will store and retain the absolute values outputted by the absolute value type rotary encoders corresponding to the base positions during a power interruption.

10 Alternatively, the position detecting means may be connected to a microcomputer which is supported by a capacitor having a capacity required to ensure that the microcomputer will store and retain the absolute values outputted by the absolute value type
15 rotary encoders corresponding to the base positions during a power interruption.

Further, the position detecting means may be connected to a microcomputer which is supported by a battery and a capacitor each having a capacity
20 required to ensure that the microcomputer will store and retain the absolute values outputted by the absolute value type rotary encoders corresponding to the base positions during a power interruption.

According to any one of the above-described
25 aspects of the present invention, the position detecting means may comprise:

receivers connected to the corresponding absolute value type rotary encoders;

a selector for selecting a serial signal outputted by at least one absolute value type rotary encoder other than the absolute value type rotary encoder;

5 serial/parallel inverters for receiving serial signals from the absolute value type rotary encoder through the corresponding receiver and serial signals selected by the selector, respectively; and

latch circuits for retaining parallel signals
10 outputted by the serial/parallel inverters, respectively, the latch circuits being connected to a microcomputer, the position detecting circuit having substantially the same circuit structure as the position detecting circuit.

15 Alternatively, the position detecting means may comprise:

a receiver connected to the absolute value type rotary encoders;

a selector for selecting a serial signal
20 outputted by the receiver;

a serial/parallel inverter for receiving serial signals selected by the selector; and

latch circuits for retaining parallel signals
outputted by the serial/parallel inverter, the latch
25 circuits being connected to a microcomputer, the position detecting circuit having substantially the same circuit structure as the position detecting circuit.

Further, the base position detectors may be provided at the lowest floors.

A further aspect of the present invention provides an elevator having any one of the control
5 devices described above.

By way of the present invention, because the control device can detect the position of a to-be-rescued elevator car by calculation on the basis of the value currently outputted by the corresponding
10 absolute value type rotary encoder and a stored value corresponding to the base position, the batteries for supporting the microcomputers during a power interruption do not need to have large capacities, and the circuit structure of the
15 position detecting circuits can be simplified.

Further, the position detecting circuit associate with a rescue elevator can detect the position of a to-be-rescued elevator even during a power interruption.

20 *Embodiments of the invention will now be described in detail, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a diagram of a control device according to an embodiment of the present invention.

Fig. 2 is a flowchart of position detection performed by a rescue elevator.

Fig. 3 is a diagram of a position detector according to the embodiment of the present invention shown in Fig. 1.

Fig. 4 is a diagram of a position detector according to another embodiment of the present invention.

A preferred embodiment of the present invention will be described hereinafter, with reference to Figs. 1 to 3.

Referring to Fig. 1, power inverters 5A, 5B adjust power supply to main electric motor 4A, 4B for driving sheaves 3A, 3B, respectively. From each of the sheaves 3A, 3B, a rope is suspended which is connected at one end thereof to an elevator car 1A or 1B and at the other end to a counter weight. Each elevator car is connected to both ends of another rope 20A or 20B, which thus substantially forms an endless loop. The loops of the ropes 20A, 20B are supported with tension by upper pulleys 6A, 6B and lower pulleys 7A, 7B, respectively. The ropes 20A, 20B cause absolute value

type rotary encoders 8A, 8B to rotate in accordance with displacements of the elevator cars 1A, 1B, respectively.

Position detecting circuits 9A, 9B are interconnected by a connecting line 21. The position detecting circuits 9A, 9B receive digital outputs indicating absolute values of rotational angles of the absolute value type rotary encoders 8A, 8B and base position signals indicating the base positions of the elevator cars 1A, 1B detected by base position detectors 12A, 12B, respectively. Then, the position detecting circuits 9A, 9B output elevator car position signals. Speed command circuits 10A, 10B calculate the positions of the elevator cars 1A, 1B on the basis of the elevator car position signals and, then, output speed commands which designate the speeds of the elevator cars. Speed control circuits 11A, 11B receive the speed commands and accordingly control the power inverters 5A, 5B, respectively. Each of the absolute value type rotary encoders 8A, 8B counts the absolute value of a rotational angle and the number of rotations thereof by, e.g., reading as individual signals individual light beams transmitted through many holes which are radially arranged in a disc. Each of the absolute value type rotary encoders 8A, 8B has its own battery and, thereby, can retain absolute angle positional information even during a power interruption. However, because the capacity of each battery is too small for the absolute value type rotary encoder to output absolute

angle positional data, the absolute value type rotary encoder of each elevator is connected to the current source of the other elevator.

It will be now assumed that the elevator car 1A of a first elevator is a rescue elevator car and the elevator car 1B of a second elevator is a to-be-rescued elevator car. The position detecting circuit 9A of the first elevator has inputted not only the output value of the absolute value type rotary encoder of the first elevator shown in Fig. 1 and the base position signal outputted by the base position detector 12A but also the output value of the absolute value type rotary encoder 8B of the second elevator and the base position signal outputted by the base position detector 12B of the second elevator through the position detecting circuit 9B of the second elevator. The position detecting circuit 9A reads the current output value of the absolute value type rotary encoder 8B of the second elevator, through the position detecting circuit 9B, and outputs the position signal concerning the position of the elevator car 1B of the damaged, second elevator. Based on the position signal, the speed command circuit 10A calculates the position of the elevator car 1B. The elevator car 1A of the first elevator is operated to approach the elevator car 1B of the second elevator while the speed of the elevator car 1A of the first elevator is controlled by the speed control circuit 11A in accordance with the position of the elevator car 1B.

Thus, the rescue operation does not require any specific means but instead requires only ordinary means, such as the absolute value type rotary encoders or the position detecting circuits, which are used for the normal operation. Even an operation for coinciding the floor surface of a rescue elevator car with the floor surface of a to-be-rescued elevator car can be performed by these ordinary means. Therefore, costs of a control device of an elevator can be significantly reduced.

Fig. 2 is a flowchart of the operation of an elevator (the first elevator) for detecting the position of the elevator car of another (the second) elevator. The first elevator constantly monitors the actions of the base position detectors which output base position signals of the first and second elevators. The control unit of the first elevator stores, as position data, elevator car position signals of the second elevator when the first and second elevator cars are stopped at the base positions or given floors. The base position detectors generate base position signals when the corresponding elevator cars are at their base positions. According to the present invention, the base position detector is provided at, for example, the lowest floor, that is, the ground floor in this embodiment. When the position detecting circuit receives a base position signal, the output value of the absolute value type rotary encoder is read by the position detecting circuit and stored in a memory of a

microcomputer which is supported by a battery and a capacitor.

Because the elevator control device of this embodiment employs absolute value type rotary encoders which mechanically detect absolute values of rotational angles, the control device can detect the positions of elevator cars even during a power interruption without requiring generation, detection or counting of pulses specific for position detection during a power interruption, or even addition or subtraction of the count values specific for position detection during a power interruption. Further, the microcomputer calculates the positions of elevator cars only when the calculation is necessary. When necessary, the position detecting circuit reads a current output value of an absolute value type rotary encoder, and the microcomputer calculates a difference between the current output value and the stored position data. Therefore, the microcomputer does not require a large throughput. Still further, because the microcomputer only has to store the output values of the absolute value type rotary encoders at the base positions during a power interruption, the capacities of the battery and capacitor to support the microcomputer do not need to be large.

Fig. 3 illustrates a position detecting circuit according to an embodiment of the present invention. Serial signals from the absolute value type rotary encoder 8A are

inputted through a receiver 13A to a serial/parallel inverter 15A. Parallel position signals are retained by a latch circuit 16A and then transmitted therefrom to a microcomputer 18A. As shown in Fig. 3, the position detecting circuit 9A of an elevator has two systems each comprising a receiver 13A, a serial/parallel inverter 15A and a latch circuit 16A corresponding to either its own elevator car or another elevator car. The outputs of the absolute value type rotary encoders of its own and another elevator are processed by the corresponding systems and the obtained position data of its own elevator car and the other elevator car are separately stored in the memory of the microcomputer 18A. If there are two elevators other than itself, a selector 14A selects the serial signals from either one of the two elevators. This selection by the selector 14A is controlled by the microcomputer 18A using a decoder 17A. The microcomputer 18A also controls the selection between the two latch circuits 16A by using the decoder 17A. The current sources provided respectively for each elevator are connected to the absolute value type rotary encoders of other elevators, as well. In this embodiment, connections are made so that, for example, the current source of the elevator car 1A can supply power to all the absolute value type rotary encoders whose output values are read for position detection by the position detecting circuit 9A. Therefore, the position detecting circuit of an elevator can provide the position data of the

elevator car of any other elevator, as well as the position data of its own elevator car, any time when the microcomputer 18A requests so.

Fig. 4 illustrates a position detecting circuit according to another embodiment. The position detecting circuit of this embodiment has one system comprising a receiver 13a, a selector 14A, a serial/parallel inverter 15A and latch circuits 16A, whereas the position detecting circuit shown in Fig. 3 has two of such systems for respectively processing the position data of its own elevator car and the other elevator cars. In the position detecting circuit 9A as shown in Fig. 4, the selector 14A selects the serial signals outputted by one absolute value type rotary encoder from the serial signals outputted by all the absolute value type rotary encoders. The position detecting circuits are thus simplified.

CLAIMS

1. A control device for an elevator comprising:
absolute value type rotary encoders (8A,8B) for
outputting absolute values of rotational angles
5 thereof indicating positions of the corresponding
elevator cars (1A,1B) of elevators built side by
side, the positions being along the corresponding
axes of the substantially vertical movements
thereof;
- 10 position detecting means (9A,9B) for comparing
absolute values of rotational angles currently
outputted by said absolute value type rotary
encoders (8A,8B) with the absolute values of the
rotational angles corresponding to the base
15 positions of said elevator cars (1A,1B),
respectively, and outputting elevator car position
signals corresponding to said elevator cars (1A,1B);
and
means for generating speed command signals
20 (10A,10B) for receiving elevator car position
signals from said position detecting means (9A,9B),
and calculating the distance between one elevator
car (1A) and another elevator car (1B) on the basis
of the elevator car position signals, respectively,
25 wherein one (10A) of said means for generating speed
command signals (10A,10B) is arranged to control the
speed of the one elevator car (1A) in accordance
with the distance of said another elevator car (1B)



with respect to the position of the one elevator car (1A) when there is a need for said one elevator car (1A) to move to come to the rescue of said another elevator car (1B).

5 2. A control device for an elevator comprising:

absolute value type rotary encoders (8A,8B) for rotating in accordance with the substantially vertical movements of the corresponding elevator cars (1A,1B) of elevators built side by side and
10 digitally outputting absolute values of rotational angles thereof indicating positions of the corresponding elevator cars (1A,1B) along the corresponding axes of the substantially vertical movements thereof;

15 position detecting means (9A,9B) for receiving the absolute values of the rotational angles outputted by said absolute value type rotary encoders (8A,8B) when base position signals are outputted by the base position detectors (12A,12B)
20 provided on base positions, respectively, and for comparing absolute values of the rotational angles currently outputted by said absolute value type rotary encoders with the absolute values of the rotational angles corresponding to the base
25 positions of said elevator cars, respectively, and outputting elevator car position signals corresponding to said elevator cars (1A,1B), said position detecting means (9A,9B) being



interconnected by a connecting line (21); and

means for generating speed command signals (10A,10B) for receiving elevator car position signals from said position detecting means (9A,9B),
5 and calculating the distance between one elevator car (1A) and another elevator car (1B) on the basis of the elevator car position signals, respectively, wherein one (10A) of said means for generating speed command signals is arranged to control the speed of
10 the one elevator car (1A) in accordance with the distance of said other elevator car (1B) with respect to the position of said one elevator car (1A) when there is a need to said one elevator car (1A) to move to come to the rescue of said another
15 elevator car (1B).

3. A control device according to claim 1, wherein:

the absolute value type rotary encoders (8A,8B) are arranged for rotating in accordance with the substantially vertical movements of the elevator
20 cars (1A,1B) and digitally outputting absolute values of rotational angles thereof indicating positions of the elevator cars (1A,1B) along the corresponding axes of the substantially vertical movements thereof, each of said absolute value type
25 rotary encoders being connected to all the current sources of said elevators;

the position detecting means (9A,9B) is arranged to receive the absolute values of the



rotational angles outputted by said absolute value type rotary encoders (8A,8B) when base position signals are outputted by base position detectors (12A,12B) provided on base positions, respective,
5 and outputting elevator car position signals corresponding to said elevator cars (1A,1B), said position detecting means (9A,9B) being interconnected by a connecting line (21).

4. A control device according to claim 3, wherein
10 each of said position detecting means (9A,9B) is connected to a microcomputer which is supported by a battery having a capacity required to ensure that said microcomputer will store and retain the absolute values outputted by said absolute value
15 type rotary encoders (8A,8B) corresponding to the base positions during a power interruption.

5. A control device according to claim 3, wherein each of said position detecting means (9A,9B) is connected to a microcomputer which is supported by a
20 capacitor having a capacity required to ensure that said microcomputer will store and retain the absolute values outputted by said absolute value type rotary encoders (8A,8B) corresponding to the base positions during a power interruption.

25 6. A control device according to claim 3, wherein each of said position detecting means (9A,9B) is connected to a microcomputer which is supported by a battery and a capacitor each having a capacity



required to ensure that said microcomputer will store and retain the absolute values outputted by said absolute value type rotary encoders (8A,8B) corresponding to the base positions during a power interruption.

7. A control device for an elevator comprising:
absolute value type rotary encoders (8A,8B) for rotating in accordance with the substantially vertical movements of the corresponding elevator cars (1A,1B) of elevators built side by side and digitally outputting absolute values of rotational angles thereof indicating positions of the corresponding elevator cars (1A,1B) along the corresponding axes of the substantially vertical movements thereof;

position detecting means (9A,9B) for receiving the absolute values of the rotational angles outputted by said absolute value type rotary encoders (8A,8B) when base position signals are outputted by base position detectors (12A,12B) provided on base positions, respectively, and for comparing absolute values of the rotational angles currently outputted by said absolute value type rotary encoders with the absolute values of the rotational angles corresponding to the base positions of said elevator cars, respectively, and outputting elevator car position signals corresponding to said elevator cars (1A,1B), said



position detecting means (9A,9B) being interconnected by a connecting line (21);

means for generating speed command signals (10A,10B) for receiving elevator car position signals from said position detecting means (9A,9B), and calculating the distance between one elevator car (1A) and another elevator car (1B) on the basis of the elevator car position signals, respectively, wherein one (10A) of said means for generating speed command signals (10A,10B) is arranged to control the speed of the one elevator car (1A) in accordance with the distance of the said another elevator car (1B) with respect to the position of said one elevator car (1A) when there is a need for said one elevator car (1A) to move to come to the rescue of said another elevator car (1B); and

microcomputers (18A,18B) for storing the absolute values of rotational angles outputted by said absolute value type rotary encoders (8A,8B) when the corresponding elevator cars (1A,1B) are at the base positions, each of said microcomputers (18A,18B) being connected to said position detecting means (9A,9B) so as to read current absolute values of rotational angles of said absolute value type rotary encoders (8A,8B) and detect the positions of said elevator cars (1A,1B) on the basis of differences between the current absolute values of rotational angles and said absolute values of



rotational angles at the base positions.

8. A control device according to any one of claims 1 to 7, wherein the position detecting means (9A) comprises:

5 receivers (13A,13B) connected to the corresponding absolute value type rotary encoders (8A,8B);

a selector (14A) for selecting a serial signal outputted by at least one absolute value type rotary encoder (8B) other than said absolute value type rotary encoder (8A);

10 serial/parallel inverters (15A,15B) for receiving serial signals from said absolute value type rotary encoder (8A) through the corresponding receiver (13A) and serial signals selected by said selector (14A), respectively; and

latch circuits (16A,16B) for retaining parallel signals outputted by said serial/parallel inverters (15A,15B), respectively, said latch circuits (16A,16B) being connected to a microcomputer (18A);

20 and wherein said position detecting means (9B) has substantially the same circuit structure as said position detecting means (9A).

9. A control device according to any one of claims 1 to 7, wherein the position detecting means (9A) comprises:

25 a receiver (13A) connected to said absolute value type rotary encoders (8A,8B);



a selector (14A) for selecting a serial signal outputted by said receiver (13A);

a serial/parallel inverter (15A) for receiving serial signals selecting by said selector (14A); and

5 latch circuits (16A,16B) for retaining parallel signals outputted by said serial/parallel inverter (15A), said latch circuits (16A,16B) being connected to a microcomputer (18A);

and wherein said position detecting means (9B) 10 has substantially the same circuit structure as said position detecting means (9A).

10. A control device according to any one of claims 1 to 9, wherein said base position detectors (12A,12B) are provided at the lowest floors.

15 11. A control device for an elevator substantially as herein described with reference to and as illustrated in Figs 1 to 3 or Fig 4 of the accompanying drawings.

12. An elevator having a control device as defined 20 in any of claims 1 to 11.

